The Effect of Mathematical Thinking Ability With Alberta Inquiry Learning Models Towards Discrete Mathematics Learning Outcomes

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Abstract: Mathematical thinking is a mathematical process, which includes five aspects; mathematical understanding, mathematical communication, mathematical connections, mathematical reasoning and mathematical problem solving. Discrete Mathematics is one of the subjects that can develop students' thinking skills. One of the lessons that can be applied to improve students' mathematical thinking skills is the Alberta Inquiry learning model. This research aims to discover the effect of mathematical thinking capabilities with the learning model of Alberta Inquiry towards the learning achievement of Discrete Mathematics Study Program FKIP of Universitas Riau in the even semester of 2017/2018 academic year. The form of this research is a quasi-experimental research. The experiment design used in this research is the Single Group Pretest /Posttest design Without Control Group. The sample of this research is students of the 6th semester Mathematics Study Program of Class A in the even semester of 2017/2018 academic year consisting 31 peoples.Based on the considerations of the researchers taken class A as the sample in this research with the reason that students in class A first took Discrete Mathematics courses in the even semester of 2017/2018 academic year. The result of the normality test of pretestand postest showed that the pretest data werenot normally distributed (sig = 0,004 < α = 0,05) and the postest data was normally distributed (sig = 0,200 > α = 0,05). The results of two similarity test average obtained sig = 0,00< α = 0,05 means postest value is better than pretest. The results of testing the determination index coefficient obtained the value of r^2_{xy} = 0,52with K_p = 52%. In other words itcan be concluded that there is an effect of mathematical thinking ability with Alberta Inquiry learning models towards Discrete mathematics learning outcomes is 52%.

Keywords: Alberta Inquiry Model, Thinking Ability, Learning Outcomes

1. Introduction

A person who studies mathematics is expected to develop into an individual who is able to think critically and creatively to ensure that he is on the right track in solving the mathematical problems faced or the mathematical material being studied, as well as guaranteeing the truth of the thinking that goes on. By always being a critical individual in learning mathematics, someone will be triggered to be creative, because to get clarity or distinguish between right and wrong so that he will try to find solutions with various alternatives. (Schneider, 1999) (inSahbandar, 2009).

Thinking mathematically is a mathematical process, that covers five aspects; mathematical understanding, mathematical communication, mathematical connections, mathematical reasoning and mathematical problem solving. According toPriatna (2003), the lack of reasoning ability towards the basic principle of mathematics is causing the students to create mistakes in solving mathematica problems. Because of that, without increasing and utilizing qualified mathematical learning that demands students to think, it will be difficult to reach the proper thinking ability that can bring out good mathematical learning outcomes.

Developing absolute thinking ability is needed in mathematics class where the subject has a characteristic as a branch of science which the object of study is abstract and related with a pattern of thinking. According to Sumarmo (2004) mathematics should be focused more as an education to enhance student' potentials such as problem solving, creativity, working habit and independence, honesty, discipline, having a good social attitude, as well as good public relationship that need to be developed.

One of the subjects in the MathematicsEducation Study Program that is hope to be able develop students' thinking ability is Discrete Mathematics. It is a compulsory subject for students of Mathematics Study Program. In this subject, students are faced with thinking abilities of constructing and understanding concepts and principles outside of doing calculation. This course requires a high level of abstraction. According to Hudoyo (1990) mathematics is abstract ideas, with hierarchical symbols and deductive reasoning so that learning mathematics is a high mental activity.

But the fact that researchers faced in teaching Discrete Mathematics courses, most students memorized the completion of the existing sample questions, so that if the problem was changed the students could not solve the problem. In addition, many students experience difficulties when faced with the question of proving a theorem. Piaget (1974) in (Hasratuddin, 2009) says that mathematics is a product of human intellectual thinking that can be raised through problems that concern everyday real life. Another view, Bell (1981) says that mathematics can be used to construct thoughts that are clear, through, precise and consistent (consistent) through training in solving problems. This means that mathematics clearly requires clear thinking and demands every individual to think critically and logically. Suryanto (2002) states that the mathematical learning at this time is often presented as a “finished product”, which is a deductive system. Students’ task is to memorize theories and definitions, solving problems or practice implementing formulas. According to Supartono (2006) the cause of students’ difficulties in learning mathematics is how to present monotonous mathematics lessons from abstract concepts to concrete, not making children enjoy learning. According to Pitadjeng (2005), in order to make students able to learn mathematics in a enjoyable atmosphere, teachers have to provide a situation, strategy, and mathematical materials that is also delightful.

One of the activities that can be done to determine the construction process of students in understanding a concept in mathematics is to enable students with the ability to investigate, find and solve problems, so that mathematical thinking skills can be known. One alternative learning that allows it to improve mathematical thinking skills is the Alberta inquiry learning model.

According to KoirulAnam (2015) the definition of inquiry is that students are asked to find outby themselves. In this inquiry learning, students not only act as recipients of the lesson through verbal explanations of the teacher, but they play a role to find out for themselves the essence of the subject matter itself. The teacher/lecturer acts as a facilitator and motivator of learning, not as a learning resource for students / students.

Alberta inquiry learning model is a learning model developed by Alberta education institutions in Canada. Alberta inquiry learning model is a process in which students are involved in learning, formulating questions, investigating extensively and then building new understandings and knowledge (Alberta Learning, 2004; Amirullah et al., 2018). According to Donham (in Alberta learning, 2004) there are six stages in the Alberta inquiry model namely planning, retrieving, completing, creating / creating, giving and sharing, and evaluating (evaluating). The stages (in Alberta Learning, 2004), namely:

1. Planning phase, students / students are directed to understand the problems that are given clearly by identifying problems by reading, understanding the problem individually, and students / students are directed to be able to make or prepare a settlement plan based on the data contained in the problem given .
2. Retrieving Stage, students are asked to collect data and recall materials that are relevant to the problem to be resolved, including the concepts that have been learned before, then choose which information is appropriate to the problem
3. Processing Phase, students solve the problem based on the data that has been obtained.
4. Creating phase, students make a percentage format by compiling selected information into their own words
5. Sharing phase, students are asked alternately each group presents the results of the group and other students / students check / correct, compare and respond
6. Evaluating phase, each student re-examines the results they have obtained, corrects, adds if there is an error or incomplete.

Thinking in mathematics is expected to produce several abilities. Thinking ability can be divided into three levels, namely reproduction, connection, and analysis of Shafer, Foster, 1997 (in Sabandar, 2009). In the level of reproduction individuals demonstrate the ability to know basic facts, use algorithms, and developing technical skills. This ability is found in students in the form of memorizing and using formulas or theorems. At the connection level, individuals can demonstrate the ability to integrate information, make connections between mathematical concepts, choosing the right formula/strategy that is used in solving a mathematical problem, find solutions to non-routine problems. At the level of analysis, students can do mathematical, analyze (comparison, difference and analogy), interpreting, developing models and strategies itself, expressing argumentation or reasoning logically, finding general patterns, conjecturing and creating generalization formally, such as conducting proof.

Based on the description above, researchers conducted a study to see the effect of mathematical thinking skills with the Alberta Inquiry learning model on learning outcomes of Discrete Mathematics students of Mathematics Education Study Program students.

The research question that becomes the formulation of the problem in this research is: Is there any effect of mathematical thinking ability with the learning model of Alberta Inquiry towards the learning outcomes of Discrete Mathematics of Students from Mathematics Education Study Program FKIPof Universitas Riau in the even semester of 2017/2018academic year?

The research hypothesis proposed is as follows: there is a significant effect on mathematical thinking ability with the learning model of Alberta Inquiry on learning outcomes of Discrete Mathematics students of Mathematics Education study program FKIP Riau University even semester 2017/2018 school year

This research aims to determine the effect of mathematical thinking ability with the learning model of Alberta Inquiry on the learning outcomes of Discrete Mathematics students of

Mathematics Study Program of Universitas Riau in the even semester of 2017/2018 academic year.

This research is expected to contribute to: (1) Students: a) Can improve the abilities of students of students of Mathematics Education Study Program of Universitas Riau in understanding the conceptDiscrete Mathematics, b) Able to improve mathematical thinking skills through collaborative learning, so that students' difficulties in understanding concepts can be minimized through teaching materials that have been systematically arranged. (2) Lecturer: a) Can develop thelecturers'ability in arranging teaching materials and developing learning strategies, b) Can improve the learning process so as to create a sense of learning mathematics in students during learning c) Can develop lecturers' insight in implementing and developing one of the Tridarma Higher Education is the writing of scientific works. (3) University of Riau: Can establish better partnerships / partnerships to improve the quality of learning in Higher Education.

2. Methodology

2.1. Place and Time of Research

This research is done in the MathematicsEducation Study Program from the FKIP of UniversitasRiau. The Time this research is done is in the even semester of 2017/2018 academic year.

2.2. Form of Research

The form of this research is a quasi-experimental research. According to Sugiyono (2010), quasi-experimental research is a research method that is used to search for the effect of certain treatment toward others within a controlled environment. The experiment design utilized within this research is the Single Group Pretest/Posttest Design (Jackson, 2003) which included Quasi Experimental Design Without Control Group. The design for this research can be illustrated as follows:

$$O_1 X \quad O_2$$

This design involves one experiment group that will receive treatment of mathematical thinking ability of the Alberta Inquiry model (X). O_1 is the pre-test result which was given to the samples about the course material that has been studied before treatment while the Tree Graph material, while the $O_2$is the post-test result which was given to the samples about the lecture Planar Graph material and Graph Field after treatment (giving thinking ability mathematically with the Alberta Inquiry learning model). In this research exercise, the researcheract as implementers in giving mathematical thinking ability with the Alberta Inquiry learning model.

2.3. Population and Research Sample

According to Sugiyono (2010) the population is the generalized area that consistsof: objects / subjects that has certain qualities and characteristics which is determined by the researcher to be studied which the draws the conclusion. The population in this research is the students of Mathematics Education Study Program FKIP UNRI in the even semester 2017/2018 academic year that took a course of Discrete Mathematic consisting of 2 classes (6th semester students of Class A, B. Characteristics of students in class A are students who has took the first discrete Mathematic course, while,there are several student of class B who have taken this course.

Based on the considerations of the researchers taken class A as the sample in this research with the reason that students in class A(total of 31 people) who have taken Discrete Mathematics courses in the even semester of 2017/2018 academic year. The reason why class B not choosen as a sample is because there are several student had take that course and they have ability and skill more class A.

2.4. Research Instruments

The instruments in this research consists of:

1. Learning tools consist of: Semester Learning Plan, Learning Plan, Teaching material sheets and student worksheets
2. Data collecting Instrument: The Data collected are about the learning outcomes of Discrete Mathematics of students of Mathematics Education Study Program from the FKIP Universitas Riau in the even semester 2017/2018 academic year before and after the process of learning (treatment). The data are collected through tests. The form of the test utilized in this research is description test.

2.5. Data Collection Techniques

The data collection technique utilized in this research is the technique of test results from Discrete Mathematics. The data collected are test scores before and after treatment. The test given before treatment is a test about The test given before the treatment was in the form of a test about material questions Tree Graph without treatment of mathematical thinking ability with the Alberta Inquiry learning model, while the test after the treatment was in the form of a test about the matter of Graph Planar and Graph Field with the treatment of mathematical thinking ability with the Alberta Inquiry learning model.

2.6. Data Analysis Techniques

The analysis technique utilized is the inferential statistical analysis technique. According to Sugiyono (2010) inferential statistics is the statistic technique used to analyse data samples and the results are enacted for the population. Analysis of learning outcomes data is done to test the research hypothesis. The steps are as follows.

2.6.1 Normality test

Observation data normality tests are used to test whether continuous data is normally distributed so that the data testing analysis can be used / implemented. The normality test was used by the Liliefors Test. The steps of testing with the Liliefors test (in SPSS using the Kolmogorov-Smirnov test) (Zulkarnaian, et al., 2010; Heleni et al, 2018) are as follows:

a. Set the statistical hypothesis, namely: H_0: $f_0 = fe$Vs $H_1 : f_0 \neq fe$ at $\alpha = 0.05$
b. Sort sample data from the lowest to the largest and determine the frequency of each data
c. Determine the z value of each data with the formula $z_i = \frac{x_i - \bar{x}}{s}$
d. Determine the amount of opportunity for each z value based on the standard normal tabeL, and call it f(z)
e. Calculate the relative cumulative frequency of each z value and call it S (z)
f. Determine the maximum Liliefors observation value, call Lo. Value of $L_o = | F(z) - S(z) |$and compare it with $L_{tabel}$from Liliefors table.
g. If the max $L_o < L_{table}$then the sample comes from the population with normal distribution

Test the normality of the data with the help of SPSS for Windows version 17.0 using the Kolmogorov-Smirnov table test. Test criteria: if the significance value (sig.) Is greater than, then $H_0$is accepted; in other cases, H_0 is rejected. If the data is not normally distributed, then a nonparametric statistical test is used, namely the Mann-Whitney U test. If the data is normally distributed, then it is continued by testing the similarity of the two means to test the proposed hypothesis. Test the two similarities on average using paired observation t test

2.6.2 Test for Two Average Equations

Test the two similarities on average using paired observation t test as follows.

$t = t = \frac{\bar{d}}{\frac{S_d}{\sqrt{n}}}$(Zulkarnain, and Zulfan, 2010)

Description $\bar{d}$ = average difference before and after

S_d = Standard deviation of the difference between before and after and

n = Sample size

The testing steps are as follows.

1. Set verbal hypothesis and statistical hypothesis. The statistical hypothesis (two-party test) is:
H_0: $\mu_1 = \mu_2$ H_1: $\mu_1 \neq \mu_2$

2. Determine α then calculate the average and variant of$\bar{d}$

3. Calculate the t value with the formula $t_{Count} == \frac{\bar{d}}{\frac{S_d}{\sqrt{n}}}$

4. Determine the table at a certain degree of freedom (db) that is db = n - 1

5. Criteria for accepting H_0 if $-t_{(\frac{\alpha}{2})}(n - 1) < t_{count} < t_{(\frac{\alpha}{2})}(n - 1)$, instead reject H_0. Give conclusions

If the pretest and posttest result were not normally distributed, then to test the similarity of the two averages, non parametric statistical tests were used, namely the Wilcoxon Signed Rank Test at α = 0.05. The test was carried out using SPSS version 22.00.

2.6.3 Influence Test Between Dependent Variable and Independent Variable

Determine the magnitude of the relationship between variables X with variable Y expressed by rxy (correlation coefficient between variables X with variable Y) used the formula: $r^2_{xy} = \frac{t^2}{t^2+n-2}$.

The amount of contribution of variable X to variable Y expressed in percent use the formula coefficient of determination or coefficient determinant is

$K_p = r^2_{xy}$ x 100%. (Zulkarnain, and Zulfan, 2010)

Description: K_p = Coefficient of determinant,

r^2_{xy} = Correlation coefficient between variables X with Variable Y,

n = number of samples.

3. Result and Discussion

To answer the problem, some results will be discussed about the thinking ability of Mathematics Education Study Program students with thinking ability mathematically with the Alberta Inquiry learning model and the influence of Mathematical Thinking ability with the Alberta Inquiry learning modeltoward the Learning Outcomes of Mathematics of students from mathematics of students from mathematics education study program FKIP of Universitas Riau in the even semester 2017/2018 academic year.

3.1. Analysis of Learning Outcome

3.1.1 Normality Test

The data tested for normality are pretest data and posttest data. The pretest data is taken from the material value of the Tree Graph and the test post data taken from the value of the Graph Planar and Graph Field material. Normality test results can be seen in Table 1 below.

Table 1. Normality Test Results for Pre-Test Data and Test Post

	Kolmogorov-Smirnov		
	Statistics	df	Sig.
Test Post	.097	31	.200
Pre-Test	.194	31	.004

Source: Adapted from the Output of SPSS version 22.00

Based on Table 1, the posttest data obtained sig. = 0.200> α = 0.05, so that the posttest data is normally distributed. But for pretest data obtained Sig. = 0.004 <α = 0.05, so the pretest data is not normally distributed.

3.1.2 Test for Two Average Equations

Based on the normality test, the data were obtained. The pretest did not have a formal distribution, so to examine the similarity of the two averages, non-Parametric Statistics test was used, namely the Wilcoxon Signed Ranks Test at α = 0.05. The test was carried out using SPSS version 22.00 and the results obtained in Table 2 follow.

Table 2. Average Two-Equivalence Test (Wilcoxon Signed Ranks Test)

	N	Mean Rank	Sum of Ranks		Pretes–Postes
Pretes-Postes Negative Ranks Positive Ranks	 24[a] 7[b]	 18.81 6.36	 45.50 44.50	Z Asymp. Sig. (2-tailed)	-3.989[a] .000
Ties	0[c]				
Total	31				

Source: Adapted from the Output of SPSS version 22.00
Description: a. Pretes<Postes
b.Pretes>Postes
c. Pretest = Postes

Based on Table 2, Sig. = 0.000 <α = 0.05, so that there is a difference between posttest and pretest values. In this case the posttest value is better than the pretest value. This means that there is a treatment effect on student learning outcomes. Thus there is an effect of student learning outcomes that were treated with the Alberta Inquiry learning model.

To find out how many effects of mathematical thinking ability with the Alberta Inquiry learning model on Discrete mathematics learning outcomes of mathematics education Study program FKIP UNRI in the even semester 2017/2018 academic year, the determination index coefficient (K_p) was tested. After testing, obtained the value of r^2_{xy} = 0,52 with the influence coefficient (K_p)= 52%. In other words, it can be concluded that the effect of mathematical thinking ability with the learning model of Alberta Inquiry on learning outcomes of Discrete Mathematics students of Mathematics Education Study Program FKIP UNRI in the even semester 2017/2018 academic year is about 52%

3.2. Discussion of Research Results

From the learning that has been carried out there are several important things obtained from the ability to think mathematically, as follows.

1. Students' thinking ability in learning Discrete mathematics in Planar graph material and Graph Field. at the level of reproduction thinking students (1) student already known some of planar graph definitions, definitions graph field, definition of thickness of a graph, definition of dual grap and definition of polyhedral graph, (2) can describe planar graph and not planar, draw subdivision graph from a graph, (3) determine the thickness of a graph, (4) describe dual graph of a planar graph, (5) mentions of regular types of polyhedrons.
2. At the level of thinking connecting student (1) investigate two homogeneous graphs, (2) investigate whether two graphs are isomorphic, the dual is also isomorphic, (3) investigate the characteristics of dual graphs.
3. At the level of thinking analysis, students have not fully developed the ability to think in solving proof problems, such as proof of Euler Formula, thickness-related theorem from a simple graph and thickness of complete graph Kn, $n \neq 2$. Students still difficult to understood and explain arguing in resolving the problem of proof. In the ability to think analytically, students when faced with a matter of proof, it seems difficult to try to prove even directly saying that the matter of proof is difficult, but when drawing and counting they say it can still be solved.

4. Conclusion

4.1. Conclusion

Based on the results and discussion of the research, it can be concluded that: there is the effect of mathematical thinking ability by using the Alberta Inquiry learning model on learning outcomes of Discrete Mathematics students of Mathematics Education Study Program FKIP Universitas Riau in the even semester 2017/2018 academic year.

4.2. Recommendations

Based on the experience gained during the research, the researcher can provide the following recommendations.

1. The ability to think mathematically using the Alberta Inquiry learning model can be used as an alternative to innovative learning.
2. Development of students' thinking ability through habit of creative thinking should be done continuously and hould be explored futher.

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