The Development of Reasoning Ability and Self Efficacy of Students through Problem-based Learning Model

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Abstract: This study aims to determine the development of reasoning ability and self-efficacy of students through Problem Based Learning model. The population in this study is all students of grade XI Prayatna High School Medan and sampling is done by purposive sampling so that selected class XI IPA-1 as the experimental class and class XI IPA-2 as the control class. This type of research is a quasi-experiment. From the test data obtained, the sample comes from a population that has a homogeneous variance and normal distribution. This research was analyzed by using two way ANAVA test. The results showed that the development of: (1) the students' reasoning ability using Problem Based Learning model is better than the conventional model with the value of F arithmetic for learning equal to 119,653 with significance 0,000 < 0,05, (2) self-efficacy of student by using model Problem Based Learning is better than the conventional model with the value of F arithmetic for learning of 11.392 with significance 0.001 < 0.05.

1   INTRODUCTION

Mathematics is a knowledge learned by students from Elementary School level to University level. This is because mathematics has a very large role in other knowledge, especially for the exact and social knowledge, such as economics in the matter of production, marketing and others. It requires to do solving based on mathematical rules. Some people consider mathematics as the most difficult field of study. Nevertheless, everyone needs to learn mathematics because it is a means to solve the problems of everyday life. (Siagian, 2016) explains that mathematics is one branch of science that has an important role in the development of science and technology as a tool in the application of other fields of science as well as in the development of mathematics itself. Mastery of mathematical material by students becomes an indispensable necessity in the arena of reasoning and decision making in an increasingly competitive era in this modern time.

Reasoning ability is one thing that should be owned by the students in learning mathematics. Beside mathematics being a knowledge that obtained by reasoning it also because one of the goals in learning mathematics is that students are able to use reasoning in patterns and character, performing mathematical manipulations in making the generalizations, compiling evidence or explaining the mathematical ideas and statements. Mathematical reasoning ability, is a component that must be governable by the student. Ayal, Kusuma, Sabandar & Dahlan (2016) explain that mathematical reasoning plays an important role, both in solving problems and in conveying ideas when learning mathematics. Russell states that mathematical reasoning is essentially about the development, justification and use of mathematical generalizations. The generalizations create an interconnected web of mathematical knowledge–conceptual understanding. Seeing mathematics as a web of interrelated ideas is both a result of an emphasis on mathematical reasoning and a foundation for reasoning further (Brodie, 2010). In an effort to improve students' mathematical reasoning there are two things that are associated with reasoning, namely inductive and deductive reasonings. Inductive reasoning is a process of thinking that seeks to relate known facts or special events to a general conclusion. Deductive reasoning is a thinking process that draws conclusions about a particular thing that stands from general thing or the things that have previously been proved (assumed) are true (Bani, 2013).

In an effort to improve students' mathematical reasoning there are Permana and Sumarmo (2007) stating that reasoning is a process of thinking in the process of drawing conclusions. Broadly speaking there are two types of reasoning, namely the inductive reasoning also called induction and deductive reasoning also called deduction. The similarity between deduction and induction is that both are structured arguments, composed of several premises and one conclusion. The difference between deduction and induction on the basis of the inference conclusion and also the characteristics of the conclusions it derives.

Besides cognitive, there are things that are also very important to note by a teacher with regard to the development of their students' attitude to mathematics itself. Attitude is the part that also determines the success of students in the learning process. According to the authors thing important to note is the self-efficacy of students. Research during the past 30 years has revealed a positive relationship between self-efficacy beliefs and academic performance and persistence (Martin & Marsh, 2006; Multon, Brown, & Lent, 1991; Skaalvik & Skaalvik, 2004). Self-efficacy is in practice synonymous with "self-belief", although "self-belief" is a non-descriptive term (Bandura, 1997), which refers to the power of belief, for example one can be very confident, but ultimately fail. Self-efficacy is defined as a person's judgment about his or her ability to attain desired or determined performance levels that will influence the subsequent action (Bandura, 1997). Mathematics self-efficacy positively impacts academic achievement by allowing one to use cognitive strategies, enhancing the belief in successful completion of tasks, and encouraging one to come up with alternative solutions for the problem in hand (Stevens, Olivarez, Lan, & Runnels, 2004). Studies shows that students with high-perceived self-efficacy make more effort to accomplish a task and are more persistent in the face of difficulties (Aşkar & Umay, 2001). Hackett & Betz (1989) report that students with higher mathematics self-efficacy have lower mathematics anxiety and place more value on mathematics.

Pintrich and De Groot (Rahmi, Nadia, Hasibah, & Hidayat, 2017) found that students who believed they could perform academic tasks using cognitive and meta-cognitive strategies are more and still doing better than unbelieving students. Self-efficacy makes a difference in the way people act, as a follow-up of feelings and thoughts. People who believe they can do something that has the potential to transform environmental events are more likely to act and more likely to succeed than those with low self-efficacy. Behavior is influenced by the extent to which a person believes to perform the actions required by the particular situation.

Based on observations made at SMA Prayatna Medan, it is known that the ability of reasoning and self-efficacy owned by students in this high school is still low. This can be seen from the only few students who are able to make allegations, perform mathematical manipulations, give reasons for the answers, present the results of group work and draw conclusions from a given mathematical problem. According to the results of interviews conducted by the authors to several mathematics teachers and some students at Prayatna High School Medan, it is found that the factors that cause the low of reasoning ability and self-efficacy of students are students are deficient in understanding the mathematical concepts such as not precisely solving a problem provided by teachers, also less using the reasoning on patterns and characteristic as explaining the mathematical ideas and statements, lacking the ability to design mathematical models and interpreting the solutions obtained. The lacks of interest in students' learning mathematics are caused by the lessons and motivations provided by teachers, difficulty to accept, their absence of interest in mathematics, lack of facilities and infrastructure, fear of the math teacher and all of this cause the students not to be active to ask if there is a lesson that students do not understand.

Based on the above problems a solution is needed to improve students' reasoning and self-efficacy by providing treatment using a problem-based model. Borrow (Huda, 2014) defines that problem-based learning (PBL) is the lessons learned through the process towards understanding the resolution of a problem. The problem is found first in the learning process. Hudojo (in Gunantara, et al, 2014) state that Problem Based Learning (PBL) is a process taken by a person to solve the problem they face until the problem is no longer a problem for them. Also, Sudarman (2014) says the PBL is an approach to learning that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills, as well as to acquire knowledge and essential concept of the subject matter.

So based on the explanation above an attempt to develop students' reasoning and self-efficacy skills, is done so the formulation of problems in this study are: (1) Is the reasoning ability of students using Problem Based Learning model is better than the

conventional model? (2) Is the student's self-efficacy using Problem Based Learning model better than conventional model?

2 METHODS

The type of research in this study is quasi-experimental research. Quasi-experimental research is a study intended to determine the existence or effect of a subject imposed on students. In other word quasi-experimental research tries to examine the presence or absence of causal relationships. Technique used to test the research hypothesis is Analysis of Variance (ANAVA) a two-way at significant level $\alpha = 0.05$. To test the requirements analysis is done by normality test and homogeneity test. The design of data analysis is using the two-way ANAVA. Instruments used to collect the data are questionnaires and tests of learning outcomes. Questionnaires are for seeing students' self-efficacy and tests to measure students' reasoning abilities of the given material and also seeing students' learning mastery.

3 RESULTS AND DISCUSSION

3.1 Results

To see whether there is a development in reasoning ability and self-efficacy of students, problem based learning model ANAVA two-way test is done:

Statistical hypothesis:

$$H_0 : \mu_1 \leq \mu_2 \tag{1}$$

$$H_a : \mu_1 > \mu_2 \tag{2}$$

Criteria: If significance $0,000 < 0,05$, then H_a accepted.

Table 1: ANAVA 2 Way Test Results of Student Reasoning Ability.

Tests of Between-Subjects Effects				
Dependent Variable: N_Gain_PM				
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.032[a]	5	.206	32.101	.000
Intercept	11.903	1	11.903	1852.057	.000
KAM	.311	2	.156	24.196	.000
Pemb	.769	1	.769	119.653	.000
KAM * Pemb	.044	2	.022	3.430	.038
Error	.463	72	.006		
Total	15.066	78			
Corrected Total	1.494	77			
a. R Squared = .690 (Adjusted R Squared = .669)				

From table 1 above it is obtained of F count for learning equal to 119,653 with significance 0,000<0,05. Then H_0 rejected or H_a accepted, meaning there is an increase in reasoning ability between experimental class students and control class students. Besides, it is also concluded that the improvement of students' reasoning ability by using learning model of problem based learning is better than students by using conventional learning.

Furthermore, by using ANAVA two-way test it will be seen whether the development of self-efficacy of students using learning model problem based learning is better than students who are given learning by using conventional learning.

Research hypothesis:

H₀: Increased self-efficacy of students using learning model problem-based learning is no better or equal to the students who use conventional learning.

Hₐ: Increased self-efficacy of students using learning model problem-based learning is better than students who use conventional learning.

Criteria: If significance $0,000 < 0,05$, then H_a accepted.

Table 2: ANAVA 2 Way Test Results of Students' *Self-Efficacy*.

Tests of Between-Subjects Effects					
Dependent Variable:N_Gain_SE					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.266[a]	5	.053	6.419	.000
Intercept	6.268	1	6.268	757.013	.000
KAM	.059	2	.029	3.547	.034
Pemb	.094	1	.094	11.392	.001
KAM * Pemb	.169	2	.084	10.177	.000
Error	.596	72	.008		
Total	7.808	78			
Corrected Total	.862	77			
a. R Squared = .308 (Adjusted R Squared = .260)					

From the table above it is obtained that F count for learning of 11.392 with significance 0.001 <0.05. Then H_0 is rejected or H_a accepted, meaning there is an increase of self-efficacy between experiment class students and control class students. So it can be concluded that the increase of self-efficacy of students by using learning model problem based learning better than students who use conventional learning.

3.2 Discussion

Based on the discussion of the results of the students' reasoning abilities test above it is obtained that the value of F count for learning is 119.653 with significance 0,000<0,05. This means that there is an increase in mathematical reasoning ability between experimental class and control class students. Likewise, with students' self-efficacy it is obtained F count for learning is 11.392 with significance 0.001 <0.05. This is also in line with the results of research that has been done by Mulyana and Sumarmo (2017) that the achievement and improvement of mathematical reasoning ability of students who received problem based learning better than students who receive conventional learning. The students 'mathematical reasoning abilities using problem based learning as the model are still moderate, and the students' mathematical reasoning using conventional learning is still low. Students on problem-based learning class still have difficulty in solving problems in terms of giving reasons for the

truth of a statement. Similarly, the results of research conducted by Sariningsih and Purwasih (2017) that the results of the calculation show that the self-efficacy of the experimental class is better than the self-efficacy of the control class, meaning that the experimental class students have the ability to complete the task of mathematical problem solving abilities provided well. This can be seen from the result of mean score percentage of self-efficacy score in experiment class is greater 3,91 from control class. Ekinci & Gökler (2017) find that learned helplessness decreases with increasing academic self-efficacy as well. Our finding is consistent with that of (Ekinci & Gökler, 2017).

4 CONCLUSION

Based on the results of the research findings, hypothesis testing and discussion, the conclusions are: (1) The development of students' reasoning ability by using problem based learning model is better than conventional learning model. (2) The development of self-efficacy of students by using problem based learning model is better than conventional learning model.

REFERENCES

Aşkar, P. & Umay, A. 2001. İlköğretim matematik öğretmenliği öğrencilerinin bilgisayarla ilgili öz-yeterlik algısı. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 21*, 1–8.

Ayal, C. S., Kusuma, Y. S., Sabandar, J., & Dahlan. J. A. 2016. The Enhancement of Mathematical Reasoning Ability of Junior High School Students by Applying Mind Mapping Strategy. *Journal of Education and Practice*. 7(25), 50-58.

Bandura, A. 1997. *Self- Efficacy: The Exercise of Control.* New York: W.H. Freeman and Company.

Bani, A. 2011. *Meningkatkan Kemampuan Pemahaman Dan Penalaran Matematik Siswa SMP Melalui Pembelajaran Penemuan Terbimbing.* Universitas Pendidikan Indonesia.

Brodie, K. 2010. Teaching Mathematical Reasoning in Secondary School Classrooms. (New York: Springer Science+Business Media).

Gunantara. dkk, 2014. Penerapan Model Pembelajaran *Problem Based Learning* Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematika Siswa Kelas V. *Jurnal Mimbar PGSD*, 2(1).

Hackett, G. & Betz, N. E. 1989. An exploration of the mathematics self-efficacy, mathematics performance correspondence. *Journal for Research in Mathematics Education, 20*, 261-273. doi: 10.2307/749515.

Huda, M. 2014. *Model-Model Pembelajaran dan Pengajaran*. Yogyakarta: Pustaka Pelajar.

Martin, A. J., & Marsh, H. W. 2006. Academic resilience and its psychological and educational correlates: A construct validity approach. *Psychology in the Schools*, 43, 267–281.

Multon, K. D., Brown, S. D., & Lent, R. W. 1991. Relation of selfefficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology*, 38, 30–38.

Mulyana, A., Sumarmo, U. 2017. Meningkatkan Kemampuan Penalaran Matematik dan Kemandirian Belajar Siswa SMP Melalui Pembelajaran Berbasis Masalah. *DIDAKTIK (Jurnal Ilmiah STKIP Siliwangi Bandung*, 9(1), 40-51.

Permana, Y dan Sumarmo, U. 2007. Mengembanngkan Kemampuan Penalaran dan Koneksi Matematik Siswa SMA Melalui Pembelajaran Berbasis Masalah. *Jurnal Educationist,* I(2), 116-123.

Rahmi, S., Nadia, R., Hasibah, B., & Hidayat, W. 2017. The Relation between *Self-Efficacy* toward Math with the Math Communication Competence. *Infinity*, 6 (2), 177-182. doi:10.22460/infinity.v6i2.p177-182.

Sariningsih, R., Purwasih, R. 2017. Pembelajaran *Problem Based Learning* untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis dan *Self Efficacy* Mahasiswa Calon Guru. *JNPM (Jurnal Nasional Pendidikan Matematika,* 1(1), 163-177

Siagian, M. D. 2016. Kemampuan Koneksi Matematik dalam Pembelajaran Matematika. *MES (Journal of Mathematics Education and Science*), 2(1), 58-67.

Skaalvik, E. M., & Skaalvik, S. 2004. Self-concept and self-efficacy: A test of the internal/external frame of reference model and predictions of subsequent motivation and achievement. *Psychological Reports*, 95, 1187–1202.

Stevens, T., Olivarez, A., Lan, W. & Runnels, M. K. 2004. Role of mathematics self-efficacy and motivation ın mathematics performance across ethnicity. *The Journal of Educational Research, 97*(4), 208-221. doi: 10.3200/JOER.97.4.208-222.

Sudarman. 2007. Problem Based Learning: Suatu Model Pembelajaran Untuk Mengembangkan dan Meningkatkan Kemampuan Memecahkan Masalah. *Jurnal Pendidikan Inovatif,* 2 (2).