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Problem Based Learning in Mathematics:

From the Higher Into the Lower Level of Students

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***Abstract*—Teacher-oriented learning and lack of teachers' understanding on how to teach mathematics is presumably resulting in a lack of student mathematics understanding. Problem Based Learning (PBL) model places students as a center in learning activities where creativity, challenging conditions, contextual and diverse student learning experiences are established through solving problems related to mathematics. The aim of this research to investigate the effect of PBL model on mathematics learning. This research was a quasi-experimental research with a randomized complete block design. The sample of this research was Class 8A students for the experimental class and Class 8B for the control class at one of secondary school at Belang- North Sulawesi. Each class consist of 16 students, divided into high and low levels of student, which is based on prior learning mastery. The result of research shows that PBL gave a positive impact to students' understanding on mathematics in both of higher and lower level of student. Moreover, it is shown there was no significant difference in mathematics understanding between student with PBL model and classical model for students with higher level, meanwhile the significant differences was shown in students' understanding between PBL model class and classical model class in lower prior knowledge students; there is no significant difference in learning outcomes between high prior knowledge students and low level students.**

Keywords: PBL, conventional, prior knowledge, learning outcomes, mathematics

I. INTRODUCTION

Mastery in mathematics is very closely related to the completeness of student in learning. Mathematical learning materials are generally arranged in a hierarchical manner, i.e. one material is the basis/prerequisite for the next material. If a student's Prior knowledge is limited, where he does not master the basic material needed, the student may not be able to master the learning material properly. Students who lack good basic knowledge and do not receive attention in the learning process, these students cannot mastery in learning. Therefore, the teacher is required to apply a model and method that can help students in all levels of Prior ability, low, medium, and high to achieve mastery learning.

Prior knowledge is an ability/knowledge that is seen as input (input) that must be possessed by students before gaining new abilities and new knowledge. A student will more easily understand and learn new subject matter, if the teaching-learning process is based on material that has been previously known so that students only have to develop their Prior abilities into new higher abilities.

Based on the observations at Belang state secondary School (SMPN 2 Belang), students still experience got problems in math understanding. The average achievement on mathematics of 7^{th} grade 51 and 8^{th} grade is 53 (max score: 100). This was allegedly because of the low Prior student knowledge. According to Reuven Lazarowitz and Carl Lieb [1], students will get obstacles/difficulties in gaining new knowledge when misunderstanding in prior knowledge occurred. In fact, the school actually has already implemented the 2013 curriculum. Nevertheless, the teaching learning process is still dominated by the teacher (teacher-centered), did not inline with the needs of curriculum itself.

A wise response is needed by the teacher to address the above problems, one of these is returning to the essence of teaching. The essence of teaching [2] itself is an effort to encourage (guide and support) students to organize activities, store, and find the relationship between new knowledge and existing knowledge. Therefore, teachers should find for the activities that can increase student learning (student-centered). This can improve student processing skills and encourage students to be active in critical thinking and foster student interest in learning in mathematics.

Concrete efforts that can be done by teachers to increase student activity in learning is using constructivist learning models. Constructivist learning models prioritize student activities in constructing their own thinking. The constructivist learning model is carried out not only in the same direction (teacher to student) but to create a learning process from various directions (teacher to student, student to teacher, student to fellow students). There are several constructivist learning models that can optimize student-centered activities, one of them is the Problem Based Learning (PBL) model.

PBL is a model in which activities are centered on student (student-centered). The current 2013 curriculum put PBL as one of the recommended learning models. According to Ibragimov et. al. [3], PBL should be seen as a type of basic training that allows to integrate educational opportunities and

other learning technologies. According to Arends [4], PBL is a learning model by exposing students to authentic and interesting problems so students can compile their own knowledge, develop their problem-solving skills and find solutions to problems that are given. Students in the PBL model are placed as learning centers (student centered) i.e. students are directed to solve problems related to the material to be discussed. By this way, creativity, class atmosphere, contextual and learning experiences will develop. According to Oguz-Unver & Arabacioglu [4], the main principle of PBL is to maximize learning by investigating, explaining, and solving contextual and meaningful problems. Therefore, this PBL model can be used to encourage students to be active in the learning process.

The research problems to be investigated are:

1) Is there an effect on the application of the Problem Based Learning (PBL) learning model to the mathematics understanding compared to the classical model?
2) Is there any significant different on mathematics understanding between lower and higher level of student?
3) Is there any difference in mathematics understanding of student between PBL class and classical class?

II. METHODS

This study used a quasi-experimental research method. This study uses a Complete Randomized Block Design as Mattjik and Sumertajaya recommended [5] and hereinafter referred to as Factorial Design in a Complete Randomized Block Design or Factorial RAKL. With the experimental design can be seen in table I.

TABLE I. RESEARCH DESIGN

Prior Mathematical Knowledge (B)	**Learning Model (A)**	
	***PBL* (A_1)**	**Conventional (A_2)**
High (B_1)	Y_{A1B1}[a]	Y_{A2B1}[b]
Low (B_2)	Y_{A1B2}[c]	Y_{A2B2}[d]

[a.] score of learning outcomes in the model class PBL with high Prior knowledge

[b.] score of learning outcomes in model class conventional with high Prior knowledge

[c.] score of learning outcomes in the model class PBL with low Prior knowledge

[d.] score of learning outcomes in model class conventional with low Prior knowledge

This research was conducted at one of State secondary school Belang, along June 2019. The research subject was the 8th grade students in odd semester 2019/2020. Two classes were used, experiment class and control class. Experimental class used PBL and the control class used classical model. The subjects were chosen on using a purposive sampling technique, i.e. the sample was chosen based on certain considerations and objectives [6], by determining the sample size using a grouping method according to Naga [7].

The dependent variable in this study is student mathematics understanding, which is actualized by scores obtained after written tests, in the form of THB. The independent variable is a learning model and prior understanding on math. The Prior knowledge of mathematics is divided into two categories, higher and lower levels. The Prior understanding on math were gained on using written test at the beginning of the research. Students understanding on math were measured through written test, after the implementation of learning. The research instruments have been subject to content validation by experts then tested through validity and reliability tests before being used as research instruments.

Data analysis techniques was two-way variant analysis [8]. The measurement of normality and homogeneity were also done.

III. RESULTS AND DISCUSSION

This research was conducted with a number of settings in situations and conditions in accordance with quasi-experimental research. The topic of learning were Numbers Pattern and the Cartesian coordinate.

After conducting a prior knowledge of mathematics test, the test results were then processed using a ranking sequence of the top three ranking techniques (attached). The number of students in each factor level combination was taken by 8 students. The data used in this study are the data of students from higher and lower levels. From the results of this grouping, the math understanding data obtained from both topics were then tested using inferential statistical analysis of variance (Anava) two paths with experimental design, Factorial Design in Complete Randomized Group Design or Factorial RAKL.

Data on students' Prior mathematical knowledge scores (high and low levels) based on the PBL and classical models are presented in table II.

TABLE II. MATHEMATICAL PRIOR KNOWLEDGE SCORE STUDENTS

Mathematical Prior Knowledge (B)	**Learning Model (A)**	
	***PBL* (A_1)**	***Conventional* (A_2)**
High (B_1)	76 72 72 68 68 68 68 64	76 76 72 72 72 68 68 64
Low (B_2)	32 28 24 24 24 20 16 16	40 40 40 32 28 28 25 16

Based on the data (Table III), it can be estimated that there are 2 factors that have a major influence on student learning outcomes, the initial knowledge of mathematics and the learning model used. Applying the learning model can optimize student learning outcomes. To optimize it, the research used 2 types of learning models, the Problem Based Learning (PBL) and the classical models. In this experiment, 8

students were tested in each combination of initial mathematical knowledge and learning models.

TABLE III. MATH UNDERSTANDING DATA IMPLEMENTATION OF LEARNING MODELS AND INITIAL KNOWLEDGE OF MATHEMATICS AND STANDARDIZED RESIDUALS (RT)

		Learning Model			
		PBL		***classical***	
		Score	***RT***	***Score***	***RT***
Mathematical Prior Knowledge	High	90	1.03	90	1.73
		90	1.03	72	-1.24
		86	0.37	84	0.74
		76	-1.28	90	1.73
		82	-0.29	70	-1.57
		80	-0.62	76	-0.58
		84	0.04	74	-0.91
		82	-0.29	80	0.08
	Average	83.75		79.5	
	Low	86	0.66	56	-0.74
		80	-0.33	60	-0.08
		76	-0.99	54	-1.07
		84	0.33	54	-1.07
		78	-0.66	72	1.89
		78	-0.66	60	-0.08
		86	0.66	60	-0.08
		88	0.99	68	1.24
	Average	82		60.5	

Before testing the hypothesis using the two-way Anava test, the Normality Test and the Variance Homogeneity Test were performed. The data used were standardized residual/residual data of math understanding from both classes. The standardized residual data was obtained with the aid of the SPSS version 25.0 statistical special calculation program. An analysis of the standardized residuals of the math understanding of the two classes was carried out to determine the normality and uniformity of the data.

The research shows that models of learning were significantly influence to the student understanding on math. Learning on using PBL model shows the better achievement of student, compare to the achievement of student who did the learning on using classical model. The other research also shows that there is a significant influence of initial high mathematics knowledge and low mathematical knowledge on student mathematics learning outcomes. Moreover, there is an interaction between the two learning models, as well as the prior knowledge of mathematics on student in understanding math.

The other result shows that the PBL and classical models are giving the similar impact to the student understanding in both of PBL and classical in higher levels. Meanwhile, the significant understanding of student found for the student in lower levels. This is meant that the PBL model worked properly for student from lower level.

Reversely, the similar result come from the higher-level student. For them, they were enjoying the class in both of PBL and classical. This is meant that as long as they are learning with good atmosphere, they can get the good learning. By the interview, most of student said that they can follow the lesson no matter the model used. Based on interview, for them, studying with PBL too often also causes them to be tired and bored. Classical learning makes them able to learn also with intensity not too high but they can catch the point to learn.

IV. CONCLUSION

By the research it can be concluded that learning mathematics with PBL model can enhance the student understanding toward mathematics. The other conclusion is the enhancement of student from lower level shows better achievement with the PBL model, compared to the classical model. Reversely found, that the models of learning do not effects to the understanding student to mathematics. Student in higher level shows the similar enhancement in both of PBL and classical class.

REFERENCES

[1] R. Lazarowitz, C. Lieb, Formative Assesment Pre-test to Identify College Students' Prior Knowledge, Misconceptions and Learning Difficulties in Biology. Taiwan: National Science Council. 2006.

[2] Munir, Kurikulum Berbasis Teknologi Informasi dan Komunikasi. i M. Dr. Munir, Kurikulum Berbasis Teknologi Informasi dan Komunikasi (s. 146). Bandung: Alfabeta. 2010.

[3] I.G. Ibragimov I G, dkk., The State and Prospects of Development of Problem-Based Learning in Higher Education. Rusia: IEJME. 2016.

[4] D. Setiawan, Keefektifan PBL Berbasis Nilai Karakter Berbantuan CD Pembelajaran terhadap Kemampuan Pemecahan Masalah Materi Segiempat Kelas VII. Journal of Mathematics Education. UJME 3 (1). 2014.

[5] A.A. Mattjik and I.M. Sumertajaya, Perancangan Percobaan. Bogor: IPB Press. 2002.

[6] Riduwan, Belajar Mudah Penelitian untuk Guru - Karyawan dan Peneliti Pemula. Bandung: Alfabeta. 2013.

[7] D.S. Naga, Teori Tes. Jakarta: Program Pascasarjana UNJ. 2010.

[8] Supardi, Aplikasi Statistika dalm Penelitian – Konsep Statistika Lebih Komprehensif. Jakarta: Smart. 2013.