Problem based learning with scaffolding technique on geometry

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Abstract. Geometry as one of the branches of mathematics has an important role in the study of mathematics. This research aims to explore the effectiveness of Problem Based Learning (PBL) with scaffolding technique viewed from self-regulation learning toward students’ achievement learning in mathematics. The research data obtained through mathematics learning achievement test and self-regulated learning (SRL) questionnaire. This research employed quasi-experimental research. The subjects of this research are students of the junior high school in Banyumas Central Java. The result of the research showed that problem-based learning model with scaffolding technique is more effective to generate students’ mathematics learning achievement than direct learning (DL). This is because in PBL model students are more able to think actively and creatively. The high SRL category student has better mathematic learning achievement than middle and low SRL categories, and then the middle SRL category has better than low SRL category. So, there are interactions between learning model with self-regulated learning in increasing mathematic learning achievement.

1. Introduction

The main purpose of the learning of mathematics is to enable students to solve problems in daily life. Unfortunately, according to the results of the latest national test of mathematics, grades according to the Department of education standards in Indonesia (2015, 2016) the changes of the 56.28 in 2015 has dropped to 50.24 in 2016. [1] One of them is the students’ difficulty of learning and understanding math materials. This is demonstrated by the 2015 international comparison of PISA (Program for International Student Assessment) on mathematics that Indonesia is ranked 63 out of 70 countries with an average score of 386 [2].

Mathematics is an important subject that is given to students to equip the ability of logical thinking, analytical, systematic, critical, creative and the ability to work together. The development of a world that is constantly changing, who can understand and master the math then it will have wider opportunities to determine his future. One of the main goals of the learning of mathematics is students can solve problems in daily life. Solving the problem is not only a goal in learning math but at the same time as the main tool in the learning process. Mathematics is a branch of abstract science; means that the learning process requires understanding and problem-solving that are not real. [3]

Through problem-solving, students can develop their ability to think. One of the material in mathematics that must be learned in school is geometry. Geometry is a branch of mathematics concerned
with point, straight line, plane figures, space, spatial figures, and the relations between them [2]. Geometry is a part of mathematics which related to student’s life, because almost all of the objects around them are geometry. [4] Based on observation and interview to junior high school teacher said that for students, geometry is one of difficult lesson. Moreover, most of the mathematics learning process is still teacher-center; teacher is the only one source. The teacher is dominant and the students do not required be independent and active during the learning process. Generally, the application of mathematics learning process gain from teacher, it causes the students become passive. [5] Mike reported that if the teacher is too old and too much talking then the students will be a passive receiver [6]

In this case, the teacher is required to revise learning strategies and media that support the success of learning process. The learning process focuses on solving problem then teachers are recommended to use problem-based learning. According to the Barrel the key components of the problem-based learning is the act of reflection where students are asked to apply what they have learned in other situations which refers to transfer knowledge. There are five components in the learning process in the classroom which include students, teachers, content, methods and the environment [7]

States that teachers must understand the context of mathematics in order to apply the suitable strategy or technique. One of the effective learning in mathematics is by using scaffolding technique. Furthermore, the combination of Problem Based Learning and scaffolding technique will benefit the students in formulating and organizing students’ mathematical learning. [8] One of technique that can be applied in learning process is scaffolding. Scaffolding is one of technique teacher can choose to help students who face difficulties. [9] Difficulties in learning must be experienced by students especially when faced new materials or information. Scaffolding can be applied to every teacher, adults, or experts in their daily life. However, in order to process scaffolding properly and effectively they need to get enough training and experience.

One of cognitive aspect which influenced achievement is self-regulated learning. Thus, learning process nowadays considered that one of its aims is to free the students from their need of teacher, so they can learn independently in their whole [10-12]; and to learn independently the students should be a self-regulated learner [13] Self-regulated learning that used in this research are autonomy, creative and initiative, responsible, and able to refrain. [14]

The purpose of this research finds out whether PBL with scaffolding technique provides better mathematics learning achievement than the direct learning model, know students who have mathematics learning achievement, better among students with high self-regulation learning, students with moderate self-regulation learning or students with low self-regulation learning, know an interaction between learning model and self-regulation learning toward students’ achievement.

2. Methods
The method that is used in this research is quantitative method. This research employed quasi experimental research. Variables that will be observed are learning model as independent variable and students’ mathematics learning achievement as dependent variable.

Population of this research is grade 7th students in SMP N 2 Sokaraja in semester 2 academic year 2016/2017. The used sampling technique is stratified cluster random sampling that is done by choosing 2 class randomly, one experimental class applying PBL model with scaffolding technique with 36 students, and one control class applying direct learning model with 36 students. The data gathering conducted on March-May 2017. The mathematic learning achievement obtained by using multiple choice test with geometry material, whereas SRL obtained by using questioner data based on the indicator made by SRL aspect.

3. Results and Discussion
Mathematic test for students was 25 multiple choice given to experimental class and control class. Based on the result, the average learning mathematic achievement for experimental class 1 was 36, and control class was 36. Before the ANOVA two ways test, normality test held on the data. The mathematic
The learning achievement normality test is held by using SPSS software with 5% level of significance. The result of normality test of student’s mathematics learning shows that in the experimental class the sig value is 0.395 > 0.05 and control class the sig value is 0.120 > 0.05. Therefore it can be concluded that the sample of achievement tests comes from a normally distributed population. The homogeneity test of student achievement test shows that the value of sig. = 0.122 > 0.05. Therefore it can be concluded that the population has the same or homogeneous variance. In this study data analysis using two-way ANOVA shown in Table 1 with the following results.

| Source          | Type III Sum of Squares | df  | Mean Square | F    | Sig.  |
|-----------------|-------------------------|-----|-------------|------|-------|
| Corrected Model | 8716.633a               | 5   | 1743.327    | 21.022 | 0.000 |
| Intercept       | 319502.863              | 1   | 319502.863  | 3.853E3 | 0.000 |
| Model           | 2042.107                | 1   | 2042.107    | 24.625 | 0.000 |
| SE              | 6033.335                | 2   | 3016.668    | 36.377 | 0.000 |
| Model*SE        | 600.340                 | 2   | 300.170     | 3.620  | 0.032 |
| Error           | 5473.242                | 66  | 82.928      |       |       |
| Total           | 369093.000              | 72  |             |       |       |
| Corrected Total | 14189.875               | 71  |             |       |       |

Based on the calculation table 1, can be seen that the influence of Problem Based Learning model with scaffolding technique toward mathematics learning achievement has the value of F arithmetic = 24.625 with sig = 0.000 < 0.05, so H0 rejected and Ha accepted. It can be concluded that there are differences between the students’ mathematics learning achievement in the experimental class used Problem Based Learning model with scaffolding technique with the control class used. Whereas, based on the average of the students’ mathematic learning achievement, so the group of students used scaffolding technique in PBL bigger than the students with direct learning. The influence of self-regulated learning towards the mathematical learning achievement has a value of F arithmetic of 36.377 and sig = 0.000 <0.05, so it can be concluded that there is a difference between categories in self-regulated learning.

Based on calculation it can be seen that there is a difference between self-regulated learning of high category students toward middle and low category. While based on calculation it shows that the self-regulated learning of the high category is better than the middle and low category self-regulated learning, and then the self-regulated learning of the middle category is better than the low self-regulated learning category.

Based on Table 1. On column Class*SRL obtained sig. = 0.032 <0.05, so it can be concluded that there is interaction between Problem Based Learning model with scaffolding technique and self-regulated learning (independence learn) student to student's mathematics learning achievement.

The use of learning model aims to overcome the problems in teaching and learning process so the material can be delivered maximally. Most of the students in learning the geometry material based on the understanding, when given the problem students do not understand it. Giving problems in everyday life is very important for students' thinking, so the use of PBL models is the right solution to use in learning. PBL uses problems to improve student achievement, so it can stimulate students to build the right solution for the given problem. [15] based on the results of this research indicate that the model of learning and self-regulated learning affect mathematics learning achievement. The use of learning strategies helps students learn activities and apply what they already know to be effective in learning. [4] The effectiveness of PBL in mathematics learning can improve creative thinking and provide great opportunities for students to actively participate in the learning process. [16]

One of the benefits that can be obtained from PBL is the emergence of students' attitude, objective and curiosity in solving the problem. Student curiosity causes students to become eager to learn and know their knowledge. Student curiosity provides motivation for students to seek answers of questions.
or problems that arise and deal with them. The presentation of geometry problems in a way that stimulates curiosity and encourages exploration, can improve their learning and attitudes toward mathematics. [5] Learning with scaffolding techniques helps students in solving the problem. The use of scaffolding is a support given to the student when the teacher gave a problem and the student cannot solve the problem. [17]

Scaffolding in learning is a teaching technique that consists of teaching a new skill by inviting students together to accomplish tasks that are too difficult if the student solve their own, and help the student in building an understanding of knowledge and new processes. [18] It shows that providing support to learners at the right time will create a better learning process of mathematics, otherwise if does not right, then it will interfere. Scaffolding should be provided sufficiently and timely so that learners can be responsible and independent of the learning they are doing. [19]

When the learning model combined with scaffolding techniques will establish student's confidence in solving a problem, so they can find the right solution to overcome the existing shortcomings. Through confidence, it will make them express opinions and independent in learning so that they can understand easily and able to solve the problems.

4. Conclusion
Based on the results of research above, the conclusion that can be taken is the difference of student achievement between students using PBL model with scaffolding technique and direct learning. The achievement of learning mathematics using PBL with scaffolding technique gives better result than the achievement of learning mathematics with direct learning. There is a difference in learning achievement between high, middle and low category students. However, the high SRL category student has better mathematic learning achievement than middle and low SRL categories, and then the middle SRL category has better than low SRL category. Based on the research discussion, the results showed that the influence of Scaffolding can increase the achievement of higher learning achievement of mathematics in PBL than the achievement of learning achievement using direct learning or conventional.

5. References
[1] Indonesia Department of education standards 2015-2016 Data Hasil Ujian Nasional PAMER UN 2010-2012 Jakarta

[2] Programme for International Student Assessment 2016 PISA Results in Focus (www.oecd.org/pisa)

[3] Biber C, Tuna A and Korkmaz S 2013 The mistakes and the misconceptions of the eighth grade students on the subject of angles European Journal of Science and Mathematics Education 1 2 50-59

[4] Mahmoud A and Kamel A 2014 The Effect of Using Discovery learning Strategy in Teaching Grammatical Rules to First Year General Secondary Student on Developing Their Achievement and Metacognitive Skills International Journal of Innovation and Scientific Research 5 2 146-153

[5] Jones K 2002 Issues In The Teaching and Learning of Geometry in Linda Haggarty (Ed), Aspects of Teaching Secondary Mathematics: perspectives on practice. (London: RoutledgeFalmer)

[6] Zuya H E and Kwalat S K 2015 Teacher’s Knowledge of Students about Geometry International Journal of Learning, Teaching and Educational Research 13 3 100-114

[7] Williams K C and Williams C C 2011 Five key ingredients for improving student motivation. Research in Higher Education Journal 12 1–23.

[8] Zakaria E, Chin L C and Daud Y 2010 The Effects of Cooperative Learning on Students’ Mathematics Achievement and Attitude toward Mathematics Journal of Social Sciences, 6 2

[9] Sutiarso, S 2009 Scaffolding dalam Pembelajaran Matematika Proc Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA Fakultas MIPA (Yogyakarta: Universitas Negeri Yogyakarta)
[10] Slavin 2009 *Educational Psychology Englewood Cliffs* (New Jersey: Prentice-Hall, Inc)
[11] Sabornie E J, Cullinan D, Osborne SS and Brock LB 2005 Intellectual, academic, and behavioral functioning of students with high-incidence disabilities: A cross-categorical meta-analysis *Exceptional Children* 72 1 47-63.
[12] Jacobsen R R and Harris S 2002 Does the type of campus influence self regulated learning as measured by the motivated strategies for learning questionnaire (MSLQ) *Education* 128 3 412-432
[13] Woolfolk 2008 *Educational Psychology Active Learning Edition Tenth Edition* (Boston: Allyn and Bacon.)
[14] Desmita 2009 *Psikologi Perkembangan Peserta Didik* (Bandung: PT Remaja Rosdakarya)
[15] Ricon T, Rosenblum S and Schreuer N 2010 Using Problem Based Learning in Training Health Professionals: Should it Suit the Individual’s Learning Style?. *Creative Education*, 1 1 25-25.
[16] Padmavathy R D 2013 Effectiveness of Problem Based Learning In Mathematics International Multidisciplinary e-Journal 02 2013 001
[17] Van de Pol, J, Volman M and Beishuizen J 2010 Scaffolding in teacher–student interaction: A decade of research. *Educational psychology review*, 22 3 271-296.
[18] Kurniasih A W 2012 Scaffolding sebagai Alternatif Upaya Meningkatkan Kemampuan Berpikir Kritis Matematika. *Kreano, Jurnal Matematika Kreatif-Inovatif* 3 2 113-124.
[19] Walqui A 2006 Scaffolding Instruction for English Language Learners: A Conceptual Framework *The International Journal of Bilingual Education and Bilingualism* 9 2 159-180