The Application of Problem Based Learning Model to Improve Mathematical Literacy Skill and The Independent Learning of Student

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Abstract. The background of the research was due to the lack skill of student mathematical literacy. The objective of the research is to know the ability and the improvement of the students in term of the mathematical literacy skill and the independent learning of the students by using problem based learning model better than students who received conventional learning. This research conducted in one of Junior High School in Serang in academic year of 2013/2014. The samples of the research were two classes. The test instrument consists of fouressay items. The results showed that ability and the improvement of the students in term of the mathematical literacy skill and the independent learning of the students by using problem based learning model better than students who received conventional learning. Based on the research results, as well as the improvement of the research, we suggest that the learning model of problem based learning can be taken into consideration by the teacher as an alternative learning at school. Additionally, we recommend further research that examines the effects of problem based learning models on different aspects for a more diverse material.

1. Introduction
Mathematics is one of humanity’s great achievements. By enhancing the capabilities of the human mind, mathematics has facilitated the development of science, technology, engineering, business, and government. For people to participate fully in society, they must know basic mathematics. Citizens who cannot reason mathematically are cut off from whole realms of human endeavor. Innumeracy deprives them not of opportunity but also of competence in everyday tasks [1]. In thus is the reason for the importance of mathematics to be learned. There are five competency in mathematics, namely mathematical problem solving, mathematical communication, mathematical reasoning, mathematical connections, and the mathematical representation [2]. The fifth of these competencies is needed by students to be able to use mathematics in daily activity. Capabilities that include five of these competencies is mathematical literacy. Mathematical literacy helps a person to understand the role or usefulness of mathematics in daily life as well use it to make the right decisions as a citizen [3]. However, the mathematical literacy skill of students in Indonesia are still quite low. PISA as the programs carried out by the OECD in 2012 has been conducting research to see mathematical literacy skills of students aged 15 years in 65 countries. From the results of these studies indicate that the mathematical literacy of children in Indonesia is ranked 64 of 65 countries with a score of 375 [4]. Indonesian’s students are only able to answer questions PISA level 1, 2 and 3, and a few students can solve level 4 [5]. Indonesian student success in solving problems of PISA is largely determined by the
evaluation system and the ability of teacher to develop student’s matematical literacy. So, teachers need to develop about a matter which is equivalent to PISA assessment [6].

On the other hand, to improve mathematical literacy skills required independent learning of student in mathematics. Independent learning is learning in which the learning goals, methods or direction to achieve the learning goals, and regulation of learning process is decided, guided and managed by the learner [7]. Independent learning can be seen quite broadly to encompass a variety of situations and contexts where students are interpreting and scaffolding new knowledge and skills independently from those around them [8]. The aim of independent learning is to teach students to learn for themselves and in turn empower them in their learning process regardless of their learning context or environment [9]. Being an independent learner does not mean ‘learning on your own’ or in an isolated way [10]. We can encourage engaged form of independent learning by facilitating peer study groups, who may meet up for weekly revision or for exam preparation [11].

One model that can be used to improve mathematical literacy skills and independent learning of students in the learning process is problem based learning model (PBL). This model began to be appointed because in general terms, problem based learning model presenting an authentic and meaningful situation to provide convenience for students to conduct an investigation [12]. Through these authentic experiences, preservice teachers develop a better understanding of constructivist teaching practices, became more successful at implementing constructivist methods [13]. Learners work collaboratively with others as they analyze complex and ill-defined problems [14]. Learners also work independently to collect information they then bring back to the group as they resume their collective problemsolving and subsequent reflection on both the issue at hand and the group’s functioning [15]. They use a priori and post priori knowledge to reason intelectually and make learners collaboration with others in small groups [16].

2. Experimental Method

The method used in this study is a quasi-experimental method. While the design of the study is the non-equivalent control group design. The design is depicted in Figure 1.

![Figure 1. Non-equivalent control group design][17]

Information:

0 = Pretest / posttest experimental class / control class
X₁ = The treatment on experimental class that is learning by problem-based learning model.
X₂ = The treatment on control class that is learning by conventional learning.
--- = Subject is not chosen at random

The population in this study were students of class VIII Junior High School 4, Serang academic year 2013/2014. The sample in this study was taken using cluster random sampling method of determining the sample if the population consists of classes of individuals or clusters [18]. In this study, samples were taken two classes, namely the control and experimental classes. Selection of the control and experimental classes chosen randomly. Students in the experimental class will learning with problem based learning model, while the control class will be given conventional learning which will then be used as a comparison of the experimental class.

The instrument that was used was test and nontest instruments. In this research, the test instrument to be used is essay question that includes indicators of matematical literacy. The given problems were tested first to know about the validity, reliability, power differeniatior, and the level of the six questions. From the test results that have been calculated, the entire matter is qualified to serve as a test of mathematics literacy ability at the beginning and end of the test execution. The non test instrumen in this research use scaling subject. Scaling subject method is a method that oriented to the subject that has purpose to put student on a continuum rating so the relative position of individual can
be obtained [19]. Analysis of the data in this research is the analysis of quantitative data. In the analysis of quantitative data, to be analyzed is pretest of mathematical literacy, scale of initial learning independence, posttest of mathematical literacy and scale of finale learning independence, and also gain of mathematical literacy skill and independent learning of student.

3. Result and Discussion

In this research, the ability that measured was mathematical literacy of experimental class and control class. The research starts from the initial test in class VIII in Junior High School 4, Serang to determine the ability of mathematical literacy. From the initial tests conducted obtained information that mathematics literacy ability of students still unsatisfactory (see Figure 2).

![Figure 2. Histogram average score result of pretest and posttest mathematical literacy ability](image)

Increased mathematics literacy is significant from occurring in the experimental class that uses the learning model of problem based learning (See Figure 2). Experimental class has higher average than control class that uses conventional learning. It’s supported also by the result increase in the experimental class is 0.62 while the control class is 0.35 (See Figure 3).

![Figure 3. Histogram result for the normalized gain](image)

| Table 1. Recapitulation of the difference of two average test |
|-------------------------------------------------------------|
| Pretest | Posttest |
| Experiment | 8.95 | 21.7 |
| Control | 8.05 | 15.5 |

Gain

| Eksperimen | 0.54 |
| Kontrol | 0.26 |
| Pretest | Posttest | Gain |
|--------|----------|------|
| Result | Count | Value of Table | Conclusion | Result | Count | Value of Table | Conclusion | Result | Count | Value of Table | Conclusion |
| 1,11   | 1,675  | There is no difference in ability between the experimental class and control class | 7,65   | 1,675  | Mathematical literacy skills in experimental class is better than control class | 9,00   | 1,675  | Increase student’s mathematical literacy skill in experimental class is better than control class |

Parametric tests, one part t-test, used for know about the conclusion of posttest and gain. This is because the data were normally distributed and homogeneous. The result of the posttest among experimental class and control class showed difference (see Table 1). Mathematical literacy skills in experimental class is better than control class. This experiment also indicates that learning using problem based learning model more involved than conventional learning. The result of the gain among experimental class and control class also showed difference (see Table 1). Increase student’s mathematical literacy skill in experimental class is better than control class. This suggests that learning by using problem based learning model can improve students' mathematical literacy.

**Table 1. Recapitulation of the difference of two average test**

| Initial Scale Score | Last Scale Score | Gain |
|---------------------|------------------|------|
| Result | Count | Value of Table | Conclusion | Result | Count | Value of Table | Conclusion | Result | Count | Value of Table | Conclusion |
| 0,78   | 1,675  | There is no difference | 2,30   | 1,675  | The independent learning of student in experimental class is better than control class | 3,86   | 1,675  | Increase of the independent learning of student’s in experimental class is better than control class |

In this research also measured independent learning of student in experimen and control class using the difference of two average test. This is because the data were normally distributed and homogeneous. From the initial test, show that there are no differences in the ability of the experimental class and control class (see Table 2), it is because the research were conducted in the same chapter and the same treatment between these two classes. Parametric tests, one part t-test, used for know about the conclusion of posttest and gain. The result showed independent learning of student in experimental class is better than control class (See Table 2). This is evidenced from the acquisition the average score of the experimental class 132 (82.5%) was better than the average score of independent learning control class 121 (75.63%).

When viewed from the gain among the last scale score and the initial scale score, gain among pretest and posttest, it show that the gain of the experimental class is higher than the gain of control class (See Table 2). This suggests that problem based learning model can improve mathematical literacy skills and learning independence of junior high school students. The results of this study show that problem based learning model is better than the conventional learning in terms of improving the literacy skills of mathematical and the independent learning of student.
It is influenced by several factors, using problem based learning model make mathematics more interesting, fun and meaningful so that the atmosphere in the learning process is not monotonous that make students bored and not interested at all to the material presented by the teacher. American preservice elementary teachers believed that “making mathematics fun” was central to the learning process [20]. However they also found that students expected that enjoyable lessons succeed in teaching mathematics regardless of content or context of the lessons.

Another factor were, with PBL model the students can build their own knowledge, so they were not easy to forget the things they have acquired. This is consistent with the constructive theory which states that students must find their own and transform complex information, check the new information with the old rules and revise them if the rules were no longer appropriate [12]. High levels of student engagement in PBL classrooms because it places students in a real world, problem-solving context [21]. Studies have revealed that PBL has positive effect on the development of higher-order thinking skills in specific groups of students [22]. An experimental study of 76 teachers who utilized PBL in their classrooms revealed that, compared to the control group of students in traditional classes, their students scored higher on standardized exams, as well as ability tests that measured problem-solving skills and content application to real-world problems [23].

In addition, using PBL model make students possible to think and exchange opinions with their friends. Learning theory by Vygotsky believe that social interaction with friends can stimulate the formation of new ideas and enrich the intellectual development of students [24]. The exchange of information between students can build new knowledge so that students can better understand the learning materials studied. Students also reported higher enjoyment of their PBL work because it gave them opportunities to interact with their friends and to make new friends through cooperative projects [25].

4. Conclusions

Based on the results and discussion of research, conclusions can be drawn that Problem Based Learning model can improve the mathematics literacy ability class VIII Junior High School 4, Serang. It can be summarized as follows: (1) The ability of mathematical literacy of students who get the learning by problem based learning model is better than the students who received conventional learning; (2) Increasing the mathematical literacy skills of students who get learning by problem based learning model is better than the students who received conventional learning; (3) Independence learning of students who get learning by problem based learning model is better than the students who received conventional learning; (4) Improved learning independence of students who had learning by problem based learning model is better than the students who received conventional learning.

Based on the above conclusion, the researchers recommend that (1) The problem based learning model can be taken into consideration by the teacher as an alternative learning at school; (2) Problem based learning model consists of five stages. In order for all stages of the learning process implemented to the fullest, it is necessary allocation of time as well as possible; (3) Further research that examines the effects of problem based learning models on different aspects for more diverse material as well.

5. References

[1] Kilpatrick J et al 2001 Adding it Up Helping Children Learn Mathematics (Washington DC: National Academy Press)
[2] National Council of Teacher of Mathematics 2000 Principles and Standards for School Mathematics (USA: NCTM)
[3] Kamaliyah, et al 2013 Jurnal IndoMSJME 4 9-28
[4] OECD 2013 PISA 2012 Results in Focus What 15-year-olds Know and What They Can Do with What They Know (USA: OECD)
[5] EdoSI, et al 2013 JIMS Journal 4 41-58
[6] Johar R 2012 Jurnal Peluang 1 30-41
[7] Balapumi R and Aitken A 2012 Proc. of 23rd Australian Conf. on Information System 2012(Victoria: Geelong) p 1-10
[8] Nagpal K 2013 *Journal of Social Science & Interdisciplinary Research* 2 27-35
[9] Broad J 2006 *Journal of Further and Higher Education* 30 119-143
[10] Meyer B. et al 2008 *Research Brief: Independent Learning-Literature Review*. (London: Department for Children Schools and Families)
[11] Damon W & Phelps E 1989 *International Journal of Educational Research* 13 9-19
[12] Trianto 2013 *Mendesain Model Pembelajaran Inovatif Progresif* (Jakarta: Kencana Prenada Media Group)
[13] Park S H and Ertmer P A 2007 *JRTE Journal* 40 247-267
[14] Hmelo S C 2004 *Educational Psychology Review* 16 235-266
[15] Simone C D 2014 *Teacher Education: Trajectories of Change* 4 17-29
[16] Carroll K 2009 *Proc. Problem-Based Learning, Pedagogy & Practice* vol 2 (Singapore) p 494-501
[17] Ruseffendi 2005 *Dasar-dasar Penelitian Pendidikan & Bidang Non-Eksata Lainnya* (Bandung: Tarsito)
[18] Sudaryono 2011 *Metode Penelitian Pendidikan* (Banten: Dinas Pendidikan Provinsi Banten)
[19] Azwar S 2013 *Penyusunan Skala Psikologi* (Yogyakarta: Pustaka Pelajar)
[20] Foss D H and Kleinsasser R 1996 *Teaching and Teacher Education* 12 429-442
[21] Brush T and Saye J 2008 *Journal of Problem-Based Learning* 2 21-56
[22] Mergendoller J. et al 2006 *Journal of Problem-Based Learning* 1 49-69
[23] Finkelstein N. et al 2010 *Effect of Problem Based Economics on High School Economics Instruction NCEE* (Washington DC: National Center for Education Evaluation and Regional Assistance)
[24] Rusman 2012 *Model-Model Pembelajaran* (Jakarta: Raja Grafindo Persada)
[25] Belland B. et al 2006 *Journal of Problem-Based Learning* 1 1-18