THE COMPARISON OF PUPILS' MATHEMATICAL PROBLEM SOLVING ABILITY IN THE CLASSROOM TAUGHT USING PROBLEMBASED LEARNING AND PROJECT BASED LEARNING MODEL IN GRADE SEVEN SMP NEGERI 2 PANAI TENGAH A.Y. 2015/2016

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Abstract

The aim of this research is to study if pupils' mathematical problem solving ability in the classroom that taught using Problem Based Learning (PBL) higher than in the classroom that taught using Project Based Learning (PjBL). The population of this research is all pupils in class VII SMP Negeri 2 Panai Tengah. The sample of this research consists of twoclasses, namely, VII – 1 as the experiment class taught using PBL (30 pupils), VII – 2 as the comparison class taught using PjBL (31 pupils). The design of this research is posttestonly comparison group. The result of the research shows that the mean score are 54.07in experiment class and 41.32 in the comparison class; and $t_{calculation} \leq t_{table}$*, that is,*$1.327 \leq 1.671$ *with significance level of 0.05 one tailed. It means that the pupils' mathematical problem solving ability in the classroom taught using PBL model is not higher than in the class taught using PjBLmodel.*

Keywords: *Mathematical Problem Solving Ability, Problem Based Learning, Project Based Learning*

INTRODUCTION

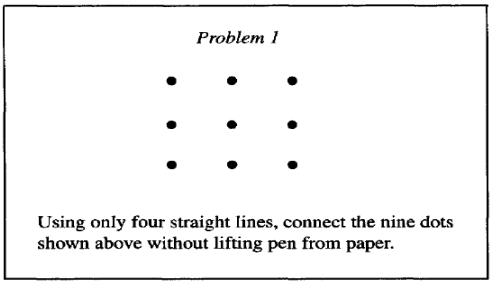
The need of mathematical problem solving is truly becoming a trend of Mathematics lesson. According to Schoenfeld, a mathematics education expert, there is one particular mathematical point of view regarding the role that problems have in the lives of those who do Mathematics. This unifying theme is that the work of mathematicians is solving problems. Mathematical problem solving is at the heart of any mathematicians work and to become a mathematician, one who discovers, conjectures, tests and proves one must become a problem solver. For this to happen, students must therefore engage in solving real problems (O' Shea, 2010).

Cockroft's Report (1982), in paragraph 243, as retrieved from http://www.educationengland.org.uk/documents/cockcroft/cockcroft1982.htmlsays that:

> Mathematics teaching at all levels should include opportunities for:exposition by the teacher; discussion between teacher and pupils and between pupils themselves; appropriate practical work; consolidation and practice of fundamental skills and routines; problem solving, including the application of mathematics to everyday situations; investigational work.

This vision has not been implemented yet, however, in practical lesson in school Mathematics. Many teachers still use only exposition, but discussion between teacher and pupils and between pupils not yet to be well organized. Cockroft reported this in his statement: "Yet we are aware that although there are some classrooms in which the teaching includes, as a matter of course, all the elements which we have listed, there are still many in which the mathematics teaching does not include even a majority of these elements." (Ibid, paragraph 243)

Other problems in learning problem solving are the difficulties and obstacles faced by pupils. Orton (2004: 94) found that "Very few people, including university students of mathematics, are able to solve Problem 1 within a limited time period. It is necessary to draw lines which go outside the shape implicitly defined by the nine dots".



Problems Proposed by Orton (2004: 93)

It seems that people work under the assumption that the four lines must lie entirely within the shape, although no such restriction was stated in the question. This phenomenon was discussed by Scheerer (1963) as 'fixation', sometimes referred to as 'problem-solving set'. It appears that everyone should be prone to making initial assumptions which are not included in the problem specification.

Specifically, based on the explanation of the principle of SMP Negeri 2 Panai Tengah, LabuhanBatu, Drs. InderaYudaSungkowo, there is a problem in which pupils are still difficult to solve mathematical problems. It can be understood because pupils are less involved in instructional process. In other direction, teacher also pays less attention to pupils in the instructional process in which the learning is still in conventional mode. This reason is acceptable for which no pupil in 7^{th} grade of the school can solve the exemplary problem above within five minutes that must be highlighted to be other crucial point of their low experience.

Actually, as a reference to the real facts above, Mink (2010: 188) proposes that there are seven difficulty factors in learning problem solving: (1)

wrong order; (2) key words; (3) extraneous numbers; (4) hidden word numbers; (5) implied numbers; (6) multiple steps; and (7) exact mathematical vocabulary.

It is clear now that learning problem solving is not without challenges and difficulties. Solving problems improves critical and creative thinking. Pupils are intended to create their own thinking during the process of problem solving. This point is still important to highlight that pupils are in Regular thinking is not enough to solve the problem and pupil must develop their ideas and connect them into other ideas. Pupils must be also identifying to which factors they tend to be very low. This is crucial because teacher should know in which case pupils are learning, so that teacher can help pupils effectively and efficiently.

Sierpinska (1994: 160) stated that "In a mathematics class, when teaching [problem solving], the teacher will point to information that is relevant from the mathematical point of view, and discard that which is irrelevant". This is important in learning problem solving for pupils, in pupil will learn meaningfully because teacher has discard unnecessary information. The role of teacher must in duty of helping pupils. It is not realized yet in SMP Negeri 2 Panai Tengah.

The lack of problem solving ability becomes a topic that teacher must focus on. Teacher, with all of his or her professionalism, must engage pupils to learn problem solving. Teacher, for example, prepares pupils with many exercises. In doing the problem solving, the openness is truly important. Here is the point in which teacher and pupils interact all together in constructing knowledge. The more exercise, the more experience pupils. The exercises will help students to enrich their experiences in problems explorations. This point is represented by Bell (Guttierez and Boereo, 2006: 34) as follows:

> … I understand problem solving to refer to the solving of problems by the forming and solving of equations; this is the narrow sense of the term. But the essential mathematical activity is that of exploring problems in an open way, extending and developing them in the search for more results and more general ones. Hence [all algebra learning] … is based on problem explorations. This is the broad sense of the term.

In order to teach problem solving Mathematics, there are two models of teaching proposed to. These models are two models offered by New Syllabus of Indonesian Mathematics 2013; i.e. Problem Based Learning (PBL) and Project Based Learning (PjBL).

Both PBL and PjBL rise higher order thinking skill (HOTS). Dehkordi and Heydarnejad, Kasai et al., Albanese and Mitchell (Shaer and Gaber, 2014: 81) reported that students in Problem Based Learning scored higher when compared to the traditional method students. Norman and Schmidt, Vernon and Blake found that PBL is effective in promoting higher order thinking (Ibid).

PBL provides an experiential learning in which students participate to exploration and discovery. Students can also find their own difficulties and

discuss them within groups and share their result of explorations.

Project – Based Learning (PjBL) is other instructional model that promoting to enhance students' learning outcomes. Project – Based Learning, as reported by New York Department of Education (2009) also increases student engagements for several reasons. The reasons can be written briefly that in Project – Based Learning students are enabled to be active learners, more social, and identify and investigate real problems.

Based on the general description above, then the researcher is interested to do research entitled "**The Comparison of Pupils' Mathematical Ability in the Classroom that Taught Using Problem – Based Learning and Project – Based Learning Model in Grade Seven SMP Negeri 2 Panai Tengah A.Y 2015/ 2016**".

Specifically, objectives of the researchis to determine ifpupils' mathematical problem solving ability in the classroom that taught using Problem Based Learning (PBL) higher than pupils' mathematical problem solving ability in the classroom that taught using Project Based Learning (PjBL). The hypothesis of this research is pupils' mathematical problem solving ability taught by Problem Based Learning is higher than pupils' mathematical communication ability taught by Project Based Learning.

Problem solving itself means engaging in a task for which the solution method is not known in advance. In order to find a solution, students must draw on their knowledge. National Council of Teacher Mathematics (NCTM) creates Problem Solving Standards in which the instructional programs from prekindergarten through grade 12 should enable students to:

1. build new mathematical knowledge through problem solving;
2. solve problems that arise in Mathematics and in other contexts;
3. apply and adapt a variety of appropriate strategies to solve the problems;
4. monitor and reflect on the process of mathematical problem solving.

(NCTM, 2000: 52)

The problem solving ability consists of understanding the problems, devising a plan, carrying out the plan, and looking back stages as Polya proposed (Isoda ed., 2007: 92). PBL and PjBL have advantage in promoting problem solving skills (Akinoglu and Tandogan, 2006; Chang et al., 2011).

RESEARCH METHOD

This research is a post-test-only comparison group design conducted to compare pupils' mathematical problem solving ability taught by Problem Based Learning and Project Based Learning in SMP Negeri 2 Panai Tengah Academic Year 2015/2016 grade 7. The design is given as follows:

Table 1. Posttest Only ComparisonGroupDesign

Class	Treatment	After Treatment
Experiment	X_1	T_1
Comparison	X_2	T_1

Explanation:
X_1 : Problem – Based Learning (PBL) model
X_2 : Project – Based Learning (PjBL) model
T_1 : Post – Test

The population of this research is all pupils of grade 7 SMP Negeri 2 Panai Tengah in academic year 2015/2016. The sample is 30 pupils in VII-1 as the experimental class taught by Problem Based Learning and VII-2 as the comparison class II taught by Project Based Learning consists of 31 pupils. In addition, the instrument was mathematical problem solving ability test.

The data are analysed using Normality test, Homogeneity test, and Independent Sample t-test.

RESULT AND DISCUSSION

The result of this research shows the mean score for each class is quite different. This table shows descriptively the difference of their mean scores. The mean score of pupils taught in Problem Based Learning (PBL) class is 54.07 with standard deviation of 40.014, and at the same time, the mean score of pupils taught in Project Based Learning (PjbL) class is 41.32 with standard deviation of 34.919.

Table 2. Descriptive Statistics Summary of PBL and PjBL Class

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
PBL Score	30	0	100	1622	54.07	40.014
PjBL Score	31	0	100	1281	41.32	34.919
Valid N (listwise)	30					

Before analysing the data by using Independent Sample t-test, the normality, independence, and homogeneity tests should be conducted. The normality test used is *Kolmogorov-Smirnov* test with significance level (α) of 5 % using SPSS Version 22. Based on the result of normality test conducted using SPSS, the significance value of mathematical problem solving ability test in the experimental class is 0.111 and the comparison class is 0.071 which are higher than significance level of 0.05. On the result of *Kolmogorov-Smirnov test*, the population is normally distributed.

Since PBL and PjBL are two independent classes, a *Levene's test* of homogeneity with significance value (α) of 5 % using SPSS 22 is selected. A Levene's test gives the statistics 1.435 and *p* value of 0.236. Since *p* -value is larger than 0.05 then the null hypothesis is accepted and the conclusion is that the variances of both groups (PBL and PjBL) are assumed equal.

An *Independent Sample t-test* should be conducted to compare two means of different groups. In this test, there are two hypotheses; they are:

H_0: $\mu_1 \leq \mu_2$

H_a: $\mu_1 > \mu_2$

Note:

μ_1 : Mean score of pupils' mathematical problem solving ability taught by PBL

μ_2 : Mean score of pupils' mathematical problem solving ability taught by PjBL

Based on the *Independent Sample t-test* is obtained $t_{calculation}$= 1.327 whereas t_{table} = 1.67. The value of $t_{calculation}$ is less than or equal to t_{table} then H_0 is accepted and H_a does no longer exist. So, we can conclude that the pupils' mathematical problem solving ability taught by PBL is not higher than pupils' mathematical problem solving ability taught by PjBL.

The result is empirically rejecting the paper of Hung (2011) for SMP Negeri 2 Panai Tengah case, although Hung viewed that pupil seems that "(PBL) is likely to result in better development of self directed learning and ability to deal with uncertainty than the (PjBL)". This study is relevant with Harahap's research (2014) stated that pupils' mathematical problem solving ability in class taught using PBL is not better than in PjBL in class X SMA Negeri 11 Medan and automatically rejecting Hung's paper (2011) as well as to the expected hypothesis. The result can be understood although pupils in PBL and PjBL classrooms learn mathematical problem solving in the same context and place, the absence of pupils while the test was conducted, was unable to prevented, besides the other factors that cannot be avoid or predicted, such as learning styles and habits, different environments, intelligence, etc. possessed by pupils.

Pupils in PBL classroom have real experiences in this research by working worksheets to hand pupils on modified problems. Every pupil works in their group and tries to solve problems using Polya's steps, from identifying what problem want they to solve, devising a plan to solve the problem and carrying it out. However, they are seemed to be confused while the problem forces them to look back at their solution although teacher has given scaffolding. Pupils tend to leave the part of 'looking back' empty in the first and second meetings. It is evident from pupils' solution in the test.

In the similar manner, pupils in PjBL classroom also have real experiences by working worksheets in order to link pupils on real life problems based on their circumstance. Pupils are doing a mini research through their worksheets. Worksheet of PjBL classroom does not provide an explicit Polya's steps like in PBL classroom, however, but it covers the steps implicitly. In the test, clearly, pupils tend not to write the Polya's steps explicitly in the test paper, but they work on it clear enough.

From both classes, there is a tendency in which pupils do not write the verification of their solution (looking part). No clear reason for leaving this part, but alternatively, there should be a thought that this part is not too important. This case is important to be highlighted in this research.

Both of instructional models have made pupils to be stronger in understanding the problem solving process. Through challenging activities, PBL and PjBL models have been giving the consciousness to pupils to learn more about the problems around them to solve. Although this research does not explain more about pupils' attitude in the classroom in the implementation of PBL and PjBL models, pupils are seemed to be interested in learning mathematics further. This is consistent to the findings of Akinoglu and Tandogan (2007),Yalcin et al. (2009), Bagheri et al. (2013), Shaer and Gaber (2014).

CONCLUSION

Based on the result of research obtained can be concluded that pupils' mathematical problem solving ability taught by PBL in the experimental class is not higher than pupils' mathematical problem solving ability taught by PjBL in the comparison class on subtopic Social Arithmetic in grade 7 SMP Negeri 2 Panai Tengah.

REFERENCES

Akinoglu, O., and Tandogan, R.O., (2007), The Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning, *EurasiaJournal of Mathematics, Science &Technology Education,* **3**(1): 71-81

Chang, C.S ., Wong., W.T., and Chang, C.Y., (2011), Integration of Project-Based Learning Strategy with Mobile Learning: Case Study of Mangrove Wetland Ecology Exploration Project, *Tamkang Journal of Science and Engineering,* **14**:265 –273

Cockroft's Report, (1982), Retrieved fromhttp://www.educationengland.org.uk/documents/cockcroft/cockcroft1982.html, 8 May 2015

Guttierez, A., and Boero, P., (2006), *Handbook of Research on the Psychology of Mathematics Education: Past, Present and Future, Sense Publisher, Rotterdam*

Hung, W., (2011), Theory to Reality: A Few Issues in Implementing Problem Based Learning, *Education Tech Research Dev*, **59**: 529–55

Isoda, M., Stephen, M., Ohara, Y., Miyakawa, T., (2007), *Japanese Lesson Study in Mathematics: Its Impact, Diversity, and Potential for Educational Improvement, World Scientific Publishing, Singapore*

Mink, D.V., (2010), *Strategies for Teaching Mathematics, Shell Education, California* NCTM, (2000), *Principle and Standard for Mathematics*, NCTM, USA.

O'Shea, J., (2010), Teaching Mathematical Problem Solving in the Primary School, *Resource and Research Guides*, **2**:1-4

Sierpinska, A.,(1994), *Understanding in Mathematics: Studies in Mathematics Education Series, Taylor and Francis, Inc.,Bristol*

Shaer, A.E., and Gaber, H., (2014), Impact of Problem-Based Learning on Students` Critical Thinking Dispositions, Knowledge Acquisition and Retention, *Journal of Education and Practice*, **5**: 74 – 85