The Effect of Problem Based Learning (PBL) Toward Mathematics Communication Ability and Curiosity

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Abstract. The purpose of this study is to determine the effect of learning using Problem Based Learning approach (PBL) toward the ability of mathematics communication and curiosity of class X students. This research is a quasi-experimental study with non-equivalence control group design with composition material and inverse function. The selection of schools used purposive sampling method. The population studied from 2 homogeneous classes. The instruments are mathematics communication observation sheets, mathematics communication test and questionnaire given at the beginning of treatment as pre-test and post-test at the end of learning in experiment class and control class in order to measure the ability of mathematical communication and curiosity of the students as well as improving students' mathematics and curiosity communication skills. Thus PBL-based learning is able to influence students' mathematics communication skills demonstrated through test and discussion results presented through mathematics ideas presented in written and spoken, express mathematical ideas, use notations, terms, symbols, tables and graphs in class and encouraging students to increase their curiosity with a very high category of 5.45%, high category increase 9.68% and medium category decreased by 9.68%. While the result of the mathematical communication ability with learning based on PBL is better than the conventional learning.

1. Introduction

The development of the knowledge and technology, especially in Indonesia had shown its progress in the 21th century. This moment trigger in making human resource that enable to compete in their own country or the foreign country, begin with education. Many effort is done by the government to repairing the quality of education in Indonesia such as change the curriculum. The change of the curriculum that happened affecting many sector, for example the change of teacher centered education become student centered education, the option for approach that must be synchroned with the students' characteristic, the development of learning instrument, and the other.

One of the effort which can be used so the learning process move effectively is selecting many strategies, approach or method which are used in the learning process have suited with the student characteristic. Effective teacher is a teacher that has preparation and activity in learning process which has arranged systematically [1]. One of the other approach that are suggested enable for learning activity is Problem Based Learning (PBL). PBL also defined as problem-based learning is learning that emphasis authentic problems like those that occur in daily life [2].

The purpose of learning using PBL is (1) the ability to find and solve the problem, which covering problem identification, problem investigation, alternate problem analysis, and making decision with
evidence, (2) the ability of independent learning, which cover learning topic identification and question, find and evaluate information, arrange and combine information and showing learning evidence, (3) the ability to cooperate, which cover listening, problem solving, arranging the difference and conflict, and suggesting, knowing and supporting also (4) the ability arranging problem work, which cover making purpose, identification learning strategy and scoring the result [3]. Based on the above suggestions, it can be generally assumed that PBL characteristic in general is 1) real problem as a start point in learning, 2) encourage the problem solving or create solution, 3) learning to gain information and knowledge, 4) using all the education resource and information, 5) small group learning, 6) teacher as facilitator and 7) create solution or result.

By using PBL, it is expected that learning will be valuable, able to solve the difficulty in learning mathematics and students are able to done the problem solving which related in the daily life and the students are able to develop the creativity [4]. Based on the several definition above, this research used syntax PBL that is problem serving, problem solving planning, problem inspecting, serving the result and analyze also evaluate problem solving process.

The success in reach the goal of learning is very depended on the process of learning that has done by the teacher in the class, because the learning process is a process of interaction between teacher and student directly. Teacher and students interaction happened through communication. Communication is an important thing in the live done by two person or more to transfer the knowledge and experience one another. The ability of students' mathematic communication are very needed to be developed because by students' mathematic communication are able to reorganize mathematic thinking well through spoken or written[5].

More specific listed that communication is the process of expressing mathematical ideas and understanding orally, visually, and writing using numbers, symbols, picture, graphs, diagrams, and word [6]. By in the book of Principles and Standards for School Mathematics, the standard of mathematic communication cover organize and combine learners' mathematic thinking through communication, communicate their mathematic thinking clearly to their friends, teacher, and the other; analyze and evaluate mathematic thinking and strategy; and using mathematics language to express mathematic ideas correctly [7]. Based on the explanation above its can be summed that mathematic communication is a way for students to express and judge mathematic ideas spoken or written, whether in the form of picture, table, chart, or demo in the idea and in the model of mathematics. In this research, indicator measurement of ability in mathematic communication for student cover the ability in understanding, interpret and evaluate mathematic idea which served in the form spoken or written, using a mathematics language approach (notion, term or logo) and representation of mathematics (formula, chart, table, graph, model) to express mathematical information and finish the problem, and change and interpret mathematical information in representation of different mathematics.

The lack of ability of students' mathematic communication is caused because the learning process that undergoing in Indonesia still oriented in mastering basic skill and only few adapted in daily life and communicate mathematically [8]. The result of observation which done by [9] shown that ability of students' mathematic communication seem law in students' learning lack of confidence in communicate their ideas and still doubt in answer the question given by teacher, students have difficulties in finish the problem in the form story task, and students enable communicate their ideas or opinion correctly yet.

To welcome 21 century in the learning must be cover competency and skill which needed for students to face the life, job field which cover thinking critically skill ability and problem solving, collaboration and leadership, agility and adaptability, initiate and entrepreneurship, able to communicate effectively whether spoken or written, able to access and analyze information, and having curiosity and imagination [10]. So, not only the ability of mathematic communication that is needed but also the students must have curiousity. Curiosity is a cognitively based emotion that occurs when student recognizes a discrepancy or conflict between what he or she believes to be true about the world and what turns out actually to be true [7]. Furthermore, it said that curiosity is a desire
to learn, investigate, or know. It is an interest leading to exploration or inquiry [11]. This statements strengthened by the statement curiosity refers to the desire for acquiring new information [12]. Meanwhile, [13] said that curiosity is the interest in the world and the capacity to analyze and to see things from different perspectives. Therefore, it can be concluded that curiosity is interest of desire to gain new information toward something that learnt, seen, listened which intended with interest to explore and ask to all thing.

The students’ curiosity in the learning process is a social attitude that need to be developed and explicitly and a part of basic competency from the curriculum that applicable in Indonesia. Curiosity is very important for students because it can become a bridge between idea, perception, concept, and representation [14]. Therefore, curiosity has many benefit for a person especially in learning because it can encourage the students to seek and find to all thing, and able to help in the cognitive development, social, emotion, spiritual and physical in the students’ daily life.

2. Material and Methods
This research done with the purpose to make a test to effectivity of Problem Based Learning (PBL) approach to facilitate the ability of mathematic communication and curiosity of the students toward inverse and composition function. This research use quantitative method with quasi approach experiment with nonequivalent control group design. This design pictured as.

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| Eksperimen | Q₁  | X₁  | Y₁  |
|------------|-----|-----|-----|
| Control    | Q₁  | X₁  | Y₁  |
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**Figure 1.** Non-equivalent control Group Design.

Keterangan:
Q₁,₂ : Pretest result
Y₁,₂ : Posttest result
X₁ : Treatment of PBL based mathematic learning
X₂ : Treatment without of PBL based mathematic learning

This research beside consist of two research group that is experiment and control class which two of them have most similar characteristic (homogene). Experiment class is given special treatment that is the learning process use PBL approach while the control class use conventional learning method.

This research is held in SMA 1 Negeri Pundong Bantul which located in Srihadono, Pundong, Bantul Yogyakarta., Indonesia in the first semester in the academic year 2017/2018. School technique sampling is based purposive sampling. Meanwhile, the research sampling consist of two class X IPA 2 and X IPA 3 which each of them have 31 students with the duration age between 15-16 years old. The class X IPA 2 as a control class and X IPA 3 as experiment class. Two of the class is taught by different teacher with long teaching duration and relative same education graduate. The choice of the class X is customized with Piaget learning theory that state students which aged more than 11 years old located in the transition step from concrete operation to formal operation which cover abstract, symbolic thinking, and logic which intended able to increase students' mathematic communication ability [15]. This research applicable for 8 hour meeting or 16 - 45 minutes on the two of the sampling class. The material that has taught is the inverse and composition function material with learning media in the form of student worksheet based PBL on the inverse and composition function material. In each section, teacher fill up the observation sheet of students' mathematics communication ability which intended to know the students' mathematics communication in the learning process is going on, whether it is in the discussion or in working on assignment. Observation sheet is based on likert scale from 1 up to 5 for the answer of the question which never, seldom, sometime, often, and always.
Instrument that is used for the research is mathematics communicat
tion test. The test is given to the experiment class and control class in the beginning of the treatment and pre test and post test in the end of the learning on the experiment class and control class. The test is given to the students to measure the students' mathematics communication and to measure the improvement of students' mathematics communication. Test for measure students' mathematics is in the essay form contain 5 task with time allocation given is 70 minutes. Therefore, the task is based on the indicator of students' mathematics communication. While the students' curiosity is obtained by questionnaire which is given after done the pre test and post test. The filling of questionnaire is 20 minutes with the 30 task and the scoring using likert scale 1 up to 5. The composition of the scoring is from never, seldom, sometime, often, and always. Validator for the test of communication ability and curiosity consist of dean/ lecturer, teacher and colleagues.

3. Conclusions
From the research that is done based 31 students in the experiment class and control class is proposed hypothesis as follow:

\[ H_0 : \mu_x^2 = \mu_y^2 \]  
Information: \( \mu_x^2 \): Mean score of experiment class student

\[ H_1 : \mu_x^2 > \mu_y^2 \]  
\( \mu_y^2 \): Mean score of control class student

\[ H_0 : \text{Mean score of experiment class is worse than control class} \]

\[ H_1 : \text{Mean score of experiment class is better than control class} \]

Test criteria:
Decline \( H_0 \) if \( p\)-value (Sig.) \(< \alpha = .05 \) while for the other term \( H_0 \) accepted.

After used SPSS 24, the result is obtained from pretest for ability of students' mathematic communication which used PBL and conventional as follow:

| Independent Samples Test | Levene's Test for Equality of Variances | Homogeneity of Variances | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|--------------------------|--------------------------------------|--------------------------|-----------------|----------------------|----------------------------------------|
|                          | df | Sig. | df | Sig (Df=24) | F | Sig. |  |  | Lower  | Upper  |
| Mathematics              | .582 | .491 | 430 | .999 | 4.06710 | .2003 | .003 | .99217 | -.32314 | .51246 |
| Mathematics not assumed  | .430 | .9112 | .999 | .88740 | 2.0037 | .003 | .99217 | -.32314 | .51246 |

**Figure 2.** The result of pretest with SPSS 24.

From the picture above, the conclusion is obtained that value of \( p\)-value = .669 \( > .05 \) this mean there is no difference between mean of two sampling and between experiment class and control class. The mean score of experiment class is 35.5645 and for control class is 34.6674. While the post test resulted after usage of PBL learning and conventional for measure of students' mathematic ability is resulted as follow:

| Independent Samples Test | Levene's Test for Equality of Variances | Homogeneity of Variances | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|--------------------------|--------------------------------------|--------------------------|-----------------|----------------------|----------------------------------------|
|                          | df | Sig. | df | Sig (Df=24) | F | Sig. |  |  | Lower  | Upper  |
| Mathematics              | .88 | .666 | 3.083 | .993 | 11.88710 | 3.53167 | .003 | 17.95149 | 17.95149 |
| Mathematics not assumed  | .88 | .5998 | .993 | 11.89740 | 3.53167 | .003 | 17.95149 | 17.95149 |

**Figure 3.** The result of posttest with SPSS 24.

From the picture above, it can be concluded that value of \( p\)-value = .003 \(< .05 \) it mean there is a difference of mean in the students’ mathematic communication ability that used PBL approach and conventional. By the mean score for the experiment class is 79.5968 and for control class is 68.7097.
Therefore, the usage of PBL approach enable to improve students' mathematic communication ability. Meanwhile, for the questionnaire of curiosity of the students resulted in the beginning of the learning is equal with very high category with the precentage 0%, high category is 48.39% and average category is 38.71%. While in the last treatment, the students' curiosity is resulted in the very high category that is 61.29%, and average category is 22.58% in the experiment class. Therefore, it can be concluded that students that used PBL learning are able to improve the curiosity about the mathematics, especially in composition function.

The result of the research is shown that learning through PBL approach is effective to improve the ability of mathematic communication of the students because syntax in the PBL is allow the students to understand, interpret, and evaluate mathematic idea which is served in the form spoken or written, use mathematic language approach (notation, term, symbol) and representation of mathematic (formula, graph, table, chart, model) to express mathematic information and solve the problem, also change and interpret mathematic information in representation of mathematic which is different through problem serving, problem planning, result serving, problem investigating, serving the result and while analyze also evaluate them. Students' affective abilities such as discussion, interest in mathematics, learning benefits can be felt from the use of PBL approaches, mathematical communication and the level of student involvement in learning using the PBL approach.

Excellence in learning using the problem approach is the establishment of interaction between students in solving challenging problems through discussion. This statement correlated with the research [16] which state that PBL enable to improve students' mathematic communication. Furthermore, [17] stated that the PBL approach is an approach that is able to place students as centers of learning in solving a problem where students are focused on reflection activities, ability in communication and collaboration and in reflecting questions from different perspectives. This is reinforced by the opinion of [18] that the ability that can be developed and become the focus in PBL is mathematical communication. While the effectiveness of PBL also enable to improve the students' curiosity, students feel challenged after given the problem in the beginning of the learning and with the learning based on PBL, the students are facilitated to have discussion with their friends. This case correlated with the research [19] which stated that PBL enable to improve students' curiosity. Curiosity can also be enhanced by linking lessons, one of which is by connecting examples of material to be studied with students' lives according to the characteristics of PBL [20].

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