The effect of problem-based learning model to students’ cognitive achievement on high and low students’ problem-solving abilities

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Abstract. This study aimed to determine the effect of PBL model on students’ cognitive achievement on high and low students’ problem solving abilities. This study was quasi experiment research by using posttest only non-equivalent control group design with 22 students of X(3) grader science class as control class (conventional model ) and 21 students of X(4) as experiment class (using PBL model) at one of senior high school in Surakarta. Students’ problem solving abilities illustrated as abilities in four aspects: identification the problem, identification the cause of problem, create the method of problem solution, examine the result of problem solving by using 40 items of multiple choice question refers to Problem Solving Skill Test [12]. Students’ problem solving abilities measured before the research is done and divided into high and low categories. Students’ cognitive achievement illustrated as students’ concept understanding and measured by using essay test as given after the PBL model used. Instrument had been validated by expert judgment and students. Data analyze by using t-test. The result showed: 1) Sig. (0,00<0,05) Ho rejected, there was difference of students’ achievement between experiment class and control class; 2) Sig (0,683 >0,05) H0 accepted, there wasn’t difference students’ achievement with high problem solving abilities between low problem solving abilities.

1. Introduction
The future education system was design to prepare young generations able to use their thinking skill and problem solving to deal with complicated problems. In the information technology era, the ability to think and solve problems is very important for students to have world-class knowledge to build the country [1,2]. However, students’ problems solving abilities is generally still low. The trends of PISA test performance based on rank and achievement score over time are relatively low ie: 38/41 with score 393 (2000); 38/40 with score 395 (2003); 53/57 with score 393 (2006); 60/65 with score 383 (2009); 64/65 with score 382 (2012); 62/70 with score 403 (2015). The trends of TIMSS test performance showed not much different ie: 32/38 with score 435 (1999); 37/46 with score 420 (2003); 35/49 with score 427 (2007); 40/45 with score 406 (2011); 46/51 with score 397 (2015).

Analyze result showed one of the factors that dominate the cause of Indonesian students’ PISA and TIMMS test performance is problem solving abilities low. This is supported by various research that
learning less to empower students’ problem solving abilities [3,4]. Learning observations and deep interview with teachers indicate that teachers are confused how to develop problem-solving-based learning [5]. The Problem-based learning (PBL) model has been introduced for use in learning through the curriculum 2013. However, in practice it has not delivered the desired results. In addition, the application of the PBL model generally less considering the important factors such as the students' problem solving abilities. Departing from that, hence this research aims to know the effect of PBL model application to students’ cognitive achievement on high and low students’ problem solving abilities.

1.1 Theoretical framework

The PBL model has syntax: orientation to the problem, organizing students, independent and group investigations, developing and presenting artifacts and exhibiting them, analyzing and evaluating problem-solving processes [6]. Characteristics of the PBL model is to expose students to practical problems in their daily lives as stimuli in learning [7]; helping students think through problem solving and constructing knowledge [8], allowing a variety of solutions to be viewed from various aspects, authentic inquiry, product yield, and co-operation [9]. There are three basic elements in the PBL model: initiating triggers, examining previously identified issues, utilizing knowledge in understanding the problem in depth [10]. The advantages of facilitating PBL models students build knowledge and make students interested in learning by being actively involved in learning [10]. Through the PBL model students are able to identify complex problems in the real world, manage conflict, make decisions independently [11, 12], developing high-order thinking skills [13, 14]. The weakness of the PBL model is less effective when applied in large classes [15]. The higher the students 'ability to solve the problem, the greater the chance of teachers' success in applying the PBL model. The importance of considering student problem solving skills in applying the PBL model. Problem Solving Skill Test (PSST) of Problem Solving Skill Test (PSST) instrument in the form of 40 multiple choice questions covering 4 aspects: identifying problems, identifying causes of problems, proposing problem solving methods, testing problem solving results [4].

2. Methods

This research is a quasi experimental research with pretest-posttest non-equivalent control group design that involves the subjects of 43 students of IP X class in a high school in Surakarta. Students' problem solving abilities were measured before the research was conducted using the Problem Solving Skill Test (PSST) instrument in the form of multiple choice questions as many as 40 covering four aspects: identifying problems, identifying causes of problems, proposing problem solving methods, testing problem solving results [4]. Problem-solving skills are grouped into 2 high and low categories. Data on cognitive learning outcomes was measured using a questionnaire test of 3 questions. The research instrument has been validated by an expert judgement and is eligible for use.

3. Results and Discussion

Data description students’ cognitive achievement shown in Table 1, Table 2 and Table 3.

| Table 1. Data of Description Students’ Cognitive Achievement |
|-----------------------------------------------------------|
| Model | KMM | Mean | Std. Deviation | N |
|-------|-----|------|----------------|---|
| PBL   | High| 86.00| 2.449          | 11|
|       | Low | 86.67| .866           | 9 |
|       | Total| 86.30| 1.895          | 20|
| Conventional | High | 78.92| 11.587         | 12|
|         | Low | 80.30| 10.067         | 10|
|         | Total| 79.55| 10.689         | 22|
| Total  | High| 82.30| 9.108          | 23|
|         | Low | 83.32| 7.853          | 19|
|         | T   | 8    | 8.476          | 42|
Table 2. Levene’s Test of Equality of Error Variances

|       | F    | df1 | df2 | Sig. |
|-------|------|-----|-----|------|
|       | 3.938| 3   | 38  | .015 |

Table 3. Levene’s Test of Equality of Error Variances showed that sig (0.015< 0.05), it mean there are differences in variation between groups

| Source        | Type III Sum of Squares | df | Mean Square | F    | Sig. |
|---------------|-------------------------|----|-------------|------|------|
| Corrected Model | 490.602a                | 3  | 163.534     | 2.531| .072 |
| Intercept     | 285832.455              | 1  | 285832.45   | 4424.261| .000 |
| Model         | 469.446                 | 1  | 469.446     | 7.266| .010 |
| KKM           | 10.906                  | 1  | 10.906      | .169| .683 |
| Model * KKM   | 1.333                   | 1  | 1.333       | .021| .887 |
| Error         | 2455.017                | 38 | 64.606      |      |      |
| Total         | 290626.000              | 42 |             |      |      |
| Corrected Total | 2945.619               | 41 |             |      |      |

Figure 1. The Average of Students’ Cognitive Achievement and High and Low Students’ Problem Solving Abilities (Source: author)

The result of t-test on the learning model shows that sig. 0.010 <0.05 concludes that H0 is rejected. It was mean that there is difference of students’ cognitive achievement between experiment class (using PBL model) and control class (using conventional model). This is related to the characteristics of the PBL syntax model which includes five: problem orientation, organizing of student learning,
investigation (individual and group), presentation and artifact exhibition, analyzing and evaluating the process of problem solving [6]. In the syntax of problem orientation students are faced with one problem in real life and students are required to identify and find problems to find the solution in terms of various aspects. Here students are trained in problem solving skills including: identification the problem, identifying the cause of problem, the problem solving as the problem solving component presented in Problem Solving Skill Test [4], so the students' ability to solve the corrected problem [2, 8]. Conventional learning, even though students solve problems but less challenging, thus less encouraging students to think high level. While by the PBL model, students are required to analyze the presented phenomena, formulate problems, develop hypotheses and design investigations [9, 13]. By performing a series of PBL model syntaxes leads to more meaningful learning. PBL learning model has the characteristics of training students to understand the subject matter in depth to develop problem solving skills [12]. Student-centered biology learning is the right way to teach students learn to increase student motivation and problem solving so as to provide opportunities for students to help overcome problems [16].

Judging from the students' problem solving abilities, t-test result shows sig 0.683> 0.05. It can be concluded that H0 is accepted, it was mean there is no significant difference of students’ cognitive achievement between high and low students’ problem solving abilities. This is because students' ability is relatively homogeneous, so the difference between high and low students’ problem solving abilities is poor. While the results of the interaction between the PBL model and students’ problem solving abilities obtained sig.0.889 and H0 received, meaning there is no interaction between PBL model and students' problem solving abilities [6]. This is related to the characteristics of the PBL model that has the potential to empower students' problem solving abilities.

4. Conclusion
Based on the results of the research can be concluded that problem-based learning model have a significant effect on students’ cognitive achievement, but not significant difference between students’ with high or low problem solving abilities.

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