

The Effect of Problem- Based Learning on Critical Thinking Skills and Student Achievement

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Abstract- The purposes of this study are (1) to know the effect of Problem-Based Learning on critical thinking, (2) to know the effect of Problem-Based Learning on student achievement in cognitive aspects, (3) to know the relationship between critical thinking and student achievement in cognitive aspects in Environmental Pollution of 10th Grade in The 1 Bantul Senior High School. The research was quasi experimental research using a control group pretest-posttest design. Sample was X IPA 5 as an experimental group while X IPA 6 as a control group. Data collection methods in this study were observation sheets, videos, photos, student's critical thinking skills data, and student's achievement data in cognitive aspect. Instruments that were used in this study were instrument to collect the implementation of PBL, instrument to collect the student's critical thinking skills and also student's achievement in cognitive aspect. Data analysis techniques were normality and homogeneity test, t test, analysis of covariance (ANACOVA), and Pearson correlation. The results show that (1) Problem-Based Learning affects critical thinking, (2) Problem-Based Learning affects student achievement in cognitive aspects, and (3) there was a significant relationship between critical thinking and student achievement in cognitive aspects. The higher critical thinking is, the higher student achievement especially cognitive aspects of the students.

Keywords: problem- based learning (PBL), critical thinking, student achievement, cognitive aspects

I. INTRODUCTION

In a rapidly changing world, every person is challenged to fulfill the global demand especially in developing skills. The impact of the rapid change in society to education is that education must prepare generation to have a certain skill needed by the society. The skills are called 21st century skills. Partnership for 21st Century Skills [1] has developed 21st century skills that consist of life and career skills, learning and innovation skills, and information media and technology skills. Teaching and learning process does not only increase student's knowledge but also develop student's creativity, critical thinking skill, characters which are included the character to has responsibility, social skills, tolerance, productivity, and adaptive skills. 21st century skills also emphasize on the ability to think critically, solve problem, communicate, and collaborate each others [2] that are included in Higher Order Thinking Skills.

Problem- Based Learning (PBL) is teaching and learning model that provide contextual problems to the classroom, so that teacher can stimulate students to learn [3]. PBL is a teaching and learning model that present many authentic problems and meaningful to the students [4]. Teaching and learning process using PBL challenges students to learn, work in group to look for the solution in contextual problem. Teaching and learning process is directed to student in order to develop student's ability in making solutions systematically.

PBL has five characteristics that need to be considered by teachers before designing the lesson plan using PBL model. The first characteristic is presenting essential question that is included problems. The others characteristic are PBL focuses on the relationship between interdisciplinary study, authentic investigation, publication of the artifact, and collaboration [4]. There are five operational steps from PBL, (1) giving orientation about the problem that will be discussed by student, (2) organizing students to do research, (3) helping students to investigate the problem, (4) developing and exhibiting the artefact, and (5) analysing and evaluating problem solving process [4].

Critical thinking is the process of complex thinking to analyse question or argument and generalize meaning and specific interpretation through logical thinking and understanding assumptions. The student's critical thinking ability can be identified by implementing proper teaching and learning model such as PBL model. Students who involved in PBL have critical thinking ability higher than students who involved in traditional teaching and learning model [5]. Teaching and learning process using PBL encourages student to think critically by presenting the extraordinary problems which the solution cannot be solved using common ways of thinking [6].

Student's achievement is student's skills that achieved by students after teaching and learning process. One of student's achievement that can be measured is cognitive aspect. According to revised Bloom Taxonomy [7] there are six aspects: (1) remember, (2) understand, (3) apply, (4) analysis, (5) evaluate, and (6) create

There are several advantages in using PBL as one of teaching and learning models. By using PBL increases student's understanding and increasing student's activities during teaching and learning process [8]. PBL helps students in transferring their factual knowledge to understand the contextual problem. PBL also develop student's responsibility and the most importantly is that PBL can increase the student's thinking ability. PBL brings the happiness in the classroom through teaching and learning process. By using PBL in classroom, it can increase student's critical thinking and also give student possibility to apply their knowledge in order to solve the problems.

One of senior high schools that has implemented curriculum of 2013 is The 1 Bantul Senior High School. Biology teaching and learning process that is used using 2013 curriculum ideally should develop student's critical thinking skill. One of teaching and learning models that develop critical thinking skills is PBL. However, not all of the teaching and learning process has developed student's critical thinking skill. Teaching and learning process still conducted by teacher give whole information to students using conventional model such as question- answer method. Whereas, critical thinking skills do not merely appear instantly. It needs efforts to develop student's critical thinking skill. This skill, critical thinking, is ability that student should have in achieving learning mastery.

Learning material that is used in this study is environmental pollution. Environmental pollution choosed to be study material because it presents contextual problem that should be solved by student in daily life. This material bring problems that usually faced by student in their daily life. The implementation of PBL is on the Standard Competition 3.10 that it emphasizes on analysing data in environmental changing and the implication in environmental changing. In this material, students are confronted with environmental problem and are demanded to solve problems using critical thinking and also gathering information to solve problem systematically. This material provides dynamic environmental problem. Environmental problems tend to be complex and need to be solved using higher order thinking skills.

Based on the background above, there are three research question for this study (1) what is the effect of PBL to critical thinking?, (2) what is the effect of PBL to student achievement in cognitive aspects?, and (3) is there any relationship between critical thinking and students achievement in cognitive aspects in Environmental Pollution in The 1 Bantul Senior High School?

II. METHOD

This study, which was carried out to know the effect of PBL to critical thinking and student achievement, was designed according to quasi experiment design using control group pretest- posttest design. This research is conducted in The 1 Bantul Senior High School, Bantul Regency, Special Region of Yogyakarta.

Population of this study was students of 10th grade of Science Program in The 1 Bantul Senior High School, which was consisted of two classes, 10th Science Program 5 as experimental group and 10th Science Program 6 as control group.

The dependent variable of this study was PBL that consists of five steps, (1) problem orientation, (2) study organization, (3) individual and group investigation, (4) presentation, and (5) analysis and evaluation. The independent variables in this study were critical thinking and student's achievement focuses on cognitive aspect. The critical thinking aspects measured in this study are interpretation, inference, explanation, analysis, and evaluation. The cognitive aspects measured in this study according to revised Bloom Taxonomy are remember, understand, apply, analyse, and evaluate.

The study conducted by determining experiment group and control group by giving treatment which was PBL for experiment group and conventional model for control group. Extraneous variables were also controlled. Data was collected using test (pre test- post test), the implementation of PBL, and student evaluation about the implementation of PBL in class. After data had been taken, data was analysed.

Data collection methods in this study were observation sheets, videos, photos, student's critical thinking skills data, and student's achievement data in cognitive aspect. Instruments that were used in this study were instrument to collect the implementation of PBL, instrument to collect the student's critical thinking skills and also student's achievement in cognitive aspect.

The data obtained in the study were SPSS program version 21. Data analysis that were used were normality test and homogeneity test. To know the difference between two groups, T test was used in order to know the difference between experiment group and control group. To know the difference between two groups before and after the implementation of PBL, Paired Sample T test was also used. Covariance analysis is also used to know the influence of covariance to the dependent variables. The relationship between variables were analysed using Pearson Correlation Test.

III. RESULT

Descriptive analysis was conducted to describe the student's critical thinking skills and student's achievement. According to descriptive analysis, experiment group had higher result in critical thinking skills and student achievement than control group.

Table 1. Descriptive Analysis of Student's Critical Thinking Skills and Student's Achievement

	Control Group		Experiment Group	
	Critical Thinking	Student Achievement	Critical Thinking	Student Achievement
Mean	66,11	69,33	77,50	79,57
Median	70	72	80	80
Mode	65	76	75	68
Max	85	88	100	100
Min	35	56	35	68
STDV	18,47	16,34	15,37	8,73

As seen on the table above, it was understood that experiment group has higher average on critical thinking (77,50) and student's achievement (79,57) than control group which has 66,11 for critical thinking and 69,33 for student's achievement.

According to Independent Sample T test, there was a significant difference between the median of critical thinking ability (sig. 0,016) and student achievement (sig 0,005) which was showed by the sig 0,05. According to the result of Paired Sample T Test, there was a difference between before and after the implementation of PBL in experiment group, whereas there is no difference in control group before and after the learning process.

Table 2. Paired Sample T- test Result

Group	Aspect	Sig	Result
Control	Critical thinking	0,805	Not difference
	Student achievement	0,0006	Difference
Experiment	Critical thinking	0,014	Difference
	Student achievement	0,000	Difference

According to Covariance Analysis, there was an effect of PBL to student's critical thinking ability and student's achievement which was shown by the sig 0,016 for critical thinking and 0,006 for student achievement. It means there is a difference between critical thinking and student achievement in the experiment group and control group.

Table 3. Covariance Analysis

Dependent variable	Sig
Critical thinking	0,016
Student achievement	0,006

The result of Pearson Correlation Test to independent variables, critical thinking and student achievement, shows that there was a relationship between thinking ability and student achievement. Correlation coefficient in critical thinking and student achievement was 0,406. It means that two independent variables, critical thinking and student achievement, had significant correlation. The correlation between critical thinking and student achievement is positive correlation. It means that the higher critical thinking was, the higher student achievement of the students after involving PBL class.

IV. DISCUSSION

The difference results between control group and experiment are caused by students in experiment group involve in PBL classroom which is student-centered learning. PBL gives students opportunities to actively participate during learning process. Students actively discuss for solving the problems provided by teacher about the environmental pollution. Students are encouraged to solve the problem using analytical thinking and also encourage them to apply their knowledge in order to solve the given problems. These activities are developing student critical thinking because student are also encouraged to seek and gather the information relating to the problem they will solve. Students are also analysing and associating the relationship between information relating to the problems. Through all these activities, students have opportunities to think deeply about the environmental concepts that they get through thinking activities during problem solving activities. All those activities are also increasing student's understanding about environmental pollution which has influence to student achievement especially cognitive aspect.

PBL consists of five steps which is begun from (1) problem orientation, (2) student organization, (3) problem investigation, (4) artifact exhibition, and evaluation [4]

1. Problem orientation

Problem orientation is presented by giving students phenomena which present the certain environmental problems. The problem orientation activities is introduced to students to solve the problem globally. The environmental pollutions which are presented in the classroom can be air pollution, water pollution, and soil pollution. Problems can be presented to students in videos or articles from local news papers. From the phenomena, students is guided to analyse the cause of that pollution problems. Students are encouraged to generally deliver their thoughts about the specific problem causing the environmental pollution phenomena. By sharing their thought about the problems, students are introduced to the broad understanding about the problem they must solve during problem investigation.

2. Student organization

Second step of PBL is student organization. In this steps, students are divided into small groups consist of 4 people. After dividing class into groups, each group made simple group organization which consisted of leader, notulen, and members. After making student organization and giving each student assignments that should be done by students. By making simple organization in each group, students will easily work on group because every student has known their responsibility. It makes them easy to discuss the problem and most importantly they will actively participate in the group discussion by giving their novel ideas.

3. Problem investigation

Problem investigation can be conducted as individual investigation or group investigation. First activity in problem investigation is finding the problem from the phenomena that has been presented by student in the beginning of the class. After finding the problems, students will state the problem by making some questions relating to the phenomena. However, there always possibility that students have difficulties in formulating problems. Students have not understand yet how to formulate the problem and make it into question. So that teacher must give examples how to formulate the problems into question. After students understand, students are encouraged to write down the question in the black board, so that every student can see the question made by students in every group. Students, accompanying by teacher, are guided to choose one of the listed questions to be a main problem discussed in the class. Through formulating the problems into questions, students are guided to the problem solving activities.

In order to investigate, student must conduct research by looking for some information to support their ideas in solving the problem. Students can use many sources such as textbooks, journals, magazines, newspapers, or other sources that can be found online. All of activities in problem investigation are student centered [4].

Problem analysis can be carried out after students have collected all of the supported informations. By group discussion, student analyse the cause of the problems and make a

connection between causes and effects. Every group also design the strategy to solve the problem systematically and write the results down as a classroom discussion topics.

4. Artifact exhibition

Artifact or product can be as a presentation. Presentations are developed based on the group discussion results. Every group must present their result in the classroom so that other groups can give their opinions in order to exchange information and solve the problems. Teacher concerns is really needed. Teacher must guide and control the discussion, so that every group can deliver their ideas and develop their ideas better. Exhibiting the discussion result also give student opportunities to develop their communication skills.

5. Evaluation

The last syntax in PBL is evaluation. Evaluation consists of evaluation and analysis of the problem solving results. Students actively participate in asking questions to other groups whose results are being presented. Students not only ask questions but also give supported comment or criticism to other group presentations. It also happens to groups whose results are being presented. They also give feedbacks by answering questions. In the end of presentation sessions, students are asked to draw conclusions and also make a reflection about the learning activities using PBL.

PBL is one of the learning model that encouraging student to identify problems from certain problems that presented in the beginning of the learning activities and also developing students ability in understanding problem better by formulating questions. PBL also gives students opportunities to access wider sources in order to find causes, process, and effect from the given problems which help students find ideas to design the solutions. Organizing students in the small group also makes student easily work in group because every student knows their assignment and has more chances to deliver their ideas. It can be concluded that these activities can develop student understanding better, because student can get a lot of information from many resources and also discuss it in the classroom.

Critical thinking skills that is measured are the ability to make interpretation, inference, explanation, analysis, and evaluation. The ability to make interpretation can be improved through giving students problems displayed in data through articles or video. Students then are asked to analyse the cause and effects of the problem and also formulate the problem in questions. Making inferences can also be developed by analysing the data exposing the certain problems. Students are driven to make a general conclusion about the problem. Explanation skill is one of critical thinking that can be developed by explaining and convincing causes and effect of a phenomenon. In PBL syntax, problem investigation, students are also driven to develop their ability in analysing a problem by analysing the relationship between causes and effects of a problem. In the end of exhibiting artefact, students are asked to make some evaluation including giving question or supporting comments to other group whose presenting the artefact in order to develop their ability in evaluating the ideas. These skills, interpretation, inference, explanation, analysis, and evaluation, are increasing during PBL teaching and learning process because PBL highly motivates and encourages student to use their thinking ability.

According to the result study, it shows that critical thinking skill has correlation with student achievement especially in cognitive aspect which has been stated by revised Bloom Taxonomy. There are five aspect that were measured in this study. There were remember, understand, apply, analyze, and evaluate. During teaching and learning activities using PBL, there are many activities that facilitate students to develop their thinking ability including Lower Order Thinking Skills or Higher Order Thinking Skills. Analysis, evaluate, and create are three level of revised Bloom Taxonomy that represent the critical thinking skills. It can be concluded that the higher critical thinking is, the higher student achievement especially in cognitive aspect. The results show that (1) Problem- Based Learning affects critical thinking, (2) Problem-Based Learning affects student achievement in cognitive aspects, and (3) there was a significant relationship between critical thinking and student achievement. The higher critical thinking is, the higher student achievement especially cognitive aspects of the students.

ACKNOWLEDGEMENT

This paper is made possible through help and support from parents, family, and friends. I would also like to express my great appreciation to Dr. Slamet Suyanto, M. Ed and Dr. Tien Aminatum, M.Si for their constructive suggestion and recommendation during the study.

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