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# The Effect of Problem based Learning Model and Concept Map Strategy for Problem Solving and Understanding of the Ecosystem Concept of High School Students

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**Abstract.** This research has purposes to: (1) determine the effect of PBL on problem solving and concept understanding of high school students, (2) determine the effect of Concept Map on problem solving and concept understanding of high school students. This research was a quasi-experimental research. The population in this research were all students of grade X SMA N 6 Yogyakarta. The samples taken for this research were four classes of the X graders out of 7 classes. Testing of differences in the effect of applying various learning models using the one way ANOVA test. These results of the research indicated that 1) the PBL learning model has significant effect on the problem solving and concept understanding of the ecosystem material of high school students; 2) Concept Map has significant effect on the problem solving and concept understanding of ecosystems material of high school students.

**Keywords:** Problem based learning; Concept map; Problem solving; Concept understanding.

## 1. Introduction

The role of education is needed by students in instilling problem solving skills. The ability to solve problems can be given from the beginning to students through learning activities at school. The application of problem solving skills to students, will be very relevant to the nature of science, namely products, processes and scientific attitudes. The nature of science in learning emphasizes students to participate in gaining their knowledge through skills and understanding.

Biology provides a variety of learning experiences to understand science concepts and processes associated with living organisms [1]. Biology included in one of the scientific fields of science, so that by nature, the researchers thought that learning in schools need to build the capacity of students' understanding of the concept is not just memorizing, especially at this biological material. That understanding can be constructed from the activities and experiences of students in order to evoke the students' potential in using thinking skills to solve problems with its understanding. Understanding of concepts in biology learning is considered very important because with the understanding that students



can understand the problems to be faced in the real world, in addition to the ability to solve problems will also appear along with the understanding that he had.

One theory proposed by Dewey learning is the learning by doing, the student should be active means to learn by doing student must play an active role intent of the phrase is in the process of learning that should be centered on the learners so that learners become more active while the teacher as facilitator. In order to empower the student's thinking, in particular an increase in the ability to solve problems and understanding the concept of high school students, some alternative models and or learning strategies considered to be a potential, so it is necessary to try to use by teachers, including teachers of biology. As dictated by Joyce and Weil in [2] that the model of teaching are really models of learning. As we help student acquire information, ideals, skills, values, ways of thinking, and means of expressing Themselves, and also we are teaching them how to learn. Based on these descriptions the teacher directs students to learn and become a facilitator, which means a student-centered learning so that students actively in learning. Most of the many potential models of learning is problem-based learning model or Problem-Based Learning (PBL).

*Problem Based Learning* (PBL) is a learning model approach to the problem of authentic student learning. According to Arends in [3] PBL is the core of authentic and meaningful presentation of the situation that acts as a foundation for investigation and inquiry of students. Meanwhile, according to Fogarty in [4] Problem Based Learning is a curriculum designed around models of real-life problems that are ill-structured, open-ended, or ambiguous. Prince in [5] states that Problem Based Learning (PBL) is an instructional method where relevant problems are Introduced at the beginning of the instruction cycle and used to provide the context and motivation for the learning that fallow.

According to [3] There are 5 steps in the model PBL must be performed by students and teachers, namely shown in Table 1:

**Table 1.** The syntax for Problem Based Learning

Stage	Teacher behavior
Phase-1 Directing students to problem	Teachers review the lesson objectives, lays an important logistic requirements and motivate students to engage in problem-solving activities
Phase-2 Prepare students to learn	Teachers help students define and develop learning tasks associated with problems
Phase-3 Helping independent and group research	Teachers encourage students to collect appropriate information, conducting experiments, and seek explanations and solutions.
Phase-4 Develop and present artifacts and long objects	Teachers assist students in planning and preparing the appropriate artifacts such as reports, videos, and models, as well as help them to share their work with others
Phase-5 Analyze and evaluate the problem solving process	Teachers help students to reflect on their investigations and the process they use

According to Daryanto [6] Problem Based Learning has the following characteristics: (1) lesson focuses on solving the problem, (2) responsibility for solving the problem lies in students, (3) teachers support the students work in solving the problem. Cheong in [7] states in his journal Problem Based Learning is the learning that results from the process of working towards the understanding and resolution of a problem in a real content. Problem Based Learning Model will effective if supported by appropriate strategies.

Therefore, in this research Concept Map Strategy will be used as a combination with the learning models. Novak and Gowin in [8] revealed that a major function in learning is learning concept. Concepts are classes or categories of stimuli that have general characteristics. Concept Map is a collection of interconnected concepts with a certain relationship between the couple the concept identified in the lines connecting some of these concepts.

One of the aspects contained in the biology of learning is the concept. Klein in [9] According to "a concept is a symbol that represents the class or group of objects or events with common properties". Nitko and Brookhart in [10] says "a concept is a class or category of Similar things (objects, people, events or relations)". That is the concept of a class or category of the similarity of objects, events or relationships. Ratna in [11] According to the concept maps developed to dig into the cognitive students and to know both for learners and teachers, to see what is already known by the learner. Map concept is an approach that can be implemented and developed either by the student or the teacher consciously and freely. According to some of these definitions, it can be concluded that a concept map is a significant relationship between one concept to the other which are connected by the words in a given unit.

Hamzah in [12] Understanding a person's ability to interpret, interpreting, translating or expressing something in its own way on the knowledge he had received. The understanding is one aspect of the cognitive domains. Based on Bloom's taxonomy, aspects of the understanding are at the second level after the knowledge of the cognitive aspects. Nuryani in [13] Category covers seven understand cognitive processes are: interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining. Syaiful in [14] The concept can be adapted to the facts change or new knowledge, while the usefulness of the concept is explained and predicted. Meanwhile, Santrock in [15] according to Zacks & Tversky concepts are categories that group objects, events and characteristics based on the common property. Science is a theoretical science used by scientists in studying natural phenomena through observation and experimentation.

According to the notion of understanding, the individual knows what is being communicated and can the make use of the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications'. Furthermore, Anderson and Krathwohl in [16] stating that the student is said to understand something if they are able to construct messages such as oral communication teaching, writing, and graphics.

Stobaugh in [17] According to the student is said to understand if students know what is being communicated and were able to use the material or the idea. Communication is done may be oral or written and verbal form or symbol. The ability of understanding can be translated into three, namely: a. translation, b. interpretation, c. extrapolation. Translating means people can communicate in a different language, with different terms, or with a different form of communication. Interpreting The ability to recognize and understand. For example, students are asked to interpret the meaning in a chart, table, or graph. Extrapolates that the ability to make mind or predictions based on understanding of the tendency of symptoms [6]. From the explanation above it can be concluded that the understanding of the concept is the ability to define, interpret, and communicate back, either orally or in writing of a symbol, classes or categories of an object, incident or relationship. Van Gundy states that problem solving can be defined as the process of making something into what you want it to be. Furthermore, he said that problem solving is the process used to solve a problem [18].

Based on the above review, analyzing the effect of the learning model of PBL and Concept Mapping on problem solving and concept understanding of ecosystem of students is interesting to be carried out so that the learning of biology is no longer just rote, but also with the discoveries concepts from biological materials that will be developed as a concept mapping in order students will have better understanding on the concept of the material which then lead the students to be able to solve some problems occur in the biological material.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

## 2. Research Method

This research was a quasi-experimental research. This research was conducted in public high school 6 on the second semester of the academic year of 2015/ 2016. The samples used in this research were four classes of grade X out of 7 classes available in the school which consists of the first X as an experimental group for the learning method of Problem Based Learning and Concept Mapping strategy, the second X as an experimental group for the learning method of Problem Based Learning, the third X third as an experimental group for the learning method with Concept Mapping strategy, and the last, the fourth X as an experimental group for the conventional learning methods. Each class consists of 28 students.

Data collection techniques in this research were test. A multiple choice test for the ability of understanding of the concept and essay test for the problem solving ability. These tests were conducted before and after the implementation of learning activities on the subject matter of the ecosystem. The hypothesis testing of the concept understanding of the students was done by using *One Way Anova*. The requirements that must be met, before performing the test of hypothesis is that the data must go through the tests of normality using *Kolmogorov-Smirnov* and homogeneity of variance using *Levene*.

## 3. Results and Discussion

This section presents the results used and the proposed discussion

### 3.1 The Description of Problem Solving Ability

Problem solving ability of students in this research was measured by using a test instrument in the form of essay tests. These tests were conducted before and after the implementation of learning activities on the subject matter of the ecosystem. The data of problem solving ability on pretest and post-test can be seen in the following Table 2.

**Table 2.** The Results of Problem Solving Ability

No.	Component	PBL class + CM		PBL class		Control class		CM class	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1.	The maximum score	70.00	85.00	85.00	85.00	80.00	85.00	70.00	70.00
2.	The minimum score	15:00	45.00	10:00	40.00	15:00	45.00	15:00	35.00
3.	Average score	43.21	71.07	45.71	64.82	41.79	65.89	38.21	58.57
4.	Variance	352.25	87.70	50.00	149.04	409.66	83.43	268.92	112.70
5.	Standard Deviation	18.77	9:37	21:03	12:21	20:24	9:13	16:40	10.62
6.	Gain	27.86		19:11		24.10		20:36	

Based on the above table, it can be seen that between pretest and post-test on both the minimum value and a maximum value of learners in the classroom PBL + CM, PBL, CM and control indicated that there is an increase in the score of problem-solving abilities. The increase in the average score of problem-solving ability in this study in PBL + CM group (27.86). Same thing with PBL + CM class, the class trial also experienced an increase in the amount of PBL (19.11), CM (24.10), and also controls (20.36).

### 3.2 The Description of Concept Understanding Ability

The understanding of the concept of the students in this research was measured by using a test instrument in the form of a multiple choice test. These tests were conducted before and after the implementation of

learning activities on the subject matter of the ecosystem. Data on the ability of understanding of the concept on pretest and post-test can be seen in the following Table 3:

**Table 3.** The Results of Concept Understanding Ability

No.	Component	PBL class + CM		PBL class		Control class		CM class	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1.	The maximum score	75.00	90.00	85.00	90.00	80.00	85.00	85.00	90.00
2.	The minimum score	40.00	60.00	40.00	60.00	40.00	60.00	40.00	60.00
3.	Average score	62.50	74.82	68.39	77.14	64.11	71.07	68.93	76.25
4.	Variance	119.44	76.82	201.95	85.98	96.40	56.22	135.85	54.86
5.	standard Deviation	10.93	8.77	14:21	9:27	9.81	7:50	11.65	7:41
6.	Improvement	12:32		8.75		6.96		7:59	

In the above table, it can be seen that there is an increase in the score of students either in the maximum score or in the minimum score in all classes. Significant changes occurred in the classroom of PBL + CM which increased at (12:32), the PBL class (8.75), whereas in CM class (7:59), and control class (6.96). The average score before treatment consecutively at PBL + CM class of (62.50), PBL class of (68.39), CM class of (68.93), and the control class is (64.11). Meanwhile, the average score after treatment respectively at PBL + CM class of (74.82), PBL class of (77.14), CM class of (76.25), and the control class is (71.07).

### 3.3 Hypothesis Test Results

#### 3.3.1. Problem solving Ability

Before the first hypothesis test analysis prerequisite test consisting of a test of normality and homogeneity. Based on the data analysis by using a computer program of SPSS, it can be found a significant value that indicates normality. The decision making criteria for normality test is that the data is stated to be normally distributed if the significance (Asymp.Sig) at the output of the Kolmogorov-Smirnov test > 0.05. Conversely, if the significance (Asymp.Sig) at the output of the Kolmogorov-Smirnov test < 0.05, the data are not normally distributed. The result of the normality test can be seen as following Table 4:

**Table 4.** The Normality Test Results of Problem Solving Ability

Troubleshooting Capabilities class	Data	significance	Conclusions Data Distribution
PBL + CM	Pre	0.089	Normal
	Post	0.173	Normal
PBL	Pre	.200	Normal
	Post	.200	Normal
CM	Pre	0.095	Normal
	Post	0,062	Normal
Control	Pre	0.089	Normal
	Post	0.173	Normal

Based on the above table, it can be seen that all the measurement data of problem solving on pretest and post-test was normally distributed since it has a greater significance value than the significance level of 0.05 so that  $H_0$  is accepted.

Test of homogeneity of this variable was used to determine the data that were analyzed had a relatively small variance. The following are the results of the measurement data on homogeneity test of problem solving abilities is shown in Table 5:

**Table 5.** The Result of Homogeneity Variant Data Test Measurement of Problem Solving Ability

Data Measurement of Problem Solving Ability	Significance	Conclusions of Variant Data
Pre	0,388	Homogeneous
Post	0.376	Homogeneous

Based on the above table, the homogeneity of variance test measurement data of problem solving ability on pretest and post-test of the students obtained a significance value greater than the significance level of 0.05, therefore,  $H_0$  is accepted. These results indicated that the data of problem solving ability on pretest and post-test of students have a homogeneous variant.

After the test conditions are met then the hypothesis test was conducted with one way Anova test. Data obtained measurement pretest problem solving ability of students have a significance value (0527) is greater than the level of significance of 0:05 so that there was no difference in the average measurement of data problem solving abilities of students from the fourth grade of trial class. It can be said that there is no difference in students' problem solving ability between classes before learning activities carried out. For the measurement of data post-test of problem solving ability of students obtained significance value (0.000) is less than the significance level (0.05), so that there is an average difference of measurement data problem solving abilities of students after the learning activities. It can be argued that there are differences in the effect of applying the learning model variations of the problem solving ability of students.

Based on the results of all classes have increased the value of problem solving abilities, it can be compared to the value of pretest and post-test. Increasing the highest value contained in the classroom of PBL + CM for the learning process on PBL fourth stage is to develop and present a long objects and the students were given the concepts and fill in the concept so that instead of solving the problems, students can also understand the conceptual existing concepts. As stated by Arends [2], PBL helps students develop the skills to think and solve problems, learn the authentic role of adults, and become independent learners.

### 3.3.2. Concept Understanding Ability

Normality test results to test the understanding of the concept of was done by using the Kolmogorov-Smirnov Test which can be seen in the following table:

**Table 6.** The Results of Normality Test of Concept Understanding Ability

Class of Concept Understanding Ability	Data	significance	Conclusions of Data Distribution
PBL + CM	Pre	0200	Normal
	Post	0052	Normal
PBL	Pre	0096	Normal
	Post	0069	Normal
CM	Pre	0088	Normal
	Post	0071	Normal
Control	Pre	0200	Normal
	Post	0052	Normal

Based on the above table, it can be seen that all the measurement of data of concept understanding ability on pretest and post-test was normally distributed since it has a greater significance value than the significance level of 0.05, therefore,  $H_0$  is accepted. The next test for the ability of understanding of the concept is homogeneity. In this research, homogeneity testing was done by using *Levene Test*. The Results of homogeneity test output on the pretest value can be seen in the following Table 7:

**Table 7.** The Results of Homogeneity Variant Test Data Measurement of Concept Understanding Ability

Data Measurement of Concept Understanding Ability	Significance	Conclusions of Variant Data
Pre	0.111	Homogeneous
Post	0.388	Homogeneous

Based on the results presented in the Table 7 above, the results of initial and final homogeneity test significance value greater than 0.05, therefore,  $H_0$  accepted, which means the data are homogeneous or have the same variant. After the test meets the requirements then proceed to test the hypothesis by one-way ANOVA. The data obtained for the measurement of the ability of understanding the concept pretest learners have a significance value (0.114) greater than the 0.05 significance level so that there is no difference in the average of data measurement of concept understanding ability of students from fourth grade of trial class. It can be said that there is no difference in the ability of understanding of the concept of students between classes before learning activities carried out. For data measurement of students' concept understanding ability on post-test obtained significance value (0.037) is less than the significance level (0.05), so that there is an average difference of concept understanding ability of data measurement of students after the learning activities. It can be argued that there are differences in the effect of applying the learning model variation in the concept understanding ability of students. The implementation of the learning model can improve students' understanding of the concept. This is because in this model involves the process of making a concept map linking the concepts that have been obtained. This is in line with the opinion [18] that a concept map is a way for students to organize their thoughts. Another opinion by Shavelson, *et al.* is learning strategies with proven concept maps can enhance and deepen the understanding of the concept [19].

#### 4. Conclusion

Problem Based Learning model has a significant effect on the problem solving and concept understanding of high school students on ecosystem material since the learning activity in the PBL classroom, students are faced with real problems in order to conclude and resolve the problem. *Concept Map* has a significant effect on the problem solving and concept understanding of high school students on ecosystems material since in the learning process, students find concepts and connected those concepts in order the concept understanding of students will last for long term.

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