Application of Model Project Based Learning on Integrated Science in Water Pollution

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Abstract. The function of this research was to analyze the influence model Project Based Learning (PjBl) on integrated science about the concept mastery for junior high school students. Method used for this research constitutes the quasi of experiment method. Population and sample for this research are the students junior high school in Bandung as many as two classes to be experiment and control class. The instrument that used for this research is the test concept mastery, assessment questionnaire of product and the questionnaire responses of the student about learning integrated science. Based on the result of this research get some data that with accomplishment the model of PjBl. Learning authority of integrated science can increase the concept mastery for junior high school students. The highest increase in the theme of pollution water is in the concept of mixtures and the separation method. The students give a positive response in learning of integrated science for the theme of pollution of the water used model PjBL with questionnaire of the opinion aspect in amount of 83.5%, the anxiety of the students in amount of 95.5%, the profit learning model of PjBL in amount of 96.25% and profit learning of integrated science in amount of 95.75%.

1. Introduction

The integrated science learning curriculum is being implemented in several countries such as Nigeria and Barbados, and research is being continuously done to see the effectiveness of the application of the integrated science curriculum [1,2]. Several studies have also been done to see the impact of integrated science learning on learners as practiced by Ameyaw; Endokpayi & Suleiman and Sarfo [3,4,5]. The application of integrated learning should be supported by professional teachers who are able to apply integrated science learning in the classroom well [6]. In addition, it is also needs to be supported by appropriate learning activities that are able to stimulate learners more actively in the learning process. One of the models that can be applied is project-based learning.

According to Silberman, project-based learning model is one model of learning that can stimulate learners to be actively involved in the learning process [7]. Project-based learning is a systematic learning model, involving learners in learning knowledge and skills through a long, structured inquiry process with authentic and complex questions and carefully designed product tasks. Project-based learning has tremendous potential to make the learning experience more interesting and meaningful for learners. The model has been proven to have a positive impact on students such as improving the achievement of learners, concept mastery of learners, the attitude of learners to science, the activeness of learners follow the learning and learning ability of learners [8,9,10,11,12,13,14,15,16,17]. In addition, project-based learning is also capable of developing professional teachers [18].
Project-based learning has also begun to be developed, not just ordinary project learning but has begun to be integrated with technologies such as computers [19,20,21,22], and the results are better than project-based learning that does not use technology. In addition, project outcomes created by learners can also serve as a learners' assessments as developed by Dunmade [23].

Research on project-based learning is increasingly developed including project-based learning in integrated science such as those conducted by Kubiatko & Vaculova [24]. The results turn out to be not as encouraging because integrated science using project-based learning model is still difficult to apply in the classroom due to some of the constraints such as time, curriculum, availability of tools, and teachers' understanding of project-based learning. Guven et al. also conducted research on project-based integrated learning for elementary school children, the results showed that project-based learning could improve the literacy of science students in grade 2 of elementary schools [25].

In the teaching-learning process of science, students are not only required to develop their cognitive potential but also hopefully able to develop their skills holistically. Therefore, by applying science learning in an integrated manner, it is expected that it will facilitate students in the application of the concept of science in daily life.

In the broad sense, integrated learning includes integrated learning in one discipline, integration among subjects, as well as integrated in and across learners. This learning can provide immediate experience so that learners can find themselves a meaningful and authentic concept. According to Fogarty there are 10 types of integration, namely fragmented, connected, nested, networked, shared, threaded, integrated, webbed, sequenced and immersed [26].

In the integrated science learning, theme is needed to facilitate the teacher in organizing and combining subject content. The theme used in this research is water pollution. The core materials on the theme of water pollution include changes in substance, the role of heat to the change of forms, water cycle, mixtures, mixing and separating technology, environmental pollution and human role in environmental management. The theme of water pollution in this study, will be reviewed from the disciplines of Physics, Chemistry and Biology. Through integrated science learning with Project Based Learning model in water pollution, it is expected that the students' mastery capability is developed.

2. Experimental Method
This research uses quasi experimental method with Randomized Pre-test Post-Test Control Group Design. This research was conducted in one of the middle school in Bandung City with the sample of the research is the students of grade VII which is divided into two groups namely the experimental group and the control group. The experimental group was given an integrated science study with the model of Project Based Learning. While the control group was given treatment of integrated science learning with conventional model (in this case using Problem Based Learning). The instrument used in this research is concept mastery test, product assessment rubric and student response questionnaire.

3. Result and Discussion
The science materials used in this study is an integrated science learning with the theme of water pollution. Analysis of integrated science learning on the theme of water pollution conducted in this study can be seen in Table 1.
Table 1. The analysis of integrated science learning on the theme of water pollution

| Core Competency | Physics | Chemistry | Biology |
|-----------------|---------|-----------|---------|
| Describe the role of heat in changing the substance and temperature of an object and its application in daily life. | Understand the separation of the mixture by physical and chemical properties | Describe contamination and its impact on living things |
| Understand the characteristics of substances, as well as physical and chemical changes in substances that can be utilized for everyday life | | Apply human role in environmental management to overcome pollution and environmental damage |

Table 1 shows the distribution of core competencies included in the theme of water pollution. In accordance with the basic competencies in Table 1. above, the design of an integrated science learning with the theme of water pollution can be seen in Figure 1.

Figure 1. Design of integration on the theme of Water Pollution

Figure 1 shows that the materials taught on the theme of water pollution include changes in the form of substances, the effects of heat on changes in substances, water cycle, mixed separation, environmental pollution and human role in environmental management.
Concept mastery is captured through multiple choice tests and the resulting product. The achievement of the score of mastering the concept of the experimental class can be seen in Table 2.

**Table 2.** Achievement of the score of mastering the concept of the experimental class

| Concept                                      | Pre-test Average | Post-test Average |
|----------------------------------------------|------------------|-------------------|
| Form changes and water cycle                 | 51.7%            | 82.1%             |
| The role of heat in form changes             | 50.0%            | 79.4%             |
| Mixtures and the separation technique        | 45.1%            | 78.4%             |
| Environmental pollution                      | 50.0%            | 80.4%             |
| The role of human in environmental management| 51.0%            | 84.3%             |
| **Average score of overall concept mastery** | **49.9%**        | **81.1%**         |

Table 2 shows that there is 31.2% increase of average score in concept mastery in the experimental class between pre-test and post-test average (pre-test 49.9% and post-test 81.1%). The highest increase is in the concept of mixtures and the separation method, which is 33.3% (pre-test 45.1% and post-test 78.4%) but this concept is also the most difficult concept (evidenced by the lowest average pre-test and Post-test). While the least difficult concept in the experimental class is the concept of human role in environmental management (84.3%).

The score of concept mastery that is acquired through the product is done by using the scoring rubric. The result of the achievement of the cognitive level concepts of C5 (synthesis) and C6 (evaluation) of experimental class collected through the resulting product can be seen in Table 3.

**Table 3.** The score of concept mastery in the experimental class

| Cognitive Level | Product Indicator                                      | Score |
|-----------------|--------------------------------------------------------|-------|
| Synthesis (C5)  | Designing product                                      | 67%   |
|                 | Integrated conceptual knowledge (synthesized)          | 93%   |
|                 | Integrated procedural knowledge (synthesized)           | 87%   |
| Evaluation (C6) | Identification of the products strengths               | 87%   |
|                 | Identification of the products flaws                   | 67%   |
|                 | Self-evaluating the products                            | 87%   |
|                 | Evaluating other peoples’ products                     | 67%   |
|                 | Criterion used for the evaluation                      | 67%   |
|                 | Taking decision to troubleshoot the product based on the review | 93%   |
| Average         |                                                        | **79.4%** |

Table 3 shows the concept of mastery acquired from the product, produces the cognitive level of C5 (synthesis) and C6 (evaluation) in the experimental class up to 79.4%.

While for the control class, the result of concept mastering test on the theme of water pollution can be seen in Table 4.
Table 4. The score of concept mastery in the control class

| Concept                                | Pre-test Average | Post-test Average |
|----------------------------------------|------------------|-------------------|
| Form changes and water cycle           | 51.2%            | 76.7%             |
| The role of heat in form changes       | 48.3%            | 73.3%             |
| Mixtures and the separation technique  | 43.3%            | 70.6%             |
| Environmental pollution                | 50.7%            | 72.2%             |
| The role of human in environmental management | 56.7%            | 76.6%             |
| **Average score of overall concept mastery** | **49.8%**       | **74.4%**         |

Table 4 shows that there is an increase in the mean concept mastery scores in the control class between mean pre-test and post-test average of 24.6% (pre-test 49.8% and post-test 74.4%). Similar to the experimental class, the highest increase in the control class was in the concept of mixture and separation method, which is 27.3% (pre-test 43.3% and post-test 70.6%) but this concept was also the most difficult concept (evidenced with the lowest average pre-test and post-test). While the least difficult concept in the control class is about changes in the form of substances, water cycle and human role in environmental management (76.7%).

The test result of concept mastery in experimental class on the theme of water pollution shows that the concept of mixtures and the separation method is the most difficult concept for students (average score of 78.4%), while the concept of human role in environmental management becomes the least difficult concept for students (average score of 84.3%). Not only in the experimental class, the concept of mixtures and the separation method is also the most difficult concept in the control class (70.6% average score) and the concept of human role in environmental management becomes the least difficult concept in the control class (76.7% average score). This is possible because the concept of mixtures and the separation method is a difficult concept and it takes a longer time to understand the concept. While for the concept of human role in environmental management, students are easier to understand the concept because it can be found and already applied in daily life. This is proportional with Nurhadi’s opinion that the focus of the Project-Based Learning model lies in the concepts and core principles of a study discipline, engaging students in problem-solving investigations, and other meaningful task activities, allowing learners to work autonomously to construct their own knowledge, and culminate it into real products [27].

The comparison between experimental class (class with Project Based Learning model) and control class (class with Problem Based Learning model), then the average post-test result of concept mastery in the experimental class is better in all concepts on the theme of water pollution than in the control class. Recapitulation of concept mastery values of both experiment and control class can be seen in Table 5.

Table 5. Score recapitulation of the concept mastery

| Class     | Pre-test Average | Post-test Average | N-Gain   |
|-----------|------------------|-------------------|----------|
| Experimental | 49.9%            | 81.1%             | 62.2 (medium) |
| Control   | 49.8%            | 74.4%             | 49.1 (medium)   |

Table 5 shows that the N-Gain pre-test and post-test in the experimental class are higher than the control class. The N-Gain in the experimental class is 62.2. If interpreted by N-Gain category according to Sugiyono [28], then N-Gain in the experimental class is medium category. While the N-Gain in the control class is 49.1. If it is interpreted by N-Gain category then N-Gain in control class is
medium category. This shows that there is an increase in the ability to master the concept on the theme of water pollution both in the experimental class and in the control class.

Between the experimental class and control class, the results indicate that the use of the model of Project Based Learning in integrated science on the theme of water pollution is better than the Problem Based Learning model. This is proven by the Mann Whitney U test (the test was chosen because the data is not normally distributed), the results indicate that there is an increase in mastery of students' concepts in integrated science learning process on the theme of water pollution by the model of Project Based Learning (Asymp Sig (2-tailed) 0.01 < 0.05). So it can be concluded that the learning process of integrated science by using the model of Project Based Learning can improve the concept mastery for student on the theme of water pollution. This is proportional to what is stated by Rais [29] who said that the model of Project Based Learning provides an appropriate environment for the application of a skill to improve the quality of students’ learning process to achieve higher cognitive level, which is one of the objectives of the learning process.

To know the student's response to integrated science learning using Project Based Learning model, data were collected by questionnaire. Questionnaire is made in the form of Likert scale, consisting of 20 statements that include positive statements and negative statements. There are 4 aspects that are asked in this questionnaire including the aspects of student opinion (8 statements), student interest (4 statements), the benefits of learning model of Project Based Learning (4 statements) and the benefits of integrated science learning (4 statements). The result of student questionnaire can be seen in Table 6.

| Table 6. Recapitulation of student response questionnaire to integrated science learning using model of Project Based Learning |
|---------------------------------------------------------------|
| Aspects                                      | Positive Response | Negative Response |
|----------------------------------------------|------------------|------------------|
| Students’ opinion                            | 83.5%            | 16.5%            |
| Students’ interest                           | 95.5%            | 4.5%             |
| The benefits of learning model of Project Based Learning | 96.25%          | 3.75%            |
| The benefits of integrated science learning  | 95.75%           | 4.25%            |
| **Average**                                  | **90.9%**        | **9.1%**         |

Table 6 shows that 90.9% students give positive responses to integrated science learning using Project Based Learning model, while a negative response is 9.1%. This shows that students love the integrated science learning on the theme of Water Pollution using the model of Project Based Learning.

4. Conclusion
Based on the analysis of the research results, it is concluded that integrated science learning using Project Based Learning model on the theme of water pollution can improve the concept mastery of junior high school students. This shows that in the case of increasing the concept mastery of middle school students on integrated science of water pollution theme, the model of Project Based Learning is better than using Problem Based Learning model. Students also give positive response to the study of type Nested integrated science on the theme of water pollution using the model of Project Based Learning with the percentage of questionnaire students’ opinion aspect of 83.5%, students’ interest of 95.5%, learning model benefits of Project Based Learning for 96.25 %, and an integrated science learning benefit of 95.75%.

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