Inquiry-Based Integrated Science Education: Implementation of Local Content “Soil Washing” Project To Improve Junior High School Students’ Environmental Literacy

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Abstract. The study was conducted based on teaching and learning problems led by conventional method that had been done in the process of learning science. It gave students lack opportunities to develop their competence and thinking skills. Consequently, the process of learning science was neglected. Students did not have opportunity to improve their critical attitude and creative thinking skills. To cope this problem, the study was conducted using Project-Based Learning model through inquiry–based science education about environment. The study also used an approach called Sains Lingkungan and Teknologi masyarakat - “Saling Temas” (Environmental science and Technology in Society) which promoted the local content in Lampung as a theme in integrated science teaching and learning. The study was a quasi-experimental with pretest-posttest control group design. Initially, the subjects were given a pre-test. The experimental group was given inquiry learning method while the control group was given conventional learning. After the learning process, the subjects of both groups were given post-test. Quantitative analysis was performed using the Mann-Whitney U-test and also a qualitative descriptive. Based on the result, environmental literacy skills of students who get inquiry learning strategy, with project-based learning model on the theme soil washing, showed significant differences. The experimental group is better than the control group. Data analysis showed the p-value or sig. (2-tailed) is 0.000 < \alpha = 0.05 with the average N-gain of experimental group is 34.72 and control group is 16.40. Besides, the learning process becomes more meaningful.

1. Introduction

Learning science as part of process of education has significant role in developing individual function in this globalization era. One of the roles is to improve students ‘ability to think creatively in learning process so that they can face the globalization era. The ability of such creative thinking leads students who can express and elaborate original concept or idea to solve any problem. This is in line with Munandar (1992) who stated that creativity or to think creatively as ability to see various possibilities of problem solving which is as the idea which still doesn’t get attention so far.

It has been known that the process of learning science took place in junior high school generally provoked lack of attention to the students’ thinking skills and its developmental process. This is due to the implementation of learning science which mostly occurred with conventional models namely a way of classical teaching. This learning process did not give students to get involved in the learning process. This
model has many weaknesses such as the role of the teacher is still more dominant (teachers centered), students tend to be passive and just accept information by memorizing concepts without adequate understanding. It is because the learning process did not guide the students to think critically, creatively, practicing to find concepts or principles to develop their creativity. So that, the achievement of learning is limited only to the aspects of knowledge (cognitive) but it did not develop in the aspect of attitudes (affective) and skills (psychomotor).

Another fact, students today have tendency to step away from values of protecting the environment. It can be seen from their consumptive behavior yet less productive in protecting the environment. There are number of students who use both private and public facilities in bad way. Gradually, their responsibility to take care public facilities is decrease even they do not have it at all. They could not take the advantage of technology to solve their problem about the environment as well as the issues about it. Also, they do not employ the environmental science, such as throwing rubbish in its place, taking care of plants in the garden, and watering the flower, then, recycling the potentially useful materials. Thus, the application of utilizing environment is still considered low so that it affected their awareness toward the environment. Therefore, problem occurred in both school system and in society today. Moreover, it seem like the environmental awareness is no longer needed. Based on this condition, one of the efforts to cope this problem is by using analysis of environmental literacy.

2. Model, analysis, design and implementation

The study used a quasi-experimental research method with pretest-posttest control group design. Subjects in both classes were given a pre-test and then the experimental group was given inquiry learning and control group was given conventional learning. After the implementation of the study, subjects in the two classes were given post-test. The subjects were students of class VII SMPN 2 Hulu Sungkai, namely Class VII B as control class that implemented conventional learning and class VII A as the experimental class implemented inquiry learning. The study used purposive sampling technique. The purpose of this technique is the study could be carried out effectively and efficiently, especially in terms of supervision, the condition of the subjects, research time, place, and procedural licensing. Based on that technique, sample of two classes obtained, namely class VII A as experimental group consisting 26 students and the class VII B as control group consisting 23 students.

By the assumption that experimental group and control group are homogenous, thus the design is likely:

Experimental group : O ------ X ------- O
Control Group : O                     O
O : pretest or post-test of problem solving ability
X : learning use discovery learning strategy
--- : Subjects are not grouped randomly

Whereas, qualitative methods played role in answering research questions derived from observations, interviews and observations that had been conducted and analyzed qualitatively by describing the findings that were obtained during research in the field.

Data process was calculated based on the normalized score-gain with the formula proposed by Cheng (Gunawan and Liliarsari, (2012)) namely:

\[ N\text{-gain} = \frac{S_{\text{post}} - S_{\text{pre}}}{S_{\text{max}} - S_{\text{pre}}} \times 100\% \]  

Note:

\( S_{\text{post}} \) = Post test score
\( S_{\text{pre}} \) = Pretest score
\( S_{\text{max}} \) = maximum score gained
2.1. Model project-based learning

Arends (Trianto, 2007: 1) explains that the learning model refers to the learning approach that will be used in learning process, including the learning goals, and the stages in the learning activities, learning environment and classroom management. Trianto (2007:2) states that learning model can be said as conceptual framework that defines systematic procedure in organizing learning experience in achieving the learning goals. The function of learning model is as the guidance for the designer of learning model and for the teacher as well in implementing learning model. The term of learning model has four special characteristics, namely: 1) logical theoretical rational that is prepared by the designer 2) The basic thoughts about what and how students learn, 3) behavior of teaching that is necessarily required for the model to be successful, 4) learning environment needed so that the learning objectives can be achieved (Sanjaya, 2006).

The syntax of learning model shows clearly what activities should be done both by teachers and students as well as particular assignment which is done by the students. Syntax of learning model has similar components such as attracting students’ attention by motivating them to get involved in learning process both in the beginning and at the end of the learning process. Arranging the syntax of the learning model must concern several factors such as differences in the management of learning environments, differences in the role of the teachers and students as well, differences in physical spaces and differences in social class system. Accordingly, those differences should be understood by teachers in implementing the learning model so as to it can be applied properly.

Project-based learning is a learning process which provides more opportunities for the teachers to manage classroom learning by involving work project. Work Project includes complex tasks based on very challenging questions and problems and that require students to design, solve problems, make decisions, conduct investigations. Moreover, the task provides opportunities for students to work independently to in completing the task. Project-based learning has syntax: (1) starts with the essential question, (2) design a plan for the project, (3) creates a schedule, (4) monitor the students and the progress of the project, (5) assess the outcome (6) Evaluate the experiences.

Scientific inquiry refers to a variety of ways for scientists to study the universe and aims to provide an explanation based on the evidence obtained. Inquiry also refers to students’ activity when they build a knowledge and understanding of scientific ideas, as scientists’ attempt to understand the universe. (National Science Education Standards, the United States, p. 23)

According to Nuryani (2005: 17), inquiry in learning indicates that effective science learning depends on the availability, organizing materials, media and tools, and technologies. Accordingly, a learning that refers to the inquiry wants to be more scrutiny through continuous research. Bruce (Sahin, 2013), explains that “inquiry-based learning is a teaching and learning approach that engages students to explore their own questions and interests, by (1) asking meaningful questions, (2) planning and executing investigation strategy, (3) gathering information from a variety sources, (4) discussing information in productive presentation, (5) reflecting on their own learning”.

Thus, it can be seen that the purpose of the inquiry learning is to develop the ability to think in a systematic, logical, and critical or develop intellectual abilities as part of the mental process. Hence, in inquiry learning students are not only required to master the subject matter, but also to know how they can
use their potential. Students who are able to master the lessons only may not be able to develop their optimal thinking ability. Whereas, the students will be able to develop their thinking skills as they could master the subject.

Hollweg et al defines environmental literacy as “The cognitive domain refers to the individual’s knowledge of ecological concepts and processes that provide the foundations for comprehending human impact on natural systems: environmental issues and environmental action strategies; as well as the cognitive skills for analyzing environmental problems and for the use of environmental action strategies. The affective domain refers to the individual’s environmental awareness and sensitivity; attitudes, values and worldview regarding the environment; locus-of-control (sense of ability to influence a situation through personal behavior, i.e. self-efficacy) and assumption of personal responsibility (sense of obligation toward the environment. i.e. personal commitment to environmentally corrective behaviors). Behavior is the ultimate expression of EL - the individual’s EL should be reflected in his/her behavior concerning the environment. It can be inferred that developing EL is equivalent to developing responsible environmental behaviour, i.e. in the context of EL, knowledge, dispositions, and competencies enable and are expressed as behaviours (Daphne Goldman et.al., 2014:3).

In brief, environmental literacy is the ability or skill in understanding the importance of protecting the environment both for current need and future generations as well. According to Amini environmental education are expected could guide students to behave and aware of the environment (Aryanti). It is an attempt to change behaviors and attitudes conducted by some sides in which in its implementation it can bring the classroom to the factual environment and in other way bring the environment to the class. This means that the learning would use the environment as a learning resource in order to achieve the learning objectives that have been stated. Good environmental management can guarantee the availability of natural resources which are important for public welfare and environment safety in the future.

2.2. Implementation local content soil washing project

In this study, the researcher used local content of soil washing project that came from Ikatan Pelopor Pertanian Oranik Lampung - IPPOL (Lampung Association of Organic Farming Pioneers) under responsible of the foundation Yabima Indonesia. IPPOL continuously conducts counseling, mentoring and coaching to Lampung organic farmers so that they become more productive and welfare through several superior programs. One of them is the training of making and using soil washing formula in soil washing project.

The soil washing technology is a technology that uses liquid (usually water and certain chemical additives) and mechanical processes to wash the soil (United States Environmental Protection Agency, 1996). Developed to improve conditions of the soil from the contaminants (hazardous substances) and pollutants using herbal ingredients which are easily found in Indonesia. Though, the technology itself is not so familiar and stills such a new thing in Indonesia, especially in our neighborhood area in North Lampung regency (an experimental procedure of soil washing is attached in appendix 5).

The materials needed to make solution of the soil washing formula are: (1) 10 kg of lime, (2) 5 kg of noni, (3) 10 kg of star fruits, (4) 40 liters of water, (5) 0.5 of citronella, (6) 0.5 kg of red betel, (7) 2 kg of Limestone. All ingredients except water and limestone mashed or blended together. After that, add the limestone and stir well. Furthermore, put all the ingredients that have been mashed into a container which had been provided. Finally add water into the container of soil washing solution materials, Stir it all up well. For soil cultivation, 1 kg of coriander is necessarily added to soil washing formula. Then, close the container tightly. Open the container and stir it once in every 5 days in order to get perfect fermentation process. The fermentation process lasts in a month and after that the solution is ready to use. In consideration of the principle of usefulness for future generations, thus the researcher deliberately
intended to introduce this soil washing technology in learning process so that students have a sensitivity and concern/awareness toward the environmental continuity.

The utilization of soil washing is to wash the soil from contaminants. It is similar to the use of medicinal plants, in which as many as 25-30 cc of dose mixed with 12 liters of water is sprayed to the ¼ ha soil. The soil is best sprayed 3 times a week before planting. If it is used as learning materials at school, so the portion produced by each group is 1/10 of the dose so as to students can easily apply it. The Media of the soil being tested also kept in some polybags.

3. Results and discussion
Based on analysis of N-gain score of students’ environmental literacy skills, the data shows the increase classification (quality) of students' scores compared with the ideal maximum score. The average of N-gain represents an increase of scientific literacy skills of students who were given inquiry learning using project-based learning model or students who were given conventional learning. The average N-gain of student’s scientific literacy skills in experimental group and control group are presented in the following table:

| Group       | Average N-gain | Classification |
|-------------|----------------|----------------|
| Control     | 16.40          | Low            |
| Experimental| 34.72          | Middle         |

Based on Table 1 above, it shows that experimental group with project-based learning model get higher average N-gain score. N-gain classification of control group considered as low grade, whereas the N-gain classification of experimental group considered as medium. This demonstrates the environmental literacy skill of experimental group is higher than the control group. It also indicates that the inquiry learning strategies using project-based learning model gives a good contribution to improve environmental literacy skills than conventional learning model does.

However, to ensure that the increase in students’ environmental literacy skills who get the learning environment project-based learning in theme Soil Washing Project is better than students who get
conventional learning needs advanced statistical tests. Statistical tests which is needed to prove the hypothesis "environmental literacy skills of experimental group is better than the control group" is namely the differential average N-gain scores Test. Although, N-gain score of the data must meet the requirements of normality and homogeneity before it is being tested.

The normality test of N-gain score is calculated by Kolmogorov-Smirnov test with SPSS 16. The results of the test are presented in the following table:

| Group        | Kolmogorov-Smirnov Statistic | Df   | Sig.  |
|--------------|-----------------------------|------|-------|
| Control      | .133                        | 26   | .200  |
| Experimental | .197                        | 23   | .021  |

Table 2 above shows that N-gain score of environmental literacy skills of students in experimental group has the Sig. <\(\alpha\) = 0.05, it means Ho is rejected. This indicates that the N-score data of experimental group is non-normal distribution. Whereas, the N-gain of control group has the Sig. > \(\alpha\) = 0.05, it means Ho is accepted. This indicates that the N-score data of control group is normal distribution. Based on the results, it can be concluded that N-gain score of experimental group considered as non-normal distribution and control group is normal distribution.

To prove the N-gain score of experimental group is better than the control group, it is necessarily conducted differential average N-gain scores Test using non-parametric test (Mann-Whitney U-test). The first hypothesis proposed in the research study, namely: there is different average on environmental literacy between the experimental group and control group.

To test the hypothesis proposed above, statistical hypothesis is formulated as follows:
- \(H_0 : \mu_1 = \mu_2\), There is no significant difference in improvement of environmental literacy between students who were given inquiry learning strategy with project-based learning model and students who were given conventional learning.
- \(H_a : \mu_1 \neq \mu_2\), There is significant difference in improvement of environmental literacy between students who were given inquiry learning strategy with project-based learning model (experimental group) and students who were given conventional learning (control group).

Notes:
The improvement of math problem solving ability of the students who were used inquiry learning strategy. \(\mu_1\) = average N-gain of environmental literacy skill of students who get inquiry learning strategy (experimental group).
\(\mu_2\) = average N-gain of environmental literacy skill of students who get conventional learning strategy (control group).

Here is the summary of the results of the differential average test of N-gain score at significance level \(\alpha\) = 0.05.

| Statistics          | Value   | Description       | Conclusion               |
|---------------------|---------|-------------------|--------------------------|
| Mann-Whitney        | 75.500  |                   |                          |
| Z                   | -4.480  |                   | Ho rejected              |
| Asymp. Sig. (2-tailed) | .000    |                   | There are differences    |
Based on Mann-Whitney Test above, $p$-value or $\text{sig. (2-tailed)}$ gained is $0.000 < \alpha = 0.05$, meaning that $H_0$ is rejected. Thus, improvement of environmental literacy skills of students who get inquiry learning model using Project-Based Learning is better than students who get conventional learning. Therefore, the hypothesis which states there is significant difference in the average score between students’ environmental literacy skill of experimental group and control group is proven.

Based on the research result, inquiry learning strategy on Project-Based learning model on theme Soil washing project gave good impact on the learning process in Grade VII SMPN 2 Hulu Sungkai. It can be seen from the improvement of students’ ability or skill to find a concept and could complete their tasks, and they also could implement it in their daily life. In addition, students get their encouragement to express their opinion, ideas and questions. From the pre-test and post-test questions given by the teacher, there were various answers appeared from students. The result was generally the same. The students also got involved in checking their work so they could know the right and wrong answer.

Teachers also led the students to think creatively in order to be able to solve problems. At the beginning of the learning, there were only few students who dared to ask questions, to develop ideas or to comment on other students. So that teachers still have to motivate the students or to manage students to come forward and present the results of working group. When students are grouped to work together and discuss how to complete teacher instruction, their collaboration and cooperation still did not appear. There are several groups that are dominated by one or two students. Although, the learning activity had increased in the next meeting, collaboration between group members appeared. It can be seen from the involvement of students in completing and implementing the instructions provided by the teacher. The number of students who conveyed the idea also increased known from variations of answers from each group in completing the worksheets provided by the teacher.

The result of analysis from pre-test and post-test also shows that there are differences on environmental literacy skill in each indicator:

Table 4. Average N-gain Indicator of environmental literacy.

| No. | Indicator                                                                 | Average N-gain |       |
|-----|---------------------------------------------------------------------------|----------------|-------|
|     |                                                                           | Control        | Experimental |
| 1   | Awareness to the environment                                              | 16.60          | 32.48 |
| 2   | Knowledge of the environment                                              | 16.17          | 43.96 |
| 3   | The application of material science in the development of integrated environmental curriculum | 20.26          | 29.54 |
| 4   | The application of environmental knowledge                                 | 17.71          | 24.45 |
| 5   | Initiative and works in environmental management                          | 19.71          | 30.96 |

The table shows that the students’ environmental literacy skills in the control group are low because the average value of N-gain is below 30%, but in the experimental group for indicator such as awareness on the environment, environmental knowledge, then the initiative and works in environmental management are categorized middle. In experimental group, indicator which was categorized as low is indicator of the application of material science in the development of integrated environmental curriculum and initiative and works in environmental management.

Based on results from the series of experiments which was conducted, students can find out that the use of chemical fertilizers continuously can reduce the fertility of the soil, because the fertilizer that is given only contain small amounts of elements needed by plants. Sometimes, the soil itself will be more excessed...
in amount of the particular elements while the other elements are declining in number. Then, for the improvement of soil composition, it needs to conduct either by using organic fertilizers or reducing the use of inorganic fertilizers. Students also know that the ideal soil conditions must be made up of 15 elements: nitrogen, potassium, phosphorus, magnesium, manganese, iron and so on. With the criteria of soil pH ranges from 6 to 8 in which good for planting. Soil has unique properties in which it can remediate itself by the assistance of particular microorganisms. So that it can degrade the heavy metal elements which pollute the soil then turn into particles or molecular which is not dangerous for life.

Thus, students can understand the importance of preserving the environment, especially the preservation of their soil as part of their life in the future. The project is expected can affect the students’ mindset in order to evoke a sense of belonging and care to the environment. Also, the project can arouse students’ desire to develop their district later when they are adult. Addition, they should forget their dream to find a job in the city or become Indonesian labor force as it had been done by people before them.

This is one of the nature of meaningful learning and one of the objectives of this study. Thus, not only to improve the students’ environmental literacy skills, but also to create moral and social values of students so that they can answer the issues and solve the problems that occurred wisely and appropriately in the future.

4. Conclusion
Based on the results of data analysis and discussion presented before, it is derived some conclusions as follows:

- Inquiry-based environmental education: the implementation of the project "soil washing" is proven could help increase the students' environmental literacy.
- The environmental literacy skill of students who use inquiry learning strategy with project-based learning model on the theme soil washing showed significant differences, the experimental group is better than the control group. The data analysis shows the \( p \)-value or \( \text{sig.} \) (2-tailed) is \( 0.000 < \alpha = 0.05 \) with Average N-gain 34.72 for experimental group and 16.40 for control group.
- Students’ learning Interest who used inquiry learning strategy with project-based learning model on the theme soil washing project has increased, it can be seen from the enthusiasm of the students when learning process took place.
- There is a correlation between students’ environmental literacy skills and students’ learning interest.
- Students can develop values that appear in the learning process such as moral and social values of the environment so that it could make meaningful learning.

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