Improvement of Students’ Environmental Literacy by Using Integrated Science Teaching Materials

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Abstract. This study aims to determine the improvement of student environmental literacy through the use of integrated science teaching materials on pollution topics. The research is used weak experiment method with the one group pre-test post-test design. The sample of the study were junior high school students in Bandung amounted to 32 people of 7th grade. Data collection in the form of environmental literacy test instrument consist of four components of environmental literacy that is (1) Knowledge, (2) Competencies (Cognitive Skill), (3) Affective and (4) Environmentally Responsible Behavior. The results show that the student’s environmental literacy ability is improved after using integrated science teaching materials. An increase in the medium category is occurring in the knowledge (N-gain=46%) and cognitive skill (N-gain=31%), while the increase in the low category occurs in the affective component (N-gain=25%) and behaviour (N-gain=24%). The conclusions of this study as a whole the improvement of students’ environmental literacy by using integrated science teaching material is in the medium category (N-gain=34%).

1. Introduction
Environmental issues are increasingly considered to be an emergency since human domination of the environment, this is exacerbated as technology advances [1]. It is very difficult to address this increasingly acute environmental problem without any public awareness to be involved and responsible. Therefore it becomes priority major countries to seek to raise the awareness of the community, by taking preventive measures against environmental conditions continue to decline through the role of environmental education [1, 2]. The importance of environmental education was first plagiarized by almost all world leaders, in the Tibilisi Declaration in 1977. The declaration contains an important message for the changing world of education and the starting point of the substance mandatory environmental education [2]. Attention and great support towards a sustainable environment through the contribution of environmental education a top priority in a number of countries [1, 2]. Since then environmental education has begun to be integrated into school curricula for each level and level, including in Indonesia. The culmination of environmental education is to make students who are literate in the environment [3].
Environmental literacy is a knowledge of how the natural environment functions and how humans play in preserving and nurturing their environment. Environmental literacy can also be defined as basic education for all people, providing basic knowledge, skills and motivations related to environmental needs and contributing to sustainable development [2]. The environmental literacy is very important for the students in order to prepare the people who understand and can solve the environmental problems, so that it can be prepared by environmental reform agencies that have a positive attitude and action toward the environment [4]. One of the basic consistency of the environmental literacy curriculum approach is integrated into the science lesson [2, 3, 5, 6]. This is in accordance with the current curriculum objectives (curriculum 2013), which develop attitudes, knowledge, and skills and apply them in various situations in schools and communities.

Research that has been done related to environmental literacy such as instructional strategy applied by teacher has a big effect on the development of students' environmental literacy [5, 6, 7, 8]. For example with the application of interactive interactive learning techniques as an alternative solution to the monotony and not contextual learning environment so far. In it integrated the use of different learning methods ranging from field trips, project delivery, and use of ICT media, there are communication exercises, and the implementation of assessments for learning and assessment of learning. Learning is more memorable and understood as they experience directly [5]. Furthermore, the use of concept maps to obtain a description of the mastery of ecological concepts as a prerequisite of environmental literacy [6]. Then another example is the use of the Environmental Education Kit (EE-Kit) in environmental studies in an effort to improve students' environmental literacy in Malaysian high school students. The EE-Kit used is a module that contains information about knowledge and skills in teaching environmental education, so that EE-Kit can help teachers in teaching about the environment effectively. EE-Kit can increase students' level of literacy environment [7].

Another study is the use of Summer Environmental Education Program (SEEP) in the achievement of students' environmental literacy. This research is based on the facts of previous research that one is often involved in environmental activities and engaging in direct learning in nature, will have connections and a sense of belonging to the environment to increase, as well as the tendency to protect the environment will be formed. In the SEEP program the learning was conducted outdoors (field trips) for a week and provided six modules (consisting of different subjects / subjects) associated with environmental literacy [8].

Based on the explanation of the environmental literacy research that has been done, the researchers tested the improvement of students' environmental literacy through the use of integrated science teaching materials for students of grade 7th junior high school. The influence of teaching materials on students is huge because between students and teaching materials have an important interaction in the learning process, meaning that students have frequent interaction frequency with teaching materials, not only in the classroom but also outside the class [9]. Learning by using teaching material allows students to learn individually, they learn actively without maximum help of a teacher. Based on previous research, teaching materials reduce teacher-oriented learning, students are more focused on finding concepts and more active in learning. In addition, teaching material can enhance students' intellectual potential which in this case is a learning goal [10]. Thus, the development of integrated teaching science teaching materials for students needs to pay attention for the characteristics and needs of students in answering 21st century challenges. The author tries to create an integrated science teaching material for students who can trill environmental literacy using multimodal representation on pollution topic. These pollution materials include material contain phenomena and events close to the students' life and the surrounding environment so as to facilitate the students in understanding the concept of environment in depth. The development of this teaching material uses the development flow of Design Representational Approach Learning to Write developed by Sinaga [11]. One of the advantages of teaching materials used is to use multimodus representation. Multimodus representation can help students in understanding the concept described. If students have difficulty in understanding a concept on verbal explanation can be helped by other visual explanations. With so many representations being used, a concept becomes easier to understand. This instructional material is also used to demand students learning activities that involve aspects of knowledge, cognitive skills, affective and behavioral with the aim of training students'
environmental literacy. The problem of this research is how to improve of students' environmental literacy which includes the aspect of knowledge, skill, affective and behavior of junior high school students toward the use of integrated science teaching materials on pollution topic?

2. Experimental Method

2.1 Research method

The method used in this research is quasy experiment with design as one group pretest-posttest without control group design (see Table 1.) [12].

| Table 1. One Group Pretest-Posttest Design. |
|--------------------------------------------|
| Pre-test | Treatment | Post-test |
| O | X | O |
| Note: X: Treatment by using integrated teaching materials |

The sample used in this research consists of 32 junior high school students in Bandung class VII include of 15 males and 17 females. The sampling technique in this study using purposive sampling with the purpose of certain purposes [13]. The research design can be seen in Figure 1 as follow:

![Figure 1. Research Design](image)

2.2 Research instrument

The students’ environmental literacy capability was measured using an environmental literacy test adapted from the Middle School Environment Literacy Survey (MSELS) developed by the National Environmental Literacy Assessment [14]. Then modified according to pollution content amounting to 74 questions representing the entire component of environmental literacy include of knowledge, cognitive skill, affective, and environmentally responsible behavior. The environmental literacy test used in this study is tested for its validity and reliability considering the change, addition, and adjustment of the test questions with the pollution content. Grid tests of environmental literacy can be seen in Table 2.

| Table 2. Grid about Student's Environmental Literacy Test. |
|-----------------------------------------------------------|
| Component of Environmental Literacy | Sub Component | Question Number | Range Score | Score |
|-------------------------------------|---------------|-----------------|-------------|-------|
| a. Knowledge (Cognitive)            | Ecological knowledge | 1-20 | 0-20 | 60 |
| b. Competency (Cognitive Skills)    | Identify environmental issues | 21-23 | 0-14 | 60 |
|                                     | Analyze environmental issues | 24-29 |       |       |
| c. Affective about the Environment  | Action Plan | 30-34 |             |       |
|                                     | Sensitivity | 35-49 | 5-125 | 60 |
|                                     | Feeling | 50-57 |             |       |
| d. Environmentally Responsible Behavior | A real commitment (pro-environmental action) | 60-74 | 5-75 | 60 |
| Total                              | 74           | 240            |             |       |
Notes: For scores on Ecological Knowledge and on Cognitive Skills, Low = 0-20, Moderate = 21-40, and High = 41-60; For scores on Environmental Affect and on Environmental Behavior, Low = 12-27, Moderate = 28-44, and High = 45-60; For Composite Scores, Low = 24-96, Moderate = 97-168, and High = 169-240.

2.3 Analysis data
The improvement of students’ environmental literacy in the form of pretest and posttest result is analyzed using Normalized gain \( g \) statistic test with the following formula (1).

\[
g = \frac{(posttest) - (pretest)}{maximum\ score - (pretest)} \quad \ldots \ldots \ldots \quad (1)
\]

The category of score acquisition can be seen in the Table 3 [15].

| Range           | Category |
|-----------------|----------|
| \( g \) \geq 0.7 | High     |
| 0.7 > \( g \) \geq 0.3 | Medium   |
| \( g \) < 0.30   | Low      |

3. Results and Discussion

3.1. Environmental knowledge
Improvement of the literacy environment on overall knowledge aspects can be seen in Table 4.

| Aspect   | Test  | N   | Mean | Std. Deviation | t    | Df  | Sig 2-tailed | Result          |
|----------|-------|-----|------|----------------|------|-----|--------------|-----------------|
| Knowledge| Pretest| 32  | 31.03| 10.32          | -11.576 | 31  | 0.000        | Differ significantly |
|          | Posttest| 32  | 44.25| 8.95           | 11.576  | 31  | 0.000        |                 |

Based on Table 4, overall obtained value of P-value (Sig 2-tailed) pretest and posttest (Sig) <0.05. This means that there are significant differences in students' environmental literacy ability in the knowledge aspect between before and after learning using integrated science teaching materials. The negative t value indicates that the posttest result is higher than the pretest which means an increase in posttest result. The average percentage of pretest, posttest and N-gain scores on the knowledge aspect can be seen in Figure 2 below.

![Figure 2](image)

Figure 2. Percentage of pretest, posttest and N-gain scores on the knowledge aspect

From Figure 2 it can be seen that there is an increase of knowledge component with 46% N-gain value is in medium category. This increase in the knowledge component is likely due to the students having little difficulty in understanding the teaching materials used. This is supported by the presentation of materials in teaching materials using phenomena and events that are close to the student’s (contextual) life and the surrounding environment so as to facilitate the students in understanding the environmental
concept in depth. The use of examples and facts contained in the environment around the students will facilitate students in understanding a concept. Therefore, teachers should be able to associate the concept with the facts contained around the students in accordance with the principle of meaningful learning. Meaningful learning is a learning that directs students to deep understanding and is able to apply concepts to real, new and different conditions [16]. Science learning should be more emphasis on giving environmental issues or problems contextually to develop the competence of students to be able to explore and understand the surrounding natural environment scientifically and directed to find and do, so as to help students to gain a deeper understanding of the surrounding environment especially related to environmental pollution.

3.2. Cognitive skills
Improvement of environmental literacy capability in the aspect of knowledge as a whole can be seen in Table 5.

Table 5. Pretest and posttest comparison for the score of cognitive skills test

| Aspect               | N   | Mean  | Std. Deviation | T     | df  | Sig 2-tailed | Result                  |
|----------------------|-----|-------|----------------|-------|-----|--------------|-------------------------|
| Cognitive Skills     |     |       |                |       |     |              |                         |
| Pretest              | 32  | 24.67 | 10.32          | 13.867| 31  | 0.000        | Differ significantly    |
| Posttest             | 32  | 35.66 | 8.95           |       |     |              |                         |

Based on Table 5. Overall values of P-value pretest and posttest (Sig) <0.05 were obtained. This means that there are significant differences in students’ literacy ability on the aspects of cognitive skills between before and after learning using integrated science materials. The negative t value indicates that posttest result is higher than the pretation which means an increase in the posttest result. The average percentage of pretest, posttest and N-gain scores on the cognitive skills aspect can be seen in Figure 3 below.

![Figure 3. Percentage of pretest, posttest and N-gain scores on the cognitive skills aspect](image)

From Figure 3 it can be seen that there is an increase in the component of cognitive skills with 31\% N-gain is in the medium category. Improvement in the component of cognitive skills is inseparable from the experience that students gain during learning as contained in the component of the teaching materials where students are given exercise questions about environmental issue articles to be able to identify, analyze and make action plans to address the issues / issues of the environment. Therefore, students get training on the problem solving ability of the environment, so that students’ cognitive skills can be achieved well. In addition to the component of teaching materials there are also Scientific Activities and discussions that invite students to experiment and simple inquiry about environmental issues that occur around the students and make it to be more actively involved in discussion activities in discussing environmental pollution issues. Only individuals with literacy, awareness, and sensitivity will contribute to addressing environmental issues. Therefore, the cultivation of environmental literacy from within students is very important so that they can become environmental reform agents that can overcome environmental problems through their action plan [17].
3.3. Affective
The improvement of environmental literacy capability in the overall affective aspect can be seen in Table 6.

Table 6. Pretest and posttest comparison for the score of affective test

| Aspect | N  | Mean | Std. Deviation | t    | df  | Sig 2-tailed  | Result               |
|--------|----|------|----------------|------|-----|---------------|----------------------|
| Affective | Pretest | 32  | 41.59          | 4.14 |     |               |                      |
|         | Posttest | 32  | 46.24          | 4.05 |     | -7.758        | 0.000                |

Based on Table 6, overall values of P-value pretest and posttest (Sig) <0.05 were obtained. This means that there are significant differences in the ability of environmental literacy on affective aspects of students between before and after learning using integrated science materials. The negative t value indicates that the posttest result is higher than the pretation which means an increase in the posttest result. The comparison of the average percentage of pretest, posttest and N-gain scores on the affective aspect can be seen in Figure 4 below.

Figure 4. Percentage of pretest, posttest and N-gain scores on the affective aspect

Based on Figure 4 it can be seen that there is an increase in the affective component with a 25% N-gain value being in the low category, although when seen from the comparison of pretest results with posttest seen there is an increase from moderate to high category. The high pretest results make it less likely to be able to raise an ideal posttest result in high categories.

The lack of maximum affective component increase is probably due to limited time allocation for the implementation of teaching materials developed and at the time of implementation is not followed by the use of strategies and teaching methods that support such as outdoor activities, field trips or hands-on activities. Although affective aspects show an increase in the low category, the contribution of the use of teaching materials in growing and improving students' affective to the environment is evident during the learning activities. When students discuss Environmental Issues contained in teaching materials can increase students' knowledge of environmental issues and provide a separate learning experience for students. From this process it is clear that the results of discussion answers most students have a great concern for the environment. The provision of opportunities to students to interact directly with the facts and issues that develop in the environment will be able to train the students' sensitivity to the environment [18]. The knowledge embedded in the target will affect his attitude towards the environment that will be manifested in an action / behavior [19].

3.4. Environmental responsible behavior
The improvement of environmental literacy capability in the overall behavioral aspect can be seen in Table 7.

Table 7. Pre test and post test comparison for the score of behavioral test

| Aspect       | N  | Mean | Std. Deviation | t    | df  | Sig 2-tailed | Result               |
|--------------|----|------|----------------|------|-----|--------------|----------------------|
| Cognitive    | Pretest | 32  | 40.98          | 5.06 |     | -6.465       | 0.000                |
| skills       | Posttest | 32  | 46.05          | 3.62 |     |              | Differ significantly |

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Based on Table 7, overall values of P-value pretest and posttest (Sig) <0.05 were obtained. This means that there are significant differences in environmental literacy capability in the aspects of behavioral of students between before and after learning using integrated science materials. The negative t value indicates that the posttest result is higher than the pretation which means an increase in the posttest result. The average percentage comparison of pretest, posttest and N-gain scores on the behavioral aspect can be seen in Figure 5 below.

**Figure 5.** Percentage of pretest, posttest and N-gain scores on the behavioral aspect

Based on Figure 5 it can be seen that overall there is an increase in the component of cognitive skills with a 24% N-gain value in the low category. The low increase in the behavioral component is due to the learning time using this learning material only two weeks only and without accompanied by the use of strategies and learning methods that support such as outdoor activities, field trips or hands-on activities. Expecting large behavioral changes in a short time is difficult because behavior is a component that is influenced by many factors so that behavior can not change instantly. To make students who have good environmental literacy skills is a process that takes a long and continuous time. The slightest change in behavior will give meaning to environmental sustainability. That small changes in behavior can have a major impact [20]. Then the contribution of teaching materials in changing the behavior of a person to the environment can be seen on the content of teaching materials through strategies by changing the way students think in advance through the development of students’ thinking skills to be able to take decisions and have the competence to act [3].

3.5. Criteria for all students’ Environmental literacy

The improvement of students’ environmental literacy in overall can be seen in Table 8.

**Table 8.** Pretest and posttest comparison for the total score of environmental literacy test

| Aspect            | N   | Mean   | Std. Deviation | t      | df  | Sig 2-tailed | Result       |
|-------------------|-----|--------|----------------|--------|-----|--------------|--------------|
| Environment literacy | Pretest | 32 | 138.27   | 16.51     |       | 31  | 0.000        | Differ significantly |
|                   | Posttest | 32 | 172.21   | 14.95     | -18.979 | 31  |              |

Based on Table 8, overall values of P-value pretest and posttest (Sig) <0.05 were obtained. This means that there are significant differences in environmental literacy of students between before and after learning using integrated science materials. The negative t value indicates that the posttest result is higher than the pretation which means an increase in the posttest result. The percentage of improvement of students’ environmental literacy ability in overall a whole can be seen in Figure 6.

**Figure 6.** Percentage The improvement of students’ environmental literacy

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Based on Figure 6, it can be seen that overall there is an increase in overall students' environmental literacy with a 34% N-gain value in the medium category. Thus it can be concluded that the integrated science teaching materials used in learning can increase the students' environmental literacy. Although the improvement of students' environmental literacy is not yet optimal (being in the medium category), the teaching materials have contributed greatly to the students' environmental literacy. To make students have the environment literacy skills of the real is a long process and cannot be done instantly. Real environmental literacy takes a long time [20]. The use of integrated science teaching materials is one of the efforts to improve of students’ environmental literacy. The effort to improve environmental literacy is an effort that must be done continuously given the ability of one's literacy environment greatly affects how a person treats his environment.

4. Conclusions
Based on the results of the use of integrated science teaching materials in learning can improve students' environmental literacy for each component there is an increasing component of knowledge and cognitive skills in the medium category, as well as an increase in affective and behavioral components in the low category. Overall, improvement of students' environmental literacy by use teaching material is in the medium category. It can be concluded the use of Integrated science teaching material can further increase the students’ environmental literacy.

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