**The Effectiveness of Mobile Learning Teaching Materials based** **Education Sustainable Development in Eco Friendly Technology to Improve Environmental Literacy**

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Received:…………..; Revised:…………; Published: …………..

**Abstract**

This study aims to develop mobile learning teaching material based ESD with the theme is Eco Friendly Technology and test its effectiveness in improving Environmental Literacy. Teaching materials were developed using ADDIE model. There were 58 students in 9th grade involved, consisting of experimental and control class. The instruments used included a Environmental Literacy test and instruments for assessing the quality of teaching materials, comprehension test sheets. The data were analysed by determining the average normalized gain, t-test means, and effect size. Based on the analysis, the data obtained: 1) the quality test and reading comprehension test are in the good, 2) The Environmental Literacy skills of experimental group increased with medium criteria, and the control group increased with low criteria. (3) There was a significant difference in the increased Environmental Literacy skills between the experimental class and control class,teaching materials can improve Environmental literacy skills with an N-Gain of 0.41, which is in the medium category, and 4) The effect size test and t test showed 1,2 which is in high category, it means teaching materials were effective in improving students' environmental literacy skills.

***Keywords:*** Teaching materials; Mobile Learning; ESD; Environmental Literacy; Eco Friendly Technology.

***How to Cite:*** First author., Second author., & Third author. (20xx). The title. *Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram, vol*(no), xx-yy. doi:<https://doi.org/10.33394/j-ps.vxxiyy>

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**INTRODUCTION**

The Education in the 21st century is experiencing changes caused by developments in science and technology. It has an impact on learning paradigms, such as curriculum, media and learning technology. In line with the demands of 21st century, learning by integrating technology as a learning medium is an effective way to developing student learning skills. Science learning expects students to understand the surrounding environment known as environmental literacy. Environmental literacy can be referred to as environmental literacy or actions based on concern for the environment. According to Roth (1992), environmental literacy is a person's ability to understand the surrounding environment and play a role in efforts to protect, repair and improve environmental quality. Environmental literacy is basic education for everyone which provides knowledge, skills and motivation to overcome environmental problems and contribute to sustainable development. Environmental literacy is basically the capacity to understand and interpret environmental conditions and take appropriate action to maintain, restore, or improve those environmental conditions (Kidman & Casinader, 2019).

 However, based on facts, environmental literacy has not been optimally improved. This is supported by the results of studies that show students' environmental literacy scores have an average percentage of 47%. Students' environmental literacy is still considered to be low due to several factors, because of the lack of intention to know and study environmental problems (Rohweder, 2004). This result of the study explains that the one of senior high school student has a level environmental Literacy skills are classified as "sufficient" with an average score of 75(Aini et al., 2021). (Igbokwe, 2016) stated that students' environmental literacy is generally low, only 29.3% of students meet environmental literacy assessment standards and the remaining 70.7% are still below standards. (Suryawati et al., 2020) stated that junior high school students' ability to identify, analyze problems, and design planning actions and practice to solve environmental problems is still low. The study results showed that the student who did not have adequate environmental knowledge related to environmental education, attitudes, concerns and perceptions of environmental problems were relatively high (Saribas et al., 2014)

 This study show that there is a gap between standards competency in junior high school and the fact of students' environmental literacy. Environmental literacy cannot be developed naturally but it should be stimulated by various stimuli and environmental conditions. There needs to be a teacher’s role to improve the quality of education. One of the teacher's role is to provide teaching materials which is appropriate with students’ need. The unpropiate teaching materials causes the low quality of education and learning systems (Kaniawati, n.d.).

 Mobile learning teaching materials provide new opportunities for students, such as learning that is personalized, contextualized, and not hindered by time or environmental constraints (Crompton & Burke, 2018; Farrah & Abu-Dawood, 2018). Mobile learning has many advantages from the user's perspective, most of them is as a learning resource(Elfeky & Yakoub Masadeh, 2016; Yousafzai et al., n.d.). Based on the results of a survey by Insani (2016), it was found that 96% of the teaching materials used by teachers in Indonesia were printed (textbooks, modules, worksheets), and 4% used electronic school books. To overcome this gap, this research is aimed at improving junior high school students' environmental literacy by using mobile learning teaching materials.

In developing teaching materials to improve certain skills, an approach is needed in the development process. The Education for Sustainable Development (ESD) can be applied in science education. ESD reflects a close relationship with sustainable development, prioritizing knowledge, skills, values and action competencies to integrate and balance the 'pillars' of Sustainability. Development: society, environment and economy, and culture (Unesco, 2017). In 2015 the SDG concept was introduced into the world of education in the form of Education for Sustainable Development (ESD) (Oh et al., n.d.). It aims to build human character and competence through education in schools (Oh et al., n.d.). However, unfortunately in Indonesia, ESD has not been included and implemented in the school curriculum. Therefore, there is still lack of learning source and teaching materials from the government that are suitable for implementing learning activities with the ESD concept.

 Moreover, the author carried out a brief analysis of ESD values in the 2013 science curriculum text book published by the government in the study of Eco Friendly Technology material. From the results of the analysis, it was found that (1) the material discussed has not contained ESD aspects and did not support the goals of sustainable education, (2) the material presented has not specifically addressed the goals of sustainable education, (3) the material presented has not contained environmental, socio-cultural and economic aspects. Environmental, economic and social aspects need to be emphasized in learning resources to support ESD-based learning(Mahaffy et al., 2019; O’Flaherty & Liddy, 2018).

Several previous studies have been developed on interactive media regarding mobile learning application. Another research conducted by (Widodo et al., 2020). He developed gadget-based interactive multimedia. There are several studies related to environmental literacy, and ESD implementation, students' sustainability awareness through ESD integration in teaching learning process (Berglund et al., 2014). The difference between this study and previous study is this research only focuses on certain topics and improving environmental literacy. The development of teaching materials in the form of e-book or e-modul form that is currently available is still in the form of transferring books to digital form and is not yet optimal for practicing certain skills such as the demands of education in the 21st century. Various literacy skills can be enhanced with the appropiate teaching material and the activities involve the surroundings in meaning-making processes, which included identity formation, agency and learning to use environmental literacy (Häggström & Schmidt, 2020). In this study, teaching materials in the natural sciences were developed for junior high school students, and their effectiveness was measured. To produce clear and concise teaching material the process of developing them was modelled after how science textbooks are written (Sinaga et al., 2017).

 Meanwhile, this study aims to develop ESD-based mobile learning teaching materials to improve environmental literacy skills on the topic of eco friendly technology. Based on the above description, it can be formulated the research problem is "How is the effectiveness of the development of mobile learning teaching material based ESD to improve junior high school students' environmental literacy skills in Eco Friendly Technology?"

**METHOD**

The method used is research and development. Development research focuses on a given product, program, process, or instructional tool (Richey & Klein, 2005). The development model used is ADDIE. It is one of the systematic learning design models, chosen based on the consideration of this model is developed systematically on the theoretical foundation of learning design. This model is structured programmed with sequences of systematic activities in efforts to solve learning problems related to learning resources that are in accordance with the needs of students. This model consists of five steps, namely: (1) analyze, (2) design, (3) development, (4) implementation, and (5) evaluation.

At the implementation stage, a test of the effectiveness of the teaching materials developed was carried out, with a pre-test, post-test control group design was chosen. By using this design the experimental group and control group have the same characteristics. The sample was determined with the purposive sampling technique and consisted of junior high school students who are divided into the experimental class and control class, of 29 students each.

The Experiment class used teaching materials that were developed while the control class used teaching materials commonly used in schools. The instruments used included a environmental literacy test and a four-rating scale questionnaire. Research instruments were in the form of tests, to measure ecological knowledge, and questionnaires that were adapted from the Middle School Environmental Literacy Survey (MSELS), to measure cognitive skills, actions, and sensitivity to the environment. Before being used, questionnaires and tests adapted from MSELS were tested.

Ecological knowledge variables were measured using multiple-choice tests consisting of 12 questions. The data were analysed by determining the average normalized gain, t-test means, and effect size, and descriptively analysing. The final stage is Evaluation, namely evaluating student learning outcomes, as well as improving products according to student needs as a basis for further research.

**RESULTS AND DISCUSSION**

1. **Teaching Material Feasibility**

The instrument for assessing the quality of Mobile Learning Teaching material based ESD consists of material relevance, media suitability and ESD components. The material relevance consists of the suitability between Basic Competencies and Indicators as well as the suitability of Content Writing, each of them has its own assessment sub-aspect. Based on the results of the quality test of teaching materials validation, the mobile learning teaching materials based ESD on the theme of Eco friendly technology are in adequate quality with an average score of 80.00. Furthermore, the media suitability aspect consists of two components: 1) presentation of mobile learning, and 2) The use of mobile learning. The average score for media is obtained 89% which is adequate category. The third aspect is ESD components, which consist of ESD Component (Environment, Social, Economic), the average score for ESD component is 80,5%.

The reading comprehension test in this study used an instrument containing text in one sub topic with four questions for each text consisting of writing the main idea of the text, sentences to supporting the main idea, sentences that were difficult to understand in the text, and unknown words in the text. The developed mobile learning teaching materials shows that from the 24 text tested, 21 text had a high level of understanding and 3 text had a medium level of understanding.

**2. Environmental Literacy Improvement**

 In this research, environmental literacy indicators were developed from the environmental literacy function according to Middle School Environmental Literacy Survey (MSELS). Students' environmental literacy on the theme of eco friendly technology were measured using a environmental literacy question instrument in the form of a description test totaling 12 questions. The increasing in environmental literacy skills in ecological knowledge is analyzed based on the increase in N-gain. The research results showed the differences in increasing environmental literacy between the experimental class and the control class.

The results of data analysis show that, it can be seen that the N-gain value for the experimental class is 0.41 and the control class is 0.18. The Environmental Literacy skills of the experimental group increased with the medium criteria, and the control group increased with low criteria. There was a significant difference in the increased environmental literacy between the experimental class and control class.

Table 1:

The average normalised gains in students’ environmental literacy skills

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Class | <Pre Test> | <Post Test> | <g > | Category |
| Experiment | 48,55 | 69,79 | 0,41 | Medium |
| Control |  47,72 | 57,41 | 0,18 | Low |

The increase in the environmental literacy skills in ecological knowledge of students who used the teaching materials, both in the overall and per-item mean scores, was higher than that of students who used common textbooks. N-gain analysis is described in more detail regarding the differences percentage of students with the improvement of environmental literacy in each category, described in Graphic 1.

Graphic 1.

Percentage of the students number based on Environmental Literacy Improvement Category

Furthermore, beside the increasing students’ environmental literacy in ecological knowledge, the developed teaching material stimulate student’s environmental sensitivity. The increasing of students’ sensitivity to the environment caused by students’ awareness from learning are able to enhance behavior towards a responsible environment and build personality of the students (Wirdianti et al., 2019). Other efforts are carried out through strengthening the source of learning as a teaching material and environmental material in the education curriculum in secondary schools. It will be followed by increasing attitudes and behaviors which become a part of environmental literacy (Varoglu et al., 2018). Some activities are carried out to increase students’ sensitivity to the environment through the school literacy movement with the appropiate learning source. The source of learning like developed teaching material based ESD is expected to be able to train activities to identify, analyze, evaluate issues, and plan actions against local environmental problem. Environment-based learning is effective in increasing students’ attitudes and knowledge(Schmitz & Da Rocha, 2018).

3. **The Effectiveness of Using Teaching Materials on Environmental Literacy**

To determine the effectiveness of the teaching materials, an effect size was used. The effect size test aims to find out how much influence the use of mobile learning teaching materials based ESD has on environmental literacy. The results analysis of the coefficient measuring the effect size of mobile learning teaching materials on environmental literacy are 1,2 with medium criteria.

Table 2.

Results analysis of the mobile learning teaching material impact on environmental literacy compared to standard textbooks.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ME | MC | SDE | SDC | NTotal | Cohen d | Criteria |
| 41,58 | 18,57 | 19,94 | 16,58 | 58 | 1,2 | Very High |

Based on the result analysis found that there is improvement of students’ environmental literacy skill. The improvement in the experimental class was higher than in the control class. Thus, the use of developed teaching materials can improve students' environmental literacy skills compared with the common textbook used in the school. The developed teaching materials has several characteristics. The former, teaching material developed based Education Sustainable Development (ESD). Education Sustainable Development aims to develop Competencies that empower to consider personal actions, considering current and future social, cultural, economic and environmental impacts (Klarin, 2018; Perello-Marín et al., 2018).

The ESD (Educational Sustainable Development) program implemented continuously in schools is able to develop environmental literacy in students (Oh et al., n.d.). To be able to build students’ character who care about the environment, a teacher should be able to apply ESD values in learning (Didham & Ofei-Manu, 2020). One indicator of environmental care can be measured through the level of environmental literacy (Hermawan, 2018).

In this way, students not only learn about science but also deep understanding of environmental problems, eco friendly technology for sustainable life as well as non-eco friendly technology and its impact on sustainable life. The findings (Suryawati et al., 2020) showed that Learning with environmental issue could significantly improve students’ environmental literacy. This study also shows that students need learning and activities related to the environment, as stated by (Dian Pratiwi & Komala, 2019). The practice of environmental education will directly enhance one’s ability to obtain, change, and apply environmental knowledge that accumulates in the right attitude towards the environment (Zheng et al., 2017).

Second, the use of developed teaching materials are student-centered and material developed contextually. The development of teaching materials is developed with user friendly so that students will not depend on the teacher's explanations. Moreover, teaching materials and exercises are arranged contextually, so it ease students to understand. The exercises are prepared based on the suitability of the content of the material and environmental literacy indicators in various representations to provide the information needed by students. Moreover the materials delivered related with students’ life. Research that conducted by (Doyan & Sukmantara, 2014; Ilhami et al., 2019) states that the application of learning science with a contextual material can Help students strengthen concepts the science they gain so that they have the ability Students' environmental literacy also increases. The development of teaching materials integrated environmental issues must be precise and efficient so as to provide maximum learning outcomes in students (Azhary et al., 2020). Thus, learning resources that Utilizing the surrounding environment can also increase environmental literacy with significant result (Fajeriadi et al., 2019; Hekmah et al., 2019)

Third, the developed teaching materials are integrated with technology. There are various visual media and forms of concept representation such as pictures, videos, graphics, as a form of technological development, it makes teaching materials more interesting and easier to access anywhere. In learning, the use of visual media can increase learning that is more interesting and interactive(Chao, 2019). Learning with more than one representation will encourage students to reason and reflect on the similarities and differences between the representations to gain a better understanding of the matery (Azhary et al., 2020; Sinaga et al., 2022). Technology, helps natural phenomena can be simulated so that they are better represented than when learning through books (Setiawan, et al., 2021). Furthermore, (Höffler et al., 2019) stated that students' interest in learning process is when students are actively involved.

Fourth, The questions development to measure students' environmental literacy, it is not only limited to questions to explore students' memories but also the addition of stimuli that are close to students' lives which contain ESD aspects. The stimuli used are taken from daily life problems that are related to economic, social, and environmental aspects. Moreover it also be taken from problems in students’ surrounding environment, such as the potential eco friendly technology of an area. It is necessary to consider to the selection of stimuli in developing assessment instruments that should be contextual and interesting (Putranta & Supahar, 2019). Thus, The results of this study that mobile learning materials designed using multiple representations, static and dynamic representation, and also Based ESD were able to improve students’ thinking skills support prior studies (Abdurrahman et al., 2019; Wiyarsi et al., 2018).

**CONCLUSION**

This study examined the impact of mobile learning teaching materials based ESD in eco friendly technology, distributed and operated on students’ individual smart phones, in training environmental literacy skills in junior high school students. Concepts are presented using multiple representations based ESD. ESD reflects a close relationship with sustainable development, prioritizing knowledge, skills, values and action competencies to integrate society, environment and economy, aspect. environmental literacy skills are trained alongside instruction on the eco friendly technology in experiment and control class.

The results of the data analysis show that: The environmental literacy skills of the experimental group increased with the medium criteria, and the control group increased with low criteria. The increasing in the environmental literacy skills of students who used the teaching materials, both in the overall and per-item mean scores, was higher than that of students who used common textbooks. The effect size test aims to find out how much influence the use of mobile learning teaching materials. The results analysis of the coefficient measuring the effect size of mobile learning teaching materials on environmental literacy skills are 0.71 with medium criteria.

**RECOMMENDATION**

 Through further studies, it is expected to explore other topic related to Education Sustainable Development research topics. Development of integrated science learning materials on the theme of eco friendly technology oriented towards environmental literacy are still limited on a particular concept, it can be developed more to other concept. Moreover, Materials can be developed further learning that is oriented towards other skill such as problem solving skill.

**ACKNOWLEDGMENT**

We state my deep sense of gratefulness to our lectures, Prof. Dr. Parlindungan Sinaga, M.Si, and Dr. Amprasto, M.Si under whose sincere guidance, supervision and support We have been able to complete this study. We are grateful to School of Post-Graduates, Indonesian University of Education., who not only provided numerous opportunities for growth, facilitated and prepared us for a variety of life changes and challenges.

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