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Applying the Education for Sustainable Development Approach to Energy Instruction Design for Encouraging Scientific Literacy of Junior High School Students

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Abstract: The purpose of this research is to produce learning designs on energy materials with the Educational for Sustainable Development (ESD) approach to develop scientific literacy that is validated and tested on a limited scale. This research uses Design and Development Research model, which uses 6 stages of the D&D model, namely 1) Identify the problems motivating the research; 2) Describe the objectives; 3) Design and develop the artifact; 4) Subject the artifact to testing; 5) Evaluating test results; and 6) Communicating test results. Interview guidelines, lesson plans, validation sheets, and worksheets are the main instruments in this research. The results are indicators derived from content standards can be found with ESD elements, and the learning design developed is considered feasible to be applied in learning. The principle in implementing ESD elements in learning is student-oriented, making the environment a source of learning and connecting local and global issues.

Keywords: education for sustainable development, scientific learning, learning design

Abstrak: *Penelitian ini bertujuan untuk menghasilkan desain pembelajaran pada materi energi dengan pendekatan Educational for Sustainable Development (ESD) untuk mengembangkan literasi sains yang tervalidasi dan teruji dalam skala terbatas. Penelitian ini menggunakan model Penelitian Design and Development Research, yang menggunakan 6 tahapan model D&D, yaitu 1) Identifikasi masalah yang memotivasi penelitian; 2) Menjelaskan tujuan penelitian; 3) Merancang dan mengembangkan produk; 4) Uji coba produki; 5) Mengevaluasi hasil uji coba; dan 6) Mengkomunikasikan hasil uji cobs. Pedoman wawancara, RPP, lembar validasi, dan LKS merupakan instrumen utama dalam penelitian ini. Hasil dari penelitian ini adalah indikator yang diturunkan dari standar isi dapat ditemukan dengan unsur ESD, dan desain pembelajaran yang dikembangkan dianggap layak untuk diterapkan dalam pembelajaran. Prinsip dalam mengimplementasikan unsur-unsur ESD dalam pembelajaran adalah berorientasi pada siswa, menjadikan lingkungan sebagai sumber belajar dan menghubungkan isu-isu lokal dan global.*

Kata kunci: education for sustainable development, *literasi sains, desain pembelajaran.*

▪ INTRODUCTION

The years between 2005 and 2014 have been declared as a worldwide Decade of Education for Sustainable Development (DESD) by the United Nations. (Burmeister, Rauch & Eilks, 2012). The goal of DESD is to integrate the principles, values, and practices of sustainable development into all aspects of education and learning (Kemdiknas, 2010). It is hoped that this effort will encourage a change of attitude that can create a sustainable future in the context of environmental integrity, economic development and a just community for present and future generations.

Along with the UNESCO program, the Ministry of National Education Research and Development has developed educational models for Sustainable Development,

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namely: (1) Educational Models for Sustainable Development through Intracurricular Activities, (2) Main Educational Materials for Sustainable Development, and (3) Guidelines for the Integration of Educational Values for Sustainable Development into Competency Standards and Basic Competencies in learning activities (Kurniasih & Sani, 2014). This is also reinforced by the opinion Eilks (2015) that teachers can add Sustainable Science as content in the science and technology curriculum. This model is based on the challenges for students in the future, namely environmental problems, a knowledge-based economy and the rise of creative and cultural industries (Kurniasih & Sani, 2014). Therefore, several competencies are needed, including having a readiness to work, having intelligence according to their talents/interests, and having a sense of responsibility towards their environment.

Competencies that must be provided to students in line with ESD policies, in practice have not been synergized with aspects of learning in schools. Based on the results of a preliminary study conducted by researchers, it was found that teachers generally do not fullly understand ESD, both in terms of concepts, objectives and programs. Besides that, there is no explicit policy on ESD that can be used as a reference on the implementation of ESD in schools, especially for teachers in carrying out learning.

The integration of the ESD program into the curriculum to be implemented in schools is needed not easy, because so far teachers in schools still have misunderstandings about the meaning of the term "sustainability". Most of the lecturers care about local and national environmental issues, but pay little attention to global problems, such as climate change, waste management and the depletion of energy resources (Spiropoulou et al., 2007). This is reinforced by the results of research Fatiyah, Riandi & Solihat (2021) that the difficulties faced by teachers when implementing ESD in the teaching and learning process are due to the lack of information about ESD and also the lack of training regarding the application of ESD for learning. Because according to Karaarslan & Teksöz (2016) that science teachers need outdoor ESD approach that supports thinking in a systemic way, feeling inter-connectedness with the natural world and understanding social, economic and environmental values of the natural system and developing an intention to act for sustainability. Beside that, one of the challenges faced by teachers with respect to ESD is the inclusion of more content into the curriculum which already overloaded. In response, it has been suggested that ESD should be introduced as an integrated perspective throughout the content of all existing subjects (Jegstad & Sinnes, 2015) .

The existence of ESD demands in science learning, indirectly requires an integrated description of the material. One of the science materials in grade VII that is predicted to require the integration of science in science is energy. This is indicated by KD 3.5 which reads to analyze the concept of energy, various energy sources, and changes in the form of energy in everyday life including photosynthesis and KD 4.5 which reads to present experimental results on changes in energy forms, including photosynthesis. Integrating science into science is necessary, because it can help students apply their knowledge in everyday life, especially those related to environmental issues.With learning that integrates one aspect of ESD, namely the environmental perspective, it is hoped that the learning process in schools can be meaningful. Because according to Kaya & Elster (2019) that enhancing the

environmental responsibility of the students might contribute to both environmental literacy and science literacy.With a learning process like this, students are required to read more, have study skills, and are more literate in science, and have good scientific literacy skills. According to Jufrida et al (2019) that scientific literacy is the ability which must be owned by the students to analyze and apply the concept of science in solving daily life problem. However, according to the results of the PISA survey from 2009 to 2018, Indonesia is one of the countries eith low scientific competence. The results of the 2009 PISA for science competence, Indonesia is ranked 60th out of 65 participating countries. The recovered science competency score decreased to 383 points (OECD, 2010). The results of PISA in 2012 for science competence, Indonesia was ranked 64th out of 65 participating countries. The science competence score obtained decreased to 382 points (OECD, 2013). The 2015 PISA results for scientific competence, Indonesia was ranked 69th out of 76 participating countries. The science competency score obtained has increased drastically to 403 points, but has not had an effect on the ranking (OECD, 2016). The results of the 2018 PISA for science competence, Indonesia ranks 62 out of 71 participating countries.

Indonesia's ranking from PISA assessment reflects the Indonesian education system that has not been able to facilitate the empowerment of students' scientific literacy. The level of scientific literacy in students can be achieved through a learning process that requires students to have the ability to think critically and logically. Students are expected not only to be able to read books, but also to have a deep understanding of science (Holbrook & Rannikmae, 2009). Students engage with science and literacy in a variety of contexts throughout their day. By paying attention to scientific literacy in the classroom, students participate in experiences that encourage them to see science not just as a subject in school, but as an area of exploration and progress. According to Allison & Goldston (2018) if students are given the opportunity to engage with science and engineering in a way that reflects what scientists do, this can improve their literacy skills.

According to Churchill, King & Fox (2013), teachers need a learning design model to help plan their learning, so that it can help teachers overcome today's learning challenges. Therefore, a learning design is needed that can assist teachers in implementing ESD and can also improve students' literacy skills. So that students can understand and apply what they learn in school to their daily lives in order to protect the environment, especially the attitude of responsibility in the use of energy. Because developing literacy education through massive investment in human capital is the first step in enhancing sustainability literacy (Oghenekohwo & Frank-Oputu, 2017) . Based on the explanation above, the researcher proposes to conduct a thesis research "Learning design on energy materials with the Educational for Sustainable Development (ESD) approach to develop scientific literacy.

▪ METHOD

Participants

This research was conducted in one of the MTs in Malang. Participants in this study were class VII students as many as 23 people. The selection of participants was taken by taking into account the cognitive level of students, namely the class with a higher cognitive level than other classes. While the formation of groups is done by

grouping heterogeneously.

Research Design and Procedures

This research is a qualitative research using the Design and Development Research model from the opinion of Peffers, et al (Ellis & Levy, 2010). The D&D model is a research method whose main purpose is to provide information for Instructional Designers, that a problem in education has been found and solved empirically and systematically through a series of research on the design, development and evaluation process (Richey & Klein, 2014). In this study using 6 stages of the D&D model, namely 1) Identify the problems motivating the research; 2) Describe the objectives; 3) Design and develop the artifact; 4) Subject the artifact to testing; 5) Evaluate the result of testing; and 6) Communicate those results (Ellis & Levy, 2010)., as shown in Figure 1.

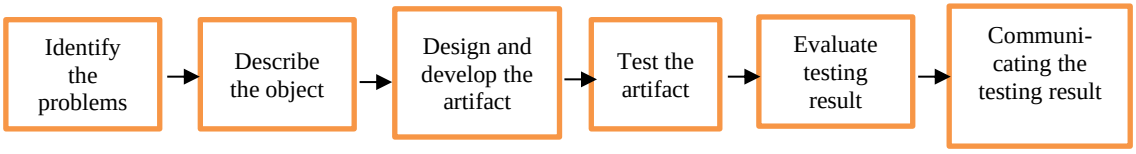

Figure 1. The phase design and development research

Identify the problem motivating the research

In this study, the identification of the problem was carried out by using interview techniques conducted by researchers to several science teachers at the junior high school in Malang. This research raises the issue of integrating ESD elements into science learning design. This happens because not many have integrated ESD elements into the design of science learning. So the researchers found a general problem in this study, namely "How is the development of energy material learning design with the Education for Sustainable Development approach to develop students' scientific literacy?".

Describe the objectives

To overcome the problems raised in this study, the researchers developed an energy material learning design with an Education for Sustainable Development approach to develop students' scientific literacy. Specifically, the purpose of this research is to produce learning designs on energy materials with the Educational for Sustainable Development (ESD) approach to develop scientific literacy that is validated and tested on a limited scale.

Design and Develop the artifact

The design of learning energy materials with the Education for Sustainable Development approach is a product that is used as a solution to the problems in this research.

Test the artifact

Product trials are carried out when the learning design that has been developed is ready to be evaluated. The product trial was carried out in one of the private MTs in Malang City, involving 23 grade VII students.

Evaluate testing result

Evaluation is carried out based on data obtained from students and then analyzed so that conclusions can be obtained regarding the product developed, whether it is in accordance with the research objectives or not. In this study, researchers tried to measure students' scientific literacy competence, namely the competence to explain scientific phenomena and evaluate and design scientific investigations with the following indicators.

Table 2. Scientific literacy competency indicators

No	Competence	Indicators
1	Explaining phenomena scientifically	Identifying problems in scientific issues
		Mention the factors that cause problems in scientific issues
2	Evaluating and designing scientific investigations	Finding solutions to problems in scientific issues

Communicating the testing result

The results of the data analysis are then concluded to be further written in the article. The communication process of the results of this data analysis contains various information regarding the process of product design and development, the contribution of products developed to the realm of education, the relationship between research conducted and previous studies, and how the results of data analysis match the objectives of the research.

Instruments

This research using several instruments as presented in Table 3.

Table 3. Research instruments

No	Instruments	Target	Data Source
1	Interview Guidelines	Identification of ESD elements in learning design	Science teachers
2	Validation Sheet	Validated learning design	Expert validator
3	Worksheets	Student’s scientific literacy ability	Students

Analysis

In analyzing the learning design that has been made using a non-test instrument in the form of a questionnaire using a Likert scale. In this study using a Likert scale of 1 to 5, with the highest score of 5 and the lowest score of 1. The final score of an item is the percentage of the average value of the indicator of all validator answers. From the calculation of the score of each statement, the percentage of respondents' overall answers are sought with the number of respondent’s answer divided with the number of ideal values in the item and then multiply with one hundred percent (Asyhari & Silvia, 2016). Then look for the percentage of validation criteria. The validaton criteria used can be seen in the following table:

Table 1. Eligibility interpretation criteria (Asyhari & Silvia, 2016)

Interval	Criteria
0%-20%	Very Inappropriate
21%-40%	Not feasible
41%-60%	Decent enough
61%-80%	Feasible
81%-100%	Very feasible

In analyzing student's scientific literacy skills, the researchers analyzed using a qualitative approach with by analyzing the answers from each group. If in question 1 the student is able to answer three problems based on the article then if in question 2, the student is also able to mention three factors that cause the problem, it can be said that the student has the ability to explain phenomena scientifically. And if the student is able to answer question 3 by finding three solutions to the problem according to the article, it can be said that the student has the ability to evaluate and design scientific investigations.

▪ RESULT AND DISSCUSSION

The problem motivating the research

Based on the results of a preliminary study conducted on 10 teachers, the following are the results of the interview data obtained:

Table 3. Interview result data

Teacher's statement	Total number of teachers
Teachers who don't understand ESD	8
Teachers who have integrated ESD into learning	2
Teachers who do not find ESD policies in the preparation of the learning process	10
Teachers who do not understand there are elements of ESD incore competence and basic competencies	10
Teachers who have integrated environmental education elements in science learning	2
Teachers who find it difficult to inset ESD elements into the learning process.	2

From table 3, we can see that eight out of ten teachers who do not understand ESD were interviewed and there are just two out of ten teachers who have integrated environmental education elements in science learning. This means that teachers generally do not fully understand ESD, both in terms of concepts, objectives and programs. Then from table 3, we also know that ten teachers who were interviewed do not find ESD policies in the preparation of the learning process and do not understand there are elements of ESD incore competence and basic competencies. It means that there is no explicit policy on ESD that can be used as a reference for developing programs and their implementation at the education unit level. This is contrary to the policy of the ministry of education and culture, where Balitbang Kemdiknas stated that it would develop a sustainable learning model (Kurniasih & Sani, 2014). Beside that, from table 3 it is known that only two teachers who have integrated ESD into learning

and they find it difficult to insert ESD elements into the learning process. Therefore, researchers develop learning designs on energy topic with the Educational for Sustainable Development (ESD) approach. Because sustainable education is highly connected to the professions involved in the development environment, as they play a role in decreasing the consumption of natural resources (Holdsworth & Sandri, 2014). Environmental education for sustainable development is arising as an important approach to promote the students to conserve and keep the natural environment in their environment (Alexandar & Poyyamoli, 2014).

Design and Develop the artifact

According Putri et all (2020), teaching material that is designed with problem-based learning concepts can improve students' science literacy skills for science learning. This is in accordance with research of Hestiana & Rosana (2020), problem based learning method can improve the science literacy and problem solving skills. And according to Pradipta & Hariyono (2021), that students can improve their problem-solving skill with ESD-based learning. So, researcher develop learning design with problem based learning method with ESD-based learning. The development of learning designs starts from the selection of materials, namely energy materials. The following are basic competencies related to energy:

Table 4. Basic competencies 3.5 dan 4.5

Basic Competencies	
3.5 Analyze the concept of energy, various energy sources, and changes in the form of energy in everyday life including photosynthesis.	4.5 Presents the results of experiments on changes in the form of energy including photosynthesis.

The next step is to describe these basic competencies into several indicators. In this study. The researchers only conducted research at first meeting. The cognitif indicators for fisrt meeting are identify scientific issues according to the article, mention the factors of energy problems according to the article and find solutions to energy problems according to the article through discussion. And the skill indicator is submit ideas to solve problems related to alternative electrical energy. After describing the basic competencies, the researches integrated ESD values in the design of energy learning topic. The following is the result of the integration of ESD values.

Table 5. Emphasizing esd values in core competence and basic competencies

Core Competence	**Basic Competencies**	**ESD Perspective**		
		Social	**Environment**	**Economy**
Understand and apply knowledge (factual, conceptual, and procedural) based on	3.5 Analyze the concept of energy, various energy sources, and changes in the form of energy in everyday life	- Think again that we need wise steps in utilizing non-renewable natural resources so that they do not run out quickly. - Waste can be	- Discuss the impact of using non-renewable natural resources continuously. - Solar energy can be used as	- Energy from biomass can be used as a renewable energy source that can be converted

Core Competence	Basic Competencies	ESD Perspective		
		Social	**Environment**	**Economy**
their curiosity about science, technology, art and culture	including photosynthesis. 4.5 Presenting the results of experiments on changes in the form of energy including photosynthesis.	used as an energy source to be converted into electrical energy. With the discovery of this energy, people are encouraged to dispose of their garbage in its place	an alternative energy source of electricity to reduce the use of electricity from coal, thereby reducing pollution to the environment.	into gas to replace LPG. This can help people to save on expenses.

Meanwhile, after integrating ESD values into core competence and basic competencies, the researchers developed a design for learning energy topic using the ESD approach. This learning design was validated by 3 people, namely two lecturers and one science teacher. From the results of the percentage calculation, it is known that the validation percentage is 78.42%. From these results it is known that the development of energy material learning designs with the ESD approach is feasible to use in the learning process

Evaluate testing result

In this study, the learning process carried out was only the first meeting. In this study, students were asked to work on worksheet 1 in groups. The groups made consist of 4 students, but there is one group consisting of 3 students. The group was arranged heterogeneously. The following are the results of the analysis of student answers on worksheet 1.

Table 6. Worksheet 1 analysis results

Group's Name	The Analysis Results		
	Question number 1	**Question number 2**	**Question number 3**
Group 1	Students are able to identify 2 problems in the article correctly	Students are able to correctly name 1 factor causing energy problems	Students are able to find 3 solutions to energy problems correctly
Group 2	Students are able to identify 1 problem in the article correctly	Students are able to correctly name 1 factor causing energy problems	Students are not able to find solutions to energy problems correctly
Group 3	Students are able to identify the 3 problems in the article correctly	Students are able to correctly name 1 factor causing energy problems	Students are able to find 2 solutions to energy problems correctly.
Group 4	Students are able to identify 1 problem in the article correctly	Students are able to correctly name 1 factor causing energy problems	Students are able to find 2 solutions to energy problems correctly

From table 6 it can be seen that in general students are able to answer each question according to the target on the indicator. So it can be said that students have experienced the development of scientific literacy competence, namely the competence to explain phenomena scientifically and the competence to evaluate and design scientific investigations. This is accordance with the findings of research Ekantini & Wilujeng (2018) that the science student worksheet with ESD approach was effective to increase student scientific literacy. This is also in accordance with the findings of Guevara (2015) that there was a statistically significant improvement in the students' science literacy upon completion of the course with integrating sustainable development concepts and principles.

▪ CONCLUSION

Based on the analysis result, it is known that the validation of development learning design percentage is 78.42%. From these results it is known that the development of energy material learning designs with the ESD approach is feasible to use in the learning process. From the results of working on worksheet 1 by students, it is known that students have met the targets of the indicators at the first meeting and have achieved the learning objectives at meeting 1. So it can be said that students have experienced the development of scientific literacy competence, namely the competence to explain phenomena scientifically and the competence to evaluate and design scientific investigations.

In general from the result of this research, it can be concluded that the design of energy material learning with the Education for Sustainable Development approach can be used to develop students' scientific literacy. Researchers hope that the results of developing this learning design can be used as a teacher reference to apply ESD-based learning with other science topics. Because the development of this learning design has limitations, which can only be used for learning energy topics.

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