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Development of Inquiry-Based Teaching Materials on Environmental Pollution to Improve High School Students' Environmental Literacy Skills

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Abstract: This research aims to produce inquiry-based e-teaching materials on environmental pollution to improve student's literacy skills in terms of validity, effectiveness, and practicality. This study used the research and development (R&D) method with the ADDIE model. This study was carried out in a senior high school in Cimahi. The e-teaching materials trial was conducted in two classes, with the experimental class using e-teaching materials and the control class as a comparison using traditional school textbooks. The e-book validation instrument used in this study was a questionnaire sheet. Validation analysis was the data analysis method employed, and the t-test and N-gain were utilized to examine the effectiveness of the instructional materials. The study's findings demonstrated that the inquiry-based teaching materials on environmental pollution material were declared valid and suitable for use in the biology learning process. According to the outcomes of employing inquiry-based e-teaching resources to enhance environmental literacy abilities, the experimental class's N-gain value was higher than the average n-gain value for the control class. Therefore, inquiry-based online teaching resources are practical and effective at enhancing students' environmental literacy abilities.

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Introduction

The ability to recognize, understand, interpret, generate, convey, and use knowledge in various circumstances is referred to as literacy (OECD, 2015). One of the literacy skills that is very important to train students is environmental literacy. Environmental literacy is a conscious attitude to maintain environmental balance (Kusumaningrum, 2018). This conscious attitude is called environmental awareness. In a sense, not only knowledge about the environment but also attitude to perceive and offer solutions to environmental problems. Environmental literacy is personal knowledge and understanding of the construction of environmental aspects, principles applied in the environment, and the ability to act to maintain environmental quality that is applied in the environment in the surrounding environment (Komariah et al, 2017). Environmental literacy education must be instilled in students, especially in formal education environments. Environmental literacy instills character in the student environment; the personality of environmentally-minded students aims to prepare them for environmental awareness so they can overcome the problems around them. *Environmental literacy* is the awareness and skills needed to develop knowledge and concepts about the environment in everyday life (Fidan and Ay, 2016). Someone with extensive environmental knowledge can solve existing environmental problems (Sari et al, 2021).

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Learning is needed for efforts to increase students' environmental literacy. Learning is a collaborative process, including teachers, students, and instructional materials. To provide learning resources that can support student learning activities, the learning process must be implemented (Windyarinani, 2016). Environmental literacy can assist individuals in restoring, maintaining, and even improving environmental conditions in several ways, including (1) Environmental literacy provides the ability to interpret and understand environmental conditions. With this understanding, individuals will be able to identify environmental problems and know the impact of their actions on the environment (Masithah et al., 2022). Environments that can be used by teachers as a source of information are referred to as teaching resources. The environment in issue consists of all messages, resources, methods, procedures, backgrounds, and people that students can use as a source for learning activities and can enhance the standard of their education (Abdullah, 2012). Learning resources are crucial instruments that can assist students in obtaining knowledge throughout educational activities.

Teaching materials are one of the learning resources that are urgent and have a big impact on learning (Permatasari et al., 2019). To speed up the learning process, instructional materials are used as manuals (Nengsi and Afriani, 2019). Learning should be made more exciting so that students can comprehend the topic being taught, and teaching materials are tools used to deliver correct and real information to students (Daryanto, 2014). As concluded by Istiqlal (2018) in his research, learning media can expedite the process of interaction between teachers and students and help students learn optimally.

Based on the preliminary study's findings, the researcher discovered that students felt the existing teaching materials were insufficient to help them find information during the learning process and that the lack of creativity in the process of creating teaching materials led to a more passive learning environment. This is consistent with studies by Agustina (2014) and Ardan (2016) that found that the choice of instructional materials and the creativity with which they were created had an impact on the quality of learning. Therefore, it is the responsibility of educators to create instructional materials that support the desired learning outcomes. According to the findings of teacher interviews conducted at the school, textbooks were the only resources used by teachers to convey the learning material. According to Yusliani et al. (2019), most textbooks currently in use do not satisfy the requirements of the current curriculum, and not all of them adhere to the standards set by the curriculum.

Teaching materials should facilitate students in exploring information in the learning process and help educators convey information in the learning process. Learning refers to the 2013 curriculum to produce people who are productive, creative, innovative, skilled, and have integrated knowledge. Therefore, to strengthen this, an appropriate learning model is needed, namely, inquiry-based learning (Komalasari et al, 2019), one of which is using inquiry-based materials. Inquiry means a statement or investigation; inquiry can be interpreted as a process carried out by humans to find and understand information. Inquiry learning is a learning process that begins with the activities of formulating problems, submitting hypotheses, collecting evidence, testing hypotheses, drawing temporary conclusions, and testing these temporary conclusions to arrive at conclusions that are believed to be true (Nurdyansyah and Fariyatul, 2016). The inquiry model is a model that will teach students directly, where the role of the teacher is to control the entire process of interaction and procedures carried out by students. Students will learn when they are actively involved in the learning process. Permatasari et al (2019) and Hanif et al (2016) suggested that the use of

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pp. 982-989

inquiry-based teaching materials is effective in improving student learning outcomes. Meanwhile, the e-book developed in this study was able to improve students' environmental literacy and critical thinking skills, especially on environmental pollution.

Teaching materials that are developed systematically follow learning steps based on an inquiry learning model, and then the teaching materials are packaged in electronic form that can be accessed using smartphones, laptops, or computers. This is a form of effort to utilize technology, which is one of the demands of the 21st century, namely the digital century. In addition to this, the use of e-learning materials is also flexible and helps students to read and study the material anywhere and anytime. Based on this background, the purpose of this research is to produce inquiry-based e-teaching materials on environmental pollution to improve students' literacy skills in terms of validity, effectiveness, and practicality.

Research Method

This research was conducted at a high school in the Cimahi area. This method of research is development research. The instrument used in this research was a validation questionnaire sheet. This questionnaire sheet determined the eligibility/validity of the National Education Standards Agency (BSNP, 2008) and the Ministry of National Education (Depdiknas, 2012). This research step refered to the development of research procedures (Sugiyono, 2017), starting from potential problems, gathering information, designing teaching materials, validating teaching materials, revising, testing, revising again, and trying again to produce teaching material products that are ready to use. The teaching materials that had been designed would then be validated by a validator consisting of 3 validators, which aims to determine the validity of the teaching materials. The validity of a product was determined by the findings of a percentage-based questionnaire study, followed by comprehension of the questionnaire. To ascertain the degree of eligibility, this is done. The eligibility requirements are shown in table 1.

Tabel 1. Eligibility criteria according to Ridwan and Akdon (2013)

Value Scale	Category	Percentage (%)
1	Very Valid	81-100
2	Valid	61-80
3	Enough	41-70
4	Invalid	21-40
5	Totally invalid	0-20

The validated e-teaching materials would be tested to determine the effect of increasing environmental literacy skills. Questions to measure environmental literacy skills refer to the National Environmental Literacy Assessment (NELA, 2008). The sample of this research was 2 classes. One experimental class of 35 students and 1 control class of 35 students. The data obtained will then be analyzed descriptively quantitatively with the Likert scale as the reference. Based on the data obtained from the validation sheet, the percentage validity of teaching materials will be calculated using a Likert scale. For data on increasing environmental literacy skills seen from the N-Gain value and the t-test.

Results and Discussion

These development study findings include inquiry-based e-teaching tools on environmental pollution, the validity or viability of such materials, and the results of using such materials to improve students' environmental literacy. The ADDIE approach, which has

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five stages: analysis, design, development, implementation, and evaluation, is used in this development research. Figure 1 displays the products of e-learning materials.

Figure 1. Appearance of inquiry-based e-learning materials

Data obtained from the validation results of inquiry-based e-teaching materials on environmental pollution material carried out by 3 validators and 2 supervisors who provided input and suggestions, presented in the following Table 2.

Tabel 2. The Supervisor Appears

Component	The Supervisor Appears
Material	The content of the instructional materials is excellent and complies with the curriculum's requirements.
Media	1. Since this is an electronic-based system, you must employ a variety of functions like video, audio, search, and electronic-based work. rather of converting the book to electronic. 2. To make it simpler for students to find something in teaching materials, use logos and hyperlinks.
Language	1. Be mindful of your language choices; you need to modify it for high school students. 2. Be careful when writing to avoid typing errors.

Based on Table 2, experts have concluded that e-teaching materials are practical and can be used with only modest adjustments. After this, it was updated based on feedback from the supervisor and was prepared for validation. This validation was only conducted with 3 biology professors to collect suggestions for improvement. BNSP is referred to as the

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Email: paedagogy@undikma.ac.id

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E-ISSN: 2722-4627
pp. 982-989

instrument used to validate e-teaching materials. Table 2 displays the findings of the validation of instructional materials.

Tabel 3. Validation Results

No.	Assessment Aspects	Score Average	Percentage
1.	Content Eligibility	3,66	91,5 %
2.	Eligibility of Presentation	3,62	90,6%
3.	Feasibility of Contextual Assessment	3,0	75%
4.	Language	3,27	81,75 %

Based on Table 3, the validator's data on the feasibility element of the content was 91.5%, according to the results. It demonstrates how highly feasible the content of teaching materials is. The findings obtained in terms of presenting feasibility were 90.6%. It further demonstrates how feasible it is to present educational materials. Possible aspects Results of the contextual assessment are 75%. It demonstrates the viability of the contestual eligibility. Considering linguistic factors, the scores were 81.75%. It demonstrates how viable the terminology employed in this electronic resource is. According to the research findings, the development of inquiry-based e-teaching materials has complied with the accepted standards by professionals. Then, once the instructional materials are current and usable, the electronic content is used in educational activities. This online learning content is used to raise pupils' environmental literacy levels. The results of implementing inquiry-based e-teaching materials are presented in Table 4.

Table 4. Environmental Literacy Ability Data Recapitulation

Data	Control class		Experiment class	
	Pretest	Posttest	Pretest	Posttest
The number of student (N)	35			
Minimum score	25	50	20	55
Maximal score	70	90	80	90
Average	48,4	66,8	54,5	72,4
Standard deviation	11,991	10,152	13,415	10,316
Normality test (Pretest)	0,203 (Normal)			
Homogenity test (Pretest)	0,720 (Homogen)			
Paired Sample T-test (Pretest)	0,032 (Significally different)			

The average pretest scores of pupils in the control and experimental classes are low, as shown in Table 4.3. The normality test findings show that the pretest data is typically distributed based on the results of the prerequisite test. The data variant is homogeneous, according to the findings of the homogeneity test. The paired sample T-test will be used because the data fits the criteria: homogeneous and normally distributed. The paired sample T-test findings showed a significant value of 0.032 for the pretest data. Therefore, there is a significant difference in the average student value because the P-value is less than 0.05.

The test will then be conducted to determine the impact of the application of inquiry-based E-teaching materials on environmental pollution, which is seen based on the N-gain presented in Table 5 because there are differences in students' initial knowledge between the control and experimental classes.

Table 5 Environmental Literacy Ability N-gain

Class	N-Gain	Interpretasi
Control	0,36	Currently
Eksperiment	0,43	Currently

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Vol. 10 No. 4 : October 2023
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pp. 982-989

Based on Table 5, Students in the experimental class had an average n-gain higher than those in the control class. It is so that students are engaged and active participants in the learning process, which is the goal of inquiry-based e-learning materials. Rusyadi (2021) argues that inquiry-based learning helps pupils build knowledge, comprehend the world's scientific ideas, and have higher-order thinking abilities. Education will be able to educate kids and will be immediately improved by learning that is intended to train students in higher-order thinking. Uswatun and Rohaeti (2015) claim that inquiry-based learning tools can help students develop their critical-thinking abilities and attitudes. It demonstrates that adopting inquiry-based e-learning materials helps students achieve good learning results.

It is so that students may best master the subject that has been taught since learning utilizing inquiry-based teaching materials will encourage students to think methodically to minimize knowledge of the concepts learned. Additionally, the challenges in inquiry-based teaching materials include local environmental issues or environmental issues that are currently trending, which makes learning more active and encourages student participation. By asking questions and seeking solutions based on curiosity, children can improve intellectual discipline and thinking abilities through inquiry-based learning, according to Sanjaya (2008). Following the findings of research by Komalasari (2019) and Hanif et al. (2016), they found that using inquiry-based teaching materials was successful in the learning process and may enhance students' conceptual comprehension abilities. As a result, learning will be more pleasurable and meaningful. Students will get meaningful learning experiences if the learning process is enjoyable. Since students will return to their home environments, this learning experience affects the learning outcomes and the environment. If what is learned is used daily, the advantages of good learning will become apparent. According to the findings of the research presented by Yuliyanti (2016), inquiry-based learning impacts student character.

The use of electronic media also contributes to the knowledge of students. E-teaching materials have several characteristics that will aid students in their learning and make it more active and interactive in keeping with Ashyfah and Rasmi's research (2023), which claims that electronic media significantly enhances student learning outcomes and is very beneficial to the learning process. Due to these findings, the experimental class's outcomes utilizing inquiry-based e-learning materials outperformed the control group's performance using typical textbooks.

Conclusion

The results of this study conclude that inquiry-based teaching materials on environmental pollution material are declared valid and suitable for use in the biology learning process. Students' environmental literacy skills increased significantly after implementing inquiry-based e-learning materials.

Recommendation

Students must bring a smartphone or laptop to use the e-learning material because it is based on the Android operating system. It is possible to gauge pupils' critical thinking abilities through future research. Meanwhile, in this study, recommendations were obtained for teachers using e-books; teachers need to prepare learning tools in digital form that can be accessed via a smartphone or laptop.

Vol. 10 No. 4 : October 2023
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Vol. 10 No. 4 : October 2023
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