Development of an E-book on Organic Waste Processing Based on Sustainable Entrepreneurship to Increase Environmental Awareness among High School Students

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Abstract

Formal environmental education is expected to be the primary means of minimizing environmental problems. Environmental-based learning is a proven way to increase students' environmental awareness. Through a sustainable entrepreneurship approach, this e-book not only provides information on organic waste processing but also instills environmentally friendly entrepreneurial values, enabling students to manage organic waste as a sustainable business opportunity. The research method used is Research and Development (R&D) with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. The study's subjects were students in class XI at SMA Negeri 5 Kota Jambi. The research used both qualitative and quantitative methods. Data were collected through observation, interviews, and questionnaires. The test was analyzed using IBM SPSS Statistics 27. The results of the e-book's feasibility were validated by material and media experts. Material validation was carried out 2 times with a percentage of 94.2%, and media validation was carried out 3 times with a percentage of 98%, both of which are in the "very feasible" category. The results of the subject teacher's assessment obtained a percentage of 90% with the "very feasible" category. The results of the assessment of students in small- and large-group trials were 82.2% and 90.3%, respectively, with both categories being "very good". The results of the effectiveness test using a paired-samples T-test showed a significance value of 0.001 (<0.005) and an average N-Gain score of 0.49 in the "moderate" category. It can be concluded that this sustainable entrepreneurship-based e-book is effective in increasing students' environmental knowledge and awareness, enabling them to better understand the importance of organic waste management and to be motivated to participate in protecting the environment.

Keywords: e-book, environmental concern, organic waste processing, sustainable entrepreneurship

INTRODUCTION

Environmental issues are a major international concern today. In addition to natural factors, human behavior that lacks environmental awareness also contributes to worsening environmental conditions. The environment and humans are two interconnected elements, possessing a complex, reciprocal relationship that influences each other. Disruption of any single factor can upset the environmental balance (Wiharjo & Henita Rahmayanti, 2021:16). Both the government and the public have undertaken efforts to protect and manage the environment. Law No. 32 of 2009 concerning Environmental Protection and Management, Article 1, paragraph 2, defines environmental protection and management as systematic and integrated efforts to preserve environmental functions and prevent pollution and/or damage, encompassing planning, utilization, control, maintenance, supervision, and law enforcement (Kadorodasih, 2017).

Education can be a key contributor to improving the quality of human resources by developing a superior and highly competitive generation. According to Landriany (2014), formal environmental

education provided to students is expected to be a step towards minimizing environmental problems and damage.   Environmentally conscious behavior must be continuously instilled through habituation. Therefore, the government is committed to protecting the environment from damage through education. One program developed by the Ministry of Environment in collaboration with the Ministry of Education and Culture is the Adiwiyata Program. The Ministry of Environment and the Ministry of Education and Culture explain that the Adiwiyata Program is implemented to create schools that foster an environmentally conscious culture (Afriliani et al., 2019).

Education is an appropriate means for building a society that implements the principles of sustainability and environmental ethics. The long-term goal of environmental education is to develop citizens who are knowledgeable about the biophysical environment and related issues. It can foster awareness, enabling them to effectively engage in action to build a better future and to be motivated to achieve it (Khanafiyah, 2013).

Entrepreneurship is part of schools' learning objectives. Entrepreneurship education can develop students' cognitive, affective, and psychomotor skills to become creative, innovative, opportunity-creating, reliable, independent, and responsible entrepreneurs (Sari et al., 2021). Waste is a persistent problem in society and has negative impacts due to a lack of awareness and knowledge about proper waste management and its economic value. Accumulated waste, if not managed properly, will impact the environmental ecosystem (Widara et al., 2021:1). The focus of sustainable entrepreneurs is not only on economic growth but also on sustainable practices that will grow and improve the company, society, and the environment (Burhanudin et al., 2023:24). The involvement of various parties, such as families, environmental communities, schools, and the government, is crucial in supporting and stimulating young people to be aware of environmental sustainability by utilizing it to create marketable products (Kristianto, 2020).

Learning media are tools used as intermediaries to provide students with information and motivate them to engage meaningfully in the learning process. Teaching content plays a significant role in learning activities. Attentive, efficient, and effective teaching certainly requires imaginative teaching materials. E-books are one such innovative teaching material. According to Maulida (2022), an e-book is an electronic version of a traditional printed book that contains multimedia such as images, videos, text, and animations and can be read on a personal computer or other information technology device. E-books are one of the results of advances in information and communication technology, packaged digitally.

Based on an interview with a biology teacher at SMAN 5 Jambi City, it was found that learning media still rely on printed textbooks, worksheets, and games. Furthermore, a preliminary survey conducted with 34 10th-grade students revealed that 50% did not understand e-books because they had never studied them or used them. Fifty-eight percent of respondents stated that the availability of books was inadequate due to a lack of them. Furthermore, 76.5% of students did not understand sustainable entrepreneurship. Furthermore, 52.9% of students stated that waste management in the school

environment was not yet optimal due to insufficient awareness, resulting in widespread littering and inadequate waste collection.

Previous research has shown that integrating environmental issues into the entrepreneurship curriculum effectively increases students' green entrepreneurship intentions. However, the development of specific media, such as e-books, that combine waste processing techniques with sustainable entrepreneurship principles remains rare. Therefore, this research aims to develop an e-book titled "Organic Waste Processing Based on Sustainable Entrepreneurship." Through the development of this media, it is hoped that it will serve as an additional learning resource and help address environmental problems. To determine the results of the development of e-book learning media. To determine the feasibility and responses of teachers and students to e-books. To determine the effectiveness of e-books on the environmental awareness of students in high school.

RESEARCH METHODS

This research is a research and development (R&D) study. The aim of this study was to develop a product using the ADDIE model developed by Branch (2009). The results are as follows: 1. The analysis phase involved several steps, namely performance gap analysis, instructional objectives analysis, and resource analysis. Researchers conducted a needs analysis of the potential and problems of the Environmental Change subject through interviews with biology teachers and questionnaires administered to class 10 students at SMAN 5, Jambi City. 2. The design phase was conducted to produce a prototype of the development, namely an e-book on sustainable entrepreneurship-based inorganic waste processing. 3. The development phase was conducted through a feasibility test by a validation team of material and media experts before its use in the field. Furthermore, the e-book was evaluated by teachers and students to gauge their reactions. 4. The implementation phase was conducted to determine the effectiveness of the developed e-book in increasing students' environmental awareness. A trial was conducted with 10th-grade students at SMA N 5 Jambi City to determine and collect data on the quality of e-book media using teacher and student responses. This data was then used to refine and perfect the developed product. 5. The evaluation phase was an assessment of the previous stages used so that revisions could be made based on the evaluation. Evaluation is a process aimed at determining whether a developed product is successful and meets initial expectations, and whether it is suitable for use in the learning process.

This study used qualitative and quantitative data. Qualitative data were obtained through comments and suggestions from validators, material and media experts, and from teacher and student responses to the e-book. Quantitative data were obtained through scores given by material and media expert validators, teacher and student responses, and the effectiveness of the e-book. Questionnaires given to material and media expert validators, as well as teacher and student responses, were assessed using a Likert scale. The scoring criteria using the Likert scale are shown in Table 1 below.

Table 1. Assessment Score Criteria

Value Scale	Category
4	Very Good
3	Good
2	Fair
1	Poor

Ridwan (2013)

The data analysis technique for the material expert validator, media expert, teacher response, and student response using the percentage obtained can then be seen, including the validity assessment category, teacher response, and student response in Table 2 below.

Table 2. Assessment Category Levels

Value Range (%)	Category
81,25 – 100	Very Good
62,50 - 81,24	Good
43,75 - 62,49	Fair
25,00 - 43,74	Poor

The results of the validity test indicate that the questions are valid; a reliability test was then conducted to determine the level of consistency of the questions. The results of the instrument's reliability calculation per item are classified according to several criteria proposed by Arikunto (2010).

Table 3. Reliability Coefficient Criteria

Reliability Coefficient	Criteria
0,81-1,00	Very high
0,61-0,80	High
0,41-0,60	Sufficient
0,21-0,40	Low
0,00-0,20	Very Low

Arikunto (2010)

Inferential statistical analysis was used to determine the product's effectiveness in increasing environmental awareness before and after its use. The paired-samples t-test is a hypothesis-testing method in which the data are not independent (paired). To determine the pretest and posttest values, a paired t-test was used. Although using the same individuals, the researchers still obtained two types of sample data: pretest data from the first treatment and posttest data from the second treatment (Montolalu & Langi, 2018).

Further analysis using the N-Gain test to see the improvement and influence of the results of the initial state (pretest) and final state (posttest) tests carried out by students (Alfahnum, 2023).

The effectiveness criteria of the N-Gain Score value can be seen in the following Table 4:

Table 4. Classification of N-Gain Score Values

N-Gain Value	Kategori
$g < 0{,}3$	Low
$0{,}7 < 0$	Medium
$0{,}3 \leq g \leq 0{,}7$	High

Alfahnum (2023:26)

RESULTS AND DISCUSSION

Analysis

Analysis of existing problems, collection of information through interviews with biology teachers at SMA Negeri 5 Kota Jambi, and distribution of student needs analysis questionnaires. The results obtained are: (1) students still experience difficulties in managing organic waste, (2) these difficulties occur due to the lack of integration of materials with the reality of everyday life, (3) students need practical, effective, innovative and efficient learning media that are in accordance with current advances in science and technology, (4) students need learning resources that can increase environmental awareness, (5) learning media that can guide student independence to. After identifying the performance gaps or problems in SMA Negeri 5 Kota Jambi, the next step is to determine the instructional objectives. This stage aims to respond to existing performance gaps.

According to Aqil et al. (2022:892), learning about environmental change in biology for grade 10 high school students is one of the topics students must understand because this material helps them understand current environmental changes. Therefore, a variety of additional media is needed to support students' learning process, making it easier to understand the material being studied. One such tool is e-books. This is due to the lack of material integration and the inadequate availability of printed books, necessitating the need for learning media. According to Rejekil et al. (2020:338), the use of learning media can help overcome learning difficulties experienced by students, thereby supporting successful learning. In a study by Prawiradilaga et al. (2017:60), given technological advances and the differences in learning styles of today's digital generation, technologies such as e-books have great potential for the learning process, as they are equipped with text, images, audio, and video that can support students in understanding the material. Therefore, implementing e-book learning media is an appropriate solution to address these problems in schools.

Design

The e-book is designed in Canva, produced as a PDF, and then edited in Heyzine flipbook. The e-book is designed in Canva. Several things must be prepared, such as collecting books and journals as references for creating the e-book and storyboards, which will then be realized to produce a product that can be used in the learning process. The design of the learning media product consists of several parts, namely the cover, foreword, table of contents, list of figures, list of tables, material description, glossary, bibliography, and biography.

Development

1. **Results of Material Expert Validation**

The material experts in this study were lecturers with expertise in environmental education. The results of the material expert validation are presented in Table 5 below.

Table 5. Results of Material Expert Validation

Assessment aspects	Percentage score (%)	Criteria
Suitability	91,6	Very eligible
Accuracy	100	Very eligible
Convenience	100	Very eligible
Interesting	75	Eligible
Completeness	100	Very eligible
Average	**93,3**	**Very eligible**

The results of the material validation based on the results of the material validation based on suggestions and input from material experts on the appearance, changing the cover by adding images of sustainable entrepreneurship indicators, adding images/photos along with their citation sources, in each sub-chapter must be added images/photos as covers relevant to the material discussed, adding relevant materials, images and adding innovative organic waste processing practices. Furthermore, the average product quality was 93.3%, indicating that the product was validated as worthy of testing without revision. This aligns with Fallensky's (2021:43) view that validation by material experts is intended to assess the feasibility of the developed learning media from a material perspective.

2. Media Experts Validation Results

The participants in this study were education experts. The results of the media expert validation are presented in Table 6 below.

Table 6. Media Expert Validation Results

Assessment Aspects	Percentage score (%)	Criteria
Integrity	100	Very worthy
Balance	100	Very worthy
Font Use	100	Very worthy
Color	100	Very worthy
Language	87,5	Very worthy
Average	**97,5**	Very worthy

Media validation includes several aspects, namely the integration of image, video, and page sequence ordering in the e-book. Balance in the suitability of the size and layout of images or videos in the e-book media. The use of varied fonts and the suitability of text in the e-book media. The colors displayed are appropriate and attractive, and the language used is structured and easy to understand. Based on these assessment aspects, improvements are made in response to suggestions and comments from media experts regarding cover design; images/photos are made more realistic; and the display is varied, including the addition of "scientific information" and barcodes. The "Scientific Information" column is intended to stimulate and motivate students in the learning process. So, it motivates students to learn and makes lessons less boring (Rahmawati & Wulandari, 2020). The product improvements achieved an average product quality of 97.5%, with consistent suggestions on writing sizes and colors, and the product is ready for field testing.

3. Teacher Response Results

The teacher responses in this study were from 10th-grade biology teachers at SMA Negeri 5, Jambi City. The results of the teacher responses are shown in Table 7.

Table 7. Teacher Response Results

Assessment Aspects	Percentage score (%)	Criteria
Presentation of Content/Material	100	Very good
E-book Structure	85	Very good
Media Display	90	Very good
Benefits	90	Very good
Average	**90,5**	**Very good**

The teacher's assessment of the e-book development received a positive response and several very constructive suggestions for product improvement. One suggestion was that the e-book's colors lacked variety, but the color combination was quite good; brighter colors should have been used. This

aligns with Pujiriyanto's (2005) opinion that color selection is crucial in determining reader response. Because the first thing seen is color, it creates an overall impression and appeal.

4. Student Response Results

Student responses were collected from students who had studied material on environmental change. These responses included responses from both small and large groups. The small groups had 8 students, and the large groups had 20. The results of the student responses are shown in Table 8.

Table 8. Student Response Results

Assessment Aspects	Percentage score (%)	
	Large group	Small group
Media display	83,5	92,1
Material presentation	81,9	88,75
Usefulness	81,25	90,4
Average	**82,25**	**90,4**
Category	**Worthy**	**Very Worthy**

The results from a small-group trial with 8 students were an average of 82.2%, categorized as "Good." In a large-group trial with 20 students, an average of 90.4% was achieved. Based on these results, it can be concluded that the e-book on organic waste processing based on sustainable entrepreneurship is suitable for use as an additional teaching material for teachers, as it has an attractive appearance and motivates students to deepen their knowledge of organic waste processing.

Implementation

Classroom learning uses an e-book on organic waste processing, developed based on sustainable entrepreneurship. This stage was conducted at SMA Negeri 5 Kota Jambi, Class X-2, with 25 students. The implementation stage aims to measure the effectiveness of the developed product by administering pretest and posttest questionnaires containing 15 questions. Test questions that have undergone analysis of the prerequisite test will be used as pretest and posttest questions. The following is an analysis of the questions, consisting of validity, reliability, and discrimination tests.

1. Testing the Validity and Reliability of Questions

Validity testing is conducted to assess the validity of the questions. Reliability testing, meanwhile, relates to the consistency and stability of the test items. The test results are shown in Table 10 below.

Table 10. Reliability Test Results

Reliability Statistics	
Cronbach's Alpha	N of Items
,910	15

The results of the reliability analysis of the questions shown in Table 10 indicate that the test of the 15 questions that were tried out obtained reliability in the very high category.

2. Paired Sample T-test

The effectiveness of the media was measured using a paired-samples t-test, which was previously tested for normality.

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Table 11. Results of the Normality Test for Pretest and Posttest Difference

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
PRETEST	,188	25	,023	,931	25	,093
POSTEST	,166	25	,074	,949	25	,235
a. Lilliefors Significance Correction						

Table 11 presents the results of the Shapiro-Wilk normality test. Based on the results, the significance values for the difference between the pretest and posttest were 0.093 and 0.235, indicating that the data were normally distributed because the significance values were greater than 0.05 ($p > 0.05$). The prerequisite test was met, so a paired sample T-test was conducted. This is in line with the statement by Aritonang et al. (2023:55) who stated that if the significance value is greater than 0.05 ($p > 0.05$), the data is considered normal. Conversely, if the significance value is less than 0.05 ($p < 0.05$), the data is considered abnormal. According to Sukarni (2020:33), the normality test for the study sample, which consisted of fewer than 50 respondents, used the Shapiro-Wilk test. After obtaining the normality test results, a paired-samples t-test was conducted.

Table 12. Paired Sample T-Test Results

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	Df	Sig. (2-tailed)
Pair 1	PRETEST-POSTEST	-7,44000	5,33135	1,06627	-9,64067	-5,23933	-6,978	24	0,000

Based on Table 12, the significance value is 0.001 (<0.05). This indicates a significant difference between the before and after states of using the media. Next, an N-gain analysis was conducted to determine the extent of the improvement.

Table 13. Pretest and Posttest Values of Environmental Concern

N= 21	PRETEST	POSTEST	N-Gain Score
Average	74,88	87,28	0,49

The paired sample t-test yielded a significance value of 0.001, indicating a difference before and after using the e-book. Furthermore, the N-gain test yielded an average score of 0.49, placing it in the moderate category. This aligns with research by Peprizal & Syah (2020), which found that a well-developed learning method can be considered effective if the N-gain value is at least in the moderate category.

This indicates that the e-book has high-quality content because the explanations are tailored to the objectives students need to achieve. Furthermore, the use of images and videos in the e-book can help students understand the material. According to Wilyanti et al. (2021), e-books can be among the teaching materials used for learning. E-books are typically self-paced, meaning students can study them independently because they are systematic and comprehensive, just like physical textbooks. E-books are digital books that can integrate images, animations, links, and videos, allowing the

information presented to be more varied (Arimbi & Pramesti, 2020). This is also in line with the thinking of Akbar et al. (2024:95) that if books often consist of many sheets of paper containing text and photos, then electronic books (e-books) also consist of digital information with text and images that can be viewed anytime and from anywhere using a computer, laptop, or smartphone.

Evaluate

The final stage is evaluation, which comprises formative and summative assessments. Formative evaluation is conducted at each stage of the ADDIE model. The analysis stage involves adding a preliminary study of student characteristics. The design stage includes the evaluation, which is contained in the storyboard design. The development stage is conducted based on the assessment results and the material and media validators' suggestions. Summative evaluation is the overall evaluation conducted after the product development process has been implemented. This stage measures the product's effectiveness through pretests, posttests, teacher assessments, and student assessments. Through these suggestions and comments, researchers can develop better products.

CONCLUSION

The development of e-book learning media was deemed suitable for use in the learning process based on the final results of material validation, media validation, and teacher and student trials. The assessment was categorized as "Very Good," indicating that the product was well received by students and can be used as a learning medium for environmental change.

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