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Empowering Environmental Consciousness: Creating High School E-Modules for Sustainable Change

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ABSTRACT

This study aims to develop valid, practical, and effective e-modules in subjects related to environmental change-oriented biology. This study uses the Rowntree development model, which consists of three stages, namely: (1) the planning stage, (2) writing preparation, (3) writing and editing stages. In the third stage, the evaluation is carried out by means of a timer evaluation (self-evaluation, expert review, one-to-one, small group, and field tests). The subjects of this study were students in grade X at a senior high school in Palembang. The data collection methods employed in this study encompassed observation, interviews, walkthroughs, questionnaires, and tests. The average validation score, based on the results of three validators, was 91%, indicating a high level of validity. The practicality test results from the one-to-one and small group evaluations yielded a score of 91.3% (very valid) for the one-to-one test and 90.75% for the small group test, placing them in the highly practical category. The effectiveness test yielded an N-gain result of 0.796, indicating a high level of efficacy. Based on the collected results, it can be inferred that the designed E-Module is valid, practical, and effective.

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1. INTRODUCTION

The development of science and technology at this time affects many elements of life, including education. Every industry, including education, has begun using technology to facilitate work, including Indonesia, which has entered the digital era (Lestari, 2018). Teachers must try to plan and prepare various strategies to ensure students successfully receive the material. Learners must invest more effort in resources, energy, and psychological readiness to get the material as effectively as possible (Latip, 2020). One of the things that needs to be prepared is learning resources. Learning resources are an important component that must be used to help the student's learning process so that learning will feel fun and effective and that students can improve their learning outcomes (Agustina et al., 2022). It is in line with research conducted by , which shows a significant influence between the use of learning resources and student learning outcomes. It is stated that students can learn and gain new

knowledge more easily, which impacts student learning achievement. Modules are one of the learning resources that can be used.

Technology-based learning resources are widely available in various forms and significantly influence education (Hill & Hannafin, 2001). Similarly, modules are available in printed and electronic forms, making it easier for students to access them, or what we usually call e-modules. Electronic modules have been transformed into digital form but have the same purpose as printed modules (Nuriah et al., 2021). In Lestari et al. (2022), Sugianto defines the word "e-module" as an electronic self-learning module that integrates audio, animation, and navigation in a well-structured and exhibited manner. Laili et al. (2019) identified that one of the benefits of utilising e-modules in education is their ability to enhance student motivation. (2) Teachers and students can ascertain the completion status or evaluation status of the item. (3) The distribution of learning resources can be made more equitable throughout the course of a single semester. (4) Teaching materials can be organised based on academic proficiency levels. (5) In contrast to printed modules, which are inflexible, e-modules can be designed to be more interactive and dynamic. (6) Audio, video, and animation can be employed to diminish the excessive reliance on written information in printed modules.

Biology is a science that discusses the relationship between humans and their environment. Biology is one of the sciences that is closely related to nature. Biology contains relevant facts, concepts, and propositions (relationships between concepts) (Irfan et al., 2019). Observations at Al-Amalul Khair Islamic High School show that many students have not reached the Minimum Completion Level (KKM) in biology subjects. One possible reason is that biology material contains too many concepts and too much material (Yahdiyani et al., 2022). Learning biology is also about the material and how to practice it in everyday life, starting with the surrounding environment. According to Sujana et al. (2018), humans who care about the environment will try to protect the natural environment around them and take the initiative to restore the damage that occurs. Teachers must provide various examples of environmental problems that occur in the surrounding environment that are easy for students to understand (Istiqomah, 2019). To develop an attitude of caring for the environment, learning resources that provide insight into the influence of the environment on biological learning are also needed. Due to the large amount of material that must be learned, students find it difficult to understand learning.

The research was undertaken by Setiyadi et al. (2017) titled "Development of Biology Learning Modules based on Scientific Approaches to Improve Student Learning Outcomes" yielded favourable feedback from both students and teachers, with students displaying active engagement in the learning process. In a recent study conducted by Mutmainnah et al. (2021), the efficacy of e-modules in enhancing cognitive learning outcomes in the subject of human digestive system was investigated at Tsanawiyah madrasah. The results revealed a significant improvement, with the average assessment score increasing from 42.03 to 89.62 following the implementation of e-modules. The rise signifies the efficient utilisation of e-modules in the learning process. While certain studies focus solely on biology e-modules, there is currently a lack of studies on e-modules specifically tailored to promote environmental awareness. This study centers on developing e-Modules that are specifically designed to promote environmental awareness among high school students.

2. METHODS

The research methodology employed in this study was developmental research. The development model employed is the Rowntree model, accompanied with the Tessmer evaluation. The study was carried out at SMA X Palembang. The participants of this study consisted of 24 students who were in grade X during the academic year 2022-2023. The material utilised in this study project was ecosystem material.

The Rowntree development model consisted of three stages: planning, preparation of writing, and writing and editing. At the evaluation stage, the Tessmer method was used: self-evaluation, expert review, one-to-one, small group, and field testing. The three steps need to be completed progressively

and methodically. Data collection techniques in this study are interviews, walkthroughs, questionnaires, and tests. An outline of this research can be seen in Figure 1.

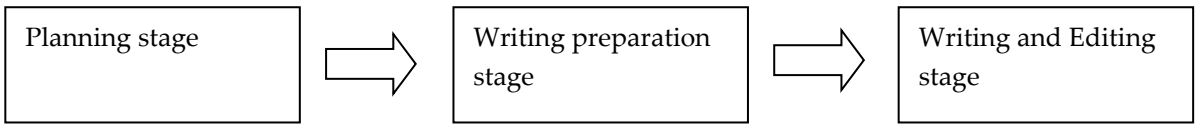


Figure 1 Rowntree Development Model

The analysis of observational data was carried out during preliminary studies and presented in the form of a qualitative description. The results of the interview analysis to find out more about the learning problems faced by students were described descriptively. The results of the walkthrough analysis required three experts: material, language, and design experts. The three experts provided suggestions and comments as a reference for improving the developed product. The assessment aspect refers to the instrument sheet, which contained five assessment indicators, namely Very Good (VG) with a score of 5, Good (G) with a score of 4, Enough (E) with a score of 3, Not Good (NG) with a score of 2, and Not Very Good (NVG) with a score of 1. Then the average score was calculated, and the results were categorized with criteria: 0%-20% (very less valid), 21%-40% (less valid), 41%-60% (quite valid), 51%-80% (valid), 81%-100% (very valid).

The questionnaire distributed to students after the trial aims to test the practicality of the module being developed. The questionnaire was used to find out about students' response regarding the use of e-Modules in classes. Questionnaires were distributed to students during one-to-one test evaluations with three students and small group evaluations with eight students. The questionnaire sheet used the Likert scale with five indicators, namely Very Good (VG) with a score of 5, Good (G) with a score of 4, Enough (E) with a score of 3, Not Good (NG) with a score of 2, and Not Very Good (NVG) with a score of 1. Then the average score was calculated, and the results were categorized with criteria <20% (impractical), 21% -40% (less practical), 41% -60% (quite practical), 51% -80% (practical), and 81% -100% (very practical)

3. FINDINGS AND DISCUSSION

3.1 Planning stage results

The preliminary phase of developmental research commences with the process of planning, which mostly involves expanding on students, setting overarching goals and particular targets, creating content summaries, selecting appropriate media, devising strategies for learning support, and taking into account the availability of teaching resources. An examination of instructors' requirements revealed that the predominant teaching resources employed were books and worksheets. Educators employed didactic techniques such as lectures, interrogations, and responses. The analysis findings also indicate that educators require electronic modules for learning. An examination of student requirements revealed that most pupils prefer visual learning, and the most commonly utilised educational materials were books or worksheets. Students have expressed a requirement for e-modules to facilitate their study.

In the next stage, general and specific objectives were formulated to produce E-Modules that were in accordance with student characteristics. Following the learning objectives after applying the E-Module in the first learning activity, students were expected to be able to explain the constituent components of the ecosystem. After applying the E-Module in the second learning activity, students were expected to be able to describe the form of interaction between ecosystem components. After implementing the E-Module in the third learning activity, students can determine the role of organisms in food chains and webs. After applying the E-Module in the fourth learning activity, students could explain the biogeochemical cycles that occur in the ecosystem.

The next step that needed to be done after determining the learning objectives was to determine the outline of the contents of the E-Module to be developed. The material in the E-Module to be developed included ecosystem components, interactions between ecosystem components, food chains, nets, and biogeochemical cycles. The next stage was to determine the media to be developed. After various considerations, the medium chosen for the development of the e-module was electronic media.

3.2 Writing preparation stage

The preparation stage of writing began by considering the sources and obstacles that would be faced. The next step was to outline the contents by creating an E-Module flowchart. Flowchart can be seen in figure 1 below:

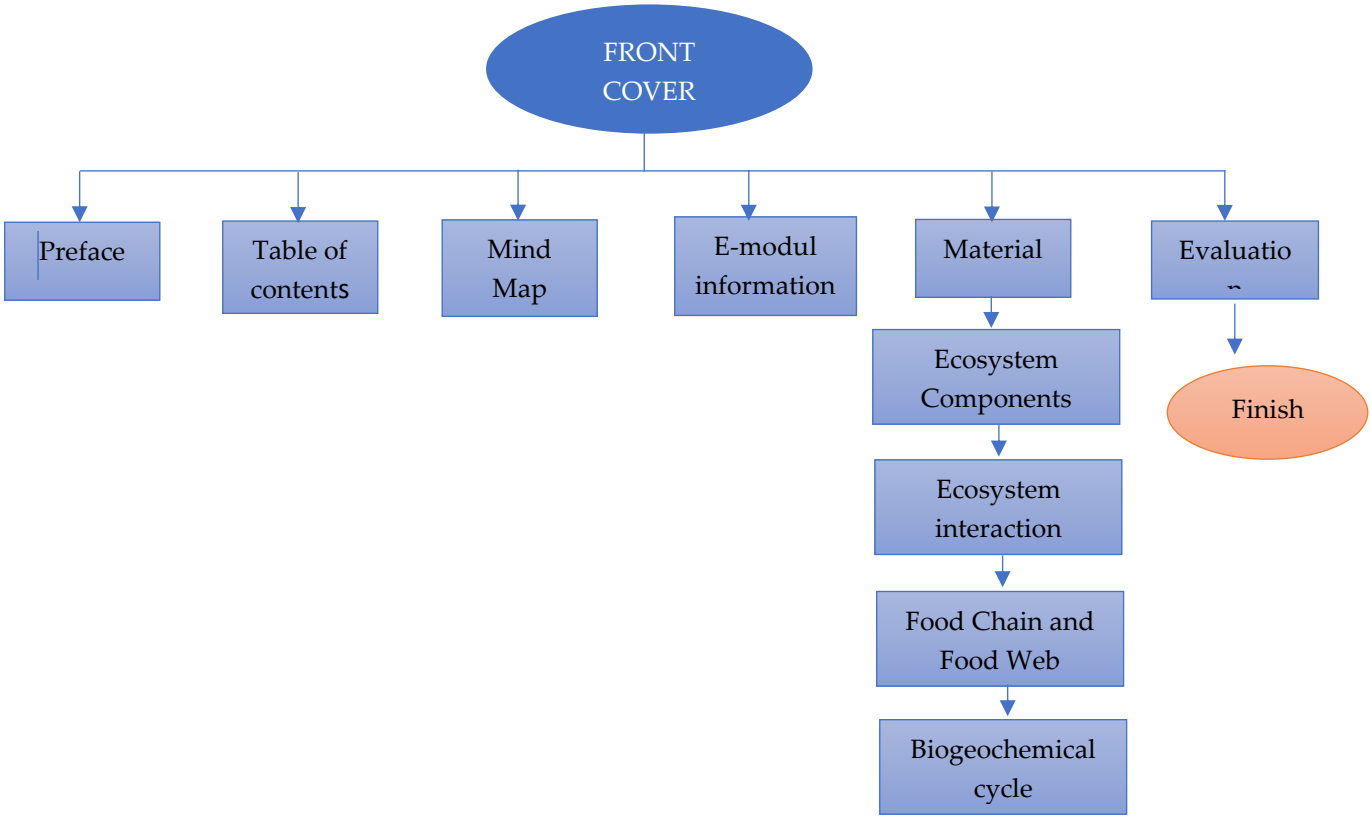


Figure 2. E-Module Flowchart

The material description of this E-Module was ecosystem material consisting of ecosystem components, interactions between components, chains and food webs, and biogeochemical cycles. Then, determine the existing examples relevant to the material in the E-Module and the image or graphic by creating a storyboard. Next, determine the equipment for development activities, such as computers, and the software needed to help design the developed e-modules.

3.3 Writing and Editing Stage (Evaluation)

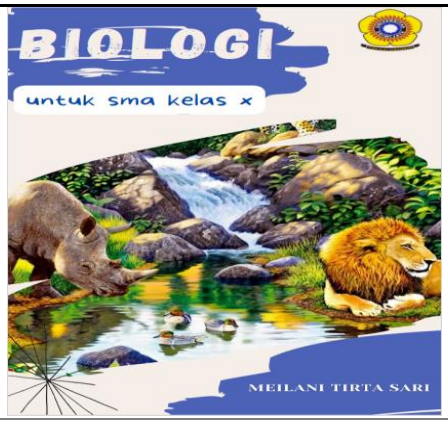
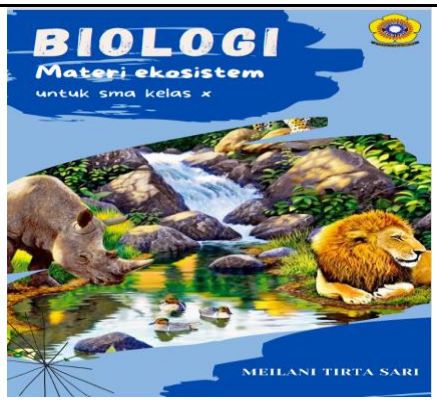
At this stage, the draft e-module was made based on a predetermined outline of the material's content. The order of the e-module that has been prepared was the front cover, which displays images and titles according to the material to be created, a table of contents, a word introduction, a core competition, a basic competition, learning objectives, and learning activities that include material

descriptions, quizzes, information related to environmental changes, summaries, responses, and evaluation questions.

3.3.1 Self Evaluation Stage

At the self-evaluation stage, activities were carried out to evaluate or assess the results of the product that had been obtained independently while still paying attention to various errors present in the product and requiring it to be revised again to minimize various errors made by researchers.

Table 1. Self Evaluation Result

Before revision	After revision
	
Front page view changed	The improvements made at this stage are: • Added writing ecosystem material • Remove the background color in the words "for high school class X" • Change the background color to make it more attractive

3.3.2 Expert validation

After conducting a self-evaluation, the next thing that needed to be done was to provide the product to three experts, namely material experts, language, and design experts, who are competent in their respective fields. The result of the expert validation on material aspect can be seen in Table 2.

Table 2. Material Expert Validation Instrument

No	Aspect	Score
1	Goals for learning are clear	4
2	The suitability of the material in the e-Module	5
3	The accuracy of the material in the e-Module	4
4	Using up to date material in the e-Modules	3
5	Availability of the supporting information on the e-Module	5
6	Lesson plans are customized to address students needs	5
7	The questions on the exercise have a different level of difficulties	4
8	The suitability of the questions on the e-Module for ecosystem material	5
	Total	35
	Average	4.375
	Percentage	87.5 (Very Valid)

Based on the table above, it can be seen that of the eight existing aspects, the result is 87.5% or is in a very valid category. Some of the suggestions from the material experts, especially regarding updates to the material, will be used to improve the content of the product. After that, the design was validated by administering a questionnaire with the following results, as shown in the table below.

Table 3. Language Expert Validation Instrument

No	Aspect	Score
1	Using communicative and informative language	5
2	The suitability of the language used in the e-module with students needs	5
3	Language eligibility	5
4	The effectiveness of the sentence in e-Module	4
5	The suitability of the language used with good and correct Indonesian rules	5
6	The coherence and integration of each paragraph	4
7	Consistency in the use of terms and symbols	4
	Total	32
	Average	4.57
	Percentage	91.4%

After the result of language validation get very valid result, then the expert review continues to design validation. Furthermore, with ten aspects, here is the indicator of the design validation instrument :

Table 4. Design Expert Validation Instrument

No	Aspect	Score
1	Cover design that is suitable with the material	5
2	The correct selection of font	4
3	The composition of color, images and text	5
4	The images used are suitable for the material	5
5	Accuracy of color selection in the design	5
6	Using the high-quality illustration	4
7	Illustration facilitates students' comprehension	4
8	The design of the e-Modules is attractive	5
9	The suitability of the image with learning goals	5
10	The design encourages students to be motivated to learn	5
	Total	47
	Average	4.7
	Percentage	94% (Very Valid)

The results of the recapitulation of the expert validation can be seen in the following table:

Table 5. Expert Validation Results

No	Validation	Percentage	Information
1	Material	87.5%	Very Valid
2	Design	91.5%	Very Valid
3	Language	94%	Very Valid
Average		91%	Very Valid

The E-Module produced has been determined to be highly valid, based on the assessment results provided by specialists in material, language, and design. The validity percentage achieved was 91%. The e-module can undergo testing and be enhanced by incorporating the recommendations provided by all three experts. This aligns with the findings of Dwi Tisa Haspen and Festiyed (2019), which discuss the importance of validity in relation to the development of goods that adhere to the intended design and materials. The following are the criticisms and recommendations provided by the reviewer.

Table 6. Critiques and Recommendations from Expert Review

Aspect	Critiques and Suggestion
Material Expert Validation	Using more relevant and up to date examples On the introduction page, use a real story The level of difficulty in essay questions is still relatively easy and there should be examples of case study
Language Expert Validation	Use effective sentences
Media Expert Validation	Use an attractive design Adding an outline to make it look more attractive according to expert advice

The reviewer's recommendation meant that the media would be good to give to pupils for further testing.

3.3.3 One-to-One Evaluation

Three students were chosen to assess the E-module product in a one-on-one review. One individual exceeded the average of the category, another one fell within the average range, and a third individual fell below the category average. The following table presents the outcomes of the one-to-one examination recapitulation:

Table 3. One-to-One Evaluation Recapitulation

Number	Name	Percentage	Category
1	AR	94%	Very Practical
2	RM	88%	Very Practical
3	AH	92%	Very Practical
Average		91.3%	Very Practical

The practical results in the one-to-one test obtained 91.3% or were in the very practical category. Students were also asked to comment on the developed e-modules. The result was that the developed e-modules were attractive, and students easily understood the material.

3.3.4 Small Group Test

Small groups consisted of eight different students on the one-on-one test. At this stage, students were also given a questionnaire to assess the practicality of the e-module being developed. The following results were the results of the recapitulation of the practicality of e-modules on a small-scale group evaluation:

Table 4. Small Group Recapitulation

Number	Name	Percentage	Category
1	AP	86%	Very Practical
2	RI	98%	Very Practical
3	IK	92%	Very Practical
4	AF	90%	Very Practical
5	RD	84%	Very Practical
6	RP	90%	Very Practical
7	DT	94%	Very Practical
8	NP	92%	Very Practical
Average		90.75%	Very Practical

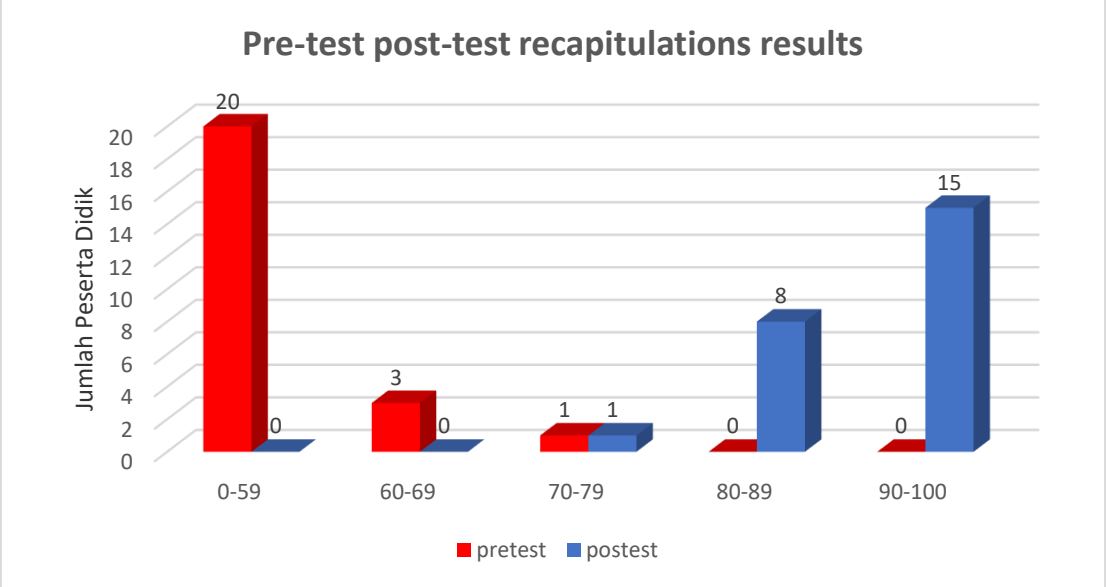
The results obtained from this small group stage are 90.75% and are included in the very practical category. It is in line with Fitria's opinion in Utama & Zulyusri (2022) that a product can be said to be practical if: (1) it can be applied in the field; (2) it can attract people to learn more about it; and (3) the ingredients contained in the product are easy to master.

3.3.5 Field Test

In the field test stage, 24 people were given a pre-test and a post-test to measure the effectiveness of the e-module developed based on student learning outcomes. The following table shows a recapitulation of student learning tests:

Table 5. Pre-test post-test recapitulations results

Value interval	Number of students		Percentage		Information
	Pretest	posttest	pretest	posttest	
90-100	0	15	0	62.5	Very Good
80-89	0	8	0	33.3	Good
70-79	1	1	4.1	4.1	Enough
60-69	3	0	12.5	0	Bad
0-59	20	0	83.3	0	Very Bad



Based on pre-test and post-test assessment data, it can be seen that there was a significant improvement. The average pre-test obtained by students was 47.7, and the final test (post-test) obtained an average of 87.91.

Table 6. N-gain Recapitulation Result

Pretest mean	**Postest mean**	**N-gain**
47.7	87.91	0.796
Category		High

According to the data in the table, the research test yielded an n-gain value of 0.796, placing it in the high group (> 7). A significant improvement in pupil learning has thus been achieved. People involved Utilising Electronic Modules If Kurniawan and Syafriani (2021) have succeeded in creating their e-modules, then they can be effective. It establishes that the product is useful by showing that including it into e-modules improves student learning results.

Field tests were also conducted at the evaluation stage, and students' environmental concerns were assessed. The results of the environmental care questionnaire can be seen in the following table:

Table 7. Recapitulation of the results of environmental concerns

No	Indicator	Skor	Percentage
1	Proud to dispose of trash in its place	24	100%
2.	Do not imitate other people who litter	24	100%
3	Put back trash that fell out of place	19	79%
4	Bring a drinker to reduce waste	16	67%
5	Use water sparingly	22	91.7%
6	Do not turn off the lights during the day	4	83%
7	Use any electricity you want.	0	100%
8	Littering if no trash	0	100%
9	t's a pleasure to make recycling material	15	62.5%
10	Invite friends to carry out class picket schedule	17	70%
11	Silent when friends littering	10	58%
12	Participate in cleaning up school environments	19	79%
13	Let the plants in the school wither	6	75%
14	Close the water tap after use	24	100%
15	Watering plants are withered	16	67%
Total			1232.2%
Average			82.14%

Based on the survey results, it is known that as many as 82.14 percent of students are concerned with the environment. Awareness of student regarding waste disposal, the use of resources such as electricity and water is very good. Susilawati et al. (2020) added that students need to be encouraged to think critically about problems in their environment, understand learning, and apply it. The thing that need to improve is that are still students who have not reduced the use of plastic or implemented recycling. This is due to the lack of student training to learn about recycling. Through education, people may learn about recycling and the benefits of doing so. Thus, course materials, events and seminars may all spread knowledge about recycling (Demir & Öteleş, 2023).

4. CONCLUSION

Based on expert validation of the material and language, we can state that the existing e-modules developed are in the category with a perfect % valid of 91. Practicum results on one-to-one and small-

group tests average 91,025 in the practical category. Based on these values, we can conclude that the e-modules developed are attractive in terms of appearance, and the existing material is also easily understood by students. On the pre-test or preliminary test, students get an average of 47.7, and after learning by using the e-module, they get an average of 87.91. And get an n-gain of 0.796, which is included in the high category, which means that the e-module is well developed and can be used in learning to support the learning process in the classroom. Environmental care test results obtained on average (81.24%) show that good students show concern for their environment. According to the acquired study data, it is evident that the generated e-modules have undergone testing to assess their validity, practicality, and efficacy following the implementation of e-module-based learning. The proposed recommendations for users and future research are as follows: 1) Users can enhance the development of more captivating educational resources for fellow scholars, such as incorporating auditory components into written texts. 2) Researchers can also integrate e-learning and e-modules to monitor student engagement and progress.

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