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Teaching Students about Education for Sustainable Development through E-module of Indonesian Traditional Fermented Food

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Abstract: The limitations of teaching materials that add values to Education for Sustainable Development (ESD) open up opportunities to develop supplementary teaching materials that integrate ESD with the latest information technology to support 21st-century skills. This study aims to develop a science e-module containing ESD theme of Indonesian traditional fermented food to build students' creative thinking skills, and sustainability awareness. The e-module development is carried out with the ADDIE development model. This study describes (1) a description of the development stages and (2) a description of the validation of the e-module in terms of mapping ESD aspects, creative thinking skills, and sustainability awareness, and a description of the validation of the e-module media display. The results of data analysis show that the results of data analysis show that the validation of mapping aspects of ESD and media obtained the categories of "excellent" and "good". There were several suggestions given by experts on e-modules and had been improved based on these suggestions. It can be concluded that the ESD e-module deserves to be implemented on a limited and wider scale.

Keywords: Education for Sustainable Development, e-module, validity

Abstrak: *Keterbatasan bahan ajar yang menyisipkan nilai-nilai Education for Sustainable Development (ESD) membuka kesempatan untuk mengembangkan bahan ajar suplemen bertntegrasi ESD dengan teknologi informasi terkini dalam upaya mendukung keterampilan abad 21. Penelitian ini bertujuan untuk mengembangkan e-modul IPA bermuatan Education for Sustainable Development (ESD) tema makanan fermentasi tradisional Indonesia. Pengembangan e-modul dilaksanakan dengan model pengembangan ADDIE. Pada penelitian ini dijelaskan (1) deskripsi dari tahapan pengembangan dan (2) deskripsi validasi e-modul dari sisi pemetaan aspek ESD, keterampilan berpikir kreatif dan kesadaran berkelanjutan dan deskripsi validasi tampilan media e-modul. Data validitas dikumpulkan menggunakan angket validasi dan dianalisis dengan presentase. Hasil analisis data menunjukkan bahwa validasi pemetaan aspek ESD dan media memperoleh kategori "excellent" dan "good". Terdapat beberapa saran yang diberikan oleh ahli terhadap e-modul dan telah diperbaiki berdasarkan saran tesebut. Dapat disimpulkan bahwa e-modul bermuatan ESD yang dikembangkan layak untuk digunakan dalam uji terbatas dan skala yang lebih luas.*

Kata kunci: *Education for Sustainable Development, modul elektronik, validitas.*

▪ INTRODUCTION

Education for Sustainable Development (ESD) is derived from two terms, education and sustainable development. The best way to understand ESD is to understand both terms independently. Sustainable development is based on three pillars, environmental, economic, and socio-cultural. For the entire sustainable development, there must be a balance of considerations of economic sustainability, environmental sustainability, and community sustainability (UNESCO Education Sector, 2010). Education improves one's abilities and improves prospects for better adaptation to the

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environment, as well as improving prospects for better health, nutrition, livelihoods, and are for a better quality of life (United Nations Educational Scientific and Cultural Organization, 2018).

ESD is the newest vision in education to realize empowered and responsible human beings that aim to create a sustainable future (Kemdiknas, 2010). Each individual needs to have an attitude of responsibility in actions that impact human life and the planet in the future. Thus, it is important to incorporate the values of Education for Sustainable Development into the teaching and learning process towards responsible individuals who solve challenges, respect cultural diversity, and contribute to creating a more sustainable world (UNESCO Education Sector, 2010). The values of Education for Sustainable Development are important to be brought into learning. According to Segera (2015) if the cultivation of sustainable values must be introduced early to students so that students have sustainability values to be able to maintain the preservation of the natural, social and cultural environment. Indrati and Hariadi (2016) stated that one of the implementations of ESD in the learning process is inserting ESD values into science learning.

Education for Sustainable Development is an important issue for the education of students worldwide because it offers knowledge, skills, attitudes and values necessary to ensure a sustainable future for humanity at local and global levels, which is nowadays becoming critical (Maidou et al., 2019). ESD enables all individuals to contribute to achieving the goals of the SDGs by equipping students with the knowledge and competencies needed, not only to understand the SDGs, but to engage as informed citizens in bringing about the necessary transformations (Rieckmann, 2017). Education for Sustainable Development is recognized as an interdisciplinary form of science (Feng, 2012). Interdisciplinary learning can stimulate critical thinking for students so that students can apply skills and practices outside of disciplines to more complex problems in everyday life (Zoller, 2012).

ESD consists of environmental, socio-cultural, and economic perspectives. From the environmental perspective, it becomes the attempt to utilize natural resources wisely. From the socio-cultural perspective is an effort to appreciate cultural diversity and understand the culture that we have and from the economic perspective, it is seen as the effort to reduce poverty, improve welfare, achieve sustained economic growth, and establish economic independence and national competitiveness (Ali, 2017). Science learning containing ESD aims to support students' creative thinking skills and build sustainable awareness. Based on the analysis conducted by Ahmad (2019), it is stated that creative thinking skills can have a positive impact on environmental management activities where a person's ability to analyze, identify, formulate and conclude a problem that occurs in the surrounding environment makes it a product of the indirect application of creative thinking.

The ability to think creatively is a challenge in 21st-century educational paradigm is the ability to create and renew (Creativity and Innovation Skills), through creativity and innovation, it is hoped that in learning students can think creatively, work creatively and be able to produce innovations (Greenstein, 2012). Torrance in Treffinger et al., (2002) stated that creative thinking skills include fluency thinking and flexibility thinking. Munandar (2009) stated that the characteristics of fluent thinking are to mention many ideas, answers, questions, and problem solving by providing many ways

or suggestions for doing various things. While flexibility thinking is characterized by the ability to generate varied ideas, answers, and questions and can see a problem from a different perspective, and be able to change the way of approach or thinking.

After creative thinking skills, ESD-based learning also grows sustainable awareness. Education for sustainable development grows an understanding of the importance of creating and balancing ecosystems and an understanding that humans are part of the ecosystem. ESD provides an understanding of the value of social responsibility to give students an idea that they are part of a social system that is in synergy with nature and its contents. With this understanding, critical attitudes will emerge towards the environment, culture, and economic development (Kemendiknas, 2010).

The implementation of ESD in Indonesian education is not a new thing. However, its implementation has not been carried out optimally (Shantini, 2016). One of the efforts to facilitate the delivery of ESD in the learning process is through the development of teaching materials that contain ESD. This ESD teaching material can be used by students as a learning resource in science lessons. Teaching materials are one of the important components of the learning process. The existence of teaching materials in the learning and teaching process helps the process of teaching activities to be easier and better (Budiastra et al., 2020). According to Setyadi & Ismail (2017) the development of teaching materials is important as an effort to improve the quality of learning to be more effective, efficient, and clear on the competencies to be achieved.

One form of effective teaching material to be developed at this time is the e-module. The importance of developing an e-module is based on several problems that are known from interviews with several junior high school teachers from several schools in a district which show that there are no ESD teaching materials used in the learning process and the teacher's lack of knowledge of materials that directly intersect with ESD. In addition to the problems above, the development of e-modules needs to be done because textbooks containing educational materials that are in line with sustainable values are still scarce (Mohammadnia & Moghadam, 2019). The same research conducted by Rahman et al., (2019) stated that if the teaching materials used by several schools were in the form of printed books and worksheets, only a few used e-module. The printed books and worksheets also do not present material that demonstrates the concept of sustainability. The importance of developing e-module is also based on technological advances and the completeness of infrastructure owned by schools or students today. it should be supported by teaching materials with the latest innovations that can be accessed easily via a smartphone or computer.

E-module is a modified print module that is redesigned so that it can be accessed via a computer or smartphone. Kimianti (2019) stated that an e-module can be used as an alternative learning resource that is practical and contextual because it can be used anywhere and the material presented is relevant to real life. With the development of this e-module, learning can run more effectively because the learning process will be more interesting. Besides being effective, the e-module also streamlines the ongoing learning process because it can not only be done in class, but can be accessed via computers and smartphones and is equipped with text, images, animations, and audio.

Through e-modules students can understand the material easily because this e-module is easy to run and does not know distance and time (Suarsana & Mahayukti,

2013). Indrati and Hariadi (2016) stated that one of ESD implementations to the learning process is to add the ESD values into science learning. Curriculum analysis is conducted by identifying the KI-KD in Curriculum 2013. Biotechnology is one of the lessons in science that can be added to the values of Education for Sustainable Development. Indicators of competency achievement in biotechnology are very relevant to the values in sustainable development, which is the application of biotechnology itself for the human to survive. Contents of science contained in the e-module relate to the theme of traditional fermented food which is a product of conventional biotechnology in the food sector. According to Dewi (2014), traditional food is a cultural phenomenon. Traditional food is not only a result of the production of a system through biochemical processes that can be consumed by humans but as an effort to maintain a culture. Imanuddin (2018) states that cultural aspects are not the most important in ESD and are used for socio-cultural contexts within the framework of Science Education for Sustainable Development. Indonesian traditional fermented foods have raw materials that come from the surrounding environment. This is in line with the goal in the environmental perspective is to use the environment wisely for life. In line with Segera (2015) who stated that through ESD students will know how to maintain environmental sustainability for the future by exploiting nature properly for human consumption.

In addition to cultural and environmental aspects, the theme of traditional fermented food will also provide an entrepreneurial stimulus for students. Khoerunnisa et al. (2016) stated that learning with the application of a module on addictive substances in traditional snacks is effective in growing students' interest in entrepreneurship with criteria starting to develop. As we know, from an economic perspective, it is hoped that efforts to alleviate poverty and create an independent economy will occur. This is closely related to the character of entrepreneurship. Therefore, Indonesian traditional fermented food is very suitable to be used as a material that contains a sustainability perspective from an environmental, socio-cultural, and economic perspective. Based on the description above, it is important to develop an e-module with the theme of traditional Indonesian fermented food as an innovative learning resource as well as a bridge to introduce ESD values in science learning to build creative thinking skills and sustainable awareness for junior high school students.

▪ METHOD

Research Design and Procedures

This research was conducted using the ADDIE model development research method which consisted of 5 stages. These stages were analysis, design, development, implementation, and evaluation as shown in Figure 1. The product developed in this research was an e-module, which was assessed for its validity against mapping ESD values, creative thinking, and environmental awareness. The stages for developing the ADDIE model were presented in the following figure.

Figure 1. The ADDIE concept (Branch, 2009)

Analysis

In the analysis stage, 3 analyzes were carried out (1) A needs analysis was carried out to analyze the reasons for the need to develop an e-module containing ESD with the theme of Indonesian traditional fermented food. The analysis was carried out based on information obtained from the teacher through the interview process and filling out a survey. (2) KD and indicator analysis is carried out by analyzing basic competencies and indicators relevant to the e-module theme. This is done so that the material presented forms the integration of knowledge. (3) Material analysis is done by analyzing material that matches the theme and content of ESD. Materials were obtained from textbooks and related articles. Furthermore, the material is validated by a material expert to determine the validity of the accuracy and precision of the material presented.

Design

At the design stage, several stages were carried out consisting of (1) determining the form of material delivery (images, texts, and videos), (2) designing evaluation question instruments (3) designing assessment validation sheets (4) compiling e-module systematics such as flowcharts, navigation, and storyboards.

Development

At the development stage, several steps were carried out consisting of (1) realizing the e-module design into the form of an e-module application, (2) the E-module being validated by ESD material experts and media experts (This assessment of the e-module is focused on mapping aspects - aspects of ESD and creative thinking skills on the material presented and the appearance of the e-module (media) (3) The e-module was revised based on the advice of the expert (4) Conducted a limited test of the validity and reliability of the question instrument.

Implementation

In the implementation stage, 2 activities were carried out consisting of (1) Implementation of an e-module containing ESD with the theme of Indonesian traditional fermented food to build students' creative thinking skills and sustainable awareness (2) an assessment of student's creative thinking skills and sustainable awareness.

Evaluation

At this stage, analysis and correction of errors that occur during the e-module development process were carried out. This evaluation stage occurred in every four previous stages of development because the goal was for revision or improvement of the e-module.

Participants and Instrumen

This research was conducted only up to the development stage. After the e-module had been developed, it was then validated by experts consisting of material experts and media experts. The subjects involved in this study consisted of 2 material experts and 2 media experts as validators for the e-module. This questionnaire uses a Likert scale scoring 1 to 5.

Data analysis

Analysis of the data obtained from the following steps: (1) The expert's assessment was calculated the average score of each aspect to determine the validity of the developed e-module. The following is a formula for calculating the validity.
$V = \frac{X}{Y}\ x\ 100$ the validity value is obtained from the Score obtained from the e-module validation results divided by the Maximum score of validation results and then multiplied by 100 percent. (2) Changed the value of e-module validity (V) into categories. The categories are:

Table 1. Conversion of achievement levels with a scale of 5

No	Achievement levels (%)	Qualification	Description
1	90-100%	Excellent	No need to revise
2	75-89%	Good	Little revision
3	65-74%	Pretty Good	Revised sufficiently
4	55-64%	Not God	Many things are revised
5	1-54%	Very Poor	Repeat to make a product

(Tegeh & Kirna, 2010)

▪ RESULT AND DISSCUSSION

The result of this research is an e-module containing Education for Sustainable Development with the theme of traditional Indonesian fermented food to build creative thinking skills and sustainable awareness. This e-module is made by displaying images, videos, and audio so that students are more interested in learning it. In addition, learning with this e-module can develop sustainable values through efforts to bring up the concept of Education for Sustainable Development (ESD) information texts and assignments. The development of this e-module is carried out through the stages of analysis, design, and development.

The first stage carried out in this e-module development research is analyzing. This stage is divided into 3, namely needs analysis, KD analysis and material analysis. The needs analysis was carried out by observing and interviewing several teachers from several schools about the teaching materials used, the integration of ESD into science learning, and students' creative thinking skills in schools.

From the results of the observations and interviews, it was found that students still had difficulty in obtaining learning resources that contained ESD. The material provided by the teacher has not been fully integrated with ESD values. The evaluations given in schools also have not implemented an increase in creative thinking skills. In addition,

there are adequate facilities and infrastructure that support learning such as smartphones but have not been used optimally in learning. Therefore, it is necessary to develop teaching material in the form of an e-module that applies an interactive learning model that is organized in such a way that students can play an active role in constructing their knowledge and experience by being involved in studying the material individually or in groups.

Based on the results of these observations and interviews, it was concluded that it was necessary to develop an e-module ESD to improve students' creative thinking skills and sustainable awareness of the theme of traditional Indonesian fermented foods. This is in line with research conducted by Kang (2021), Ang (2021), and Ammoneit et al., (2022) that teacher need to include content related to ESD in the teacher education curriculum so that teachers can cultivate positive attitudes toward ESD and improve their self-efficacy in student engagement and instruction in the context of ESD. Educators have a pivotal role in promoting education for sustainable development (ESD). It is imperative to focus on sustainable development in order to survive and thrive in the present, and thus ensure that there would be a bright future for humankind.

After the needs analysis stage is carried out, the next stage is the KD analysis. KD analysis was carried out by analyzing Basic Competencies (KD) based on the chosen theme for the development of e-modules, namely Indonesian traditional fermented foods. The Basic Competencies (KD) are:

Table 2. Basic Competencies in e-module containing ESD with the theme of Indonesian Traditional Fermented Food

No	Class	Basic Competencies
1	IX	3.7 Applying the concept of biotechnology and its role in human life 4.7 Making one of the conventional biotechnology products from the surrounding environment
2	VIII	3.5 Analyzing the digestive system in humans and understanding disorders related to the digestive system, as well as efforts to maintain a healthy digestive system
3	VII	3.3 Explain the concept of mixtures and single substances (elements and compounds), physical and chemical properties, and physical and chemical changes in everyday life

The last stage of the analysis is to analyze the material that will be presented in the e-module based on the KD and ESD content. KD that has been analyzed is compiled into learning materials for traditional Indonesian fermented food themes. The sources used to compile the materials are textbooks and related articles. This material analysis was validated by 2 material experts using the "Yes-No" Guttman scale. The assessment of the accuracy of this material is carried out to validate that the material that has been prepared by the researcher is true and accurate. The results of the assessment of the accuracy of the material are:

Table 3 . Validation results of content and material accuracy

Learning activity	Total of contents	Topic-material accuracy assessment		Category
		Material expert 1	Material expert 2	
Learning activity 1	5 contents	100%	100%	Excellent
Learning activity 2	12 contents	100%	100%	Excellent
Learning activity 3	24 contents	100%	100%	Excellent

Based on the table above, it can be seen that all content that was validated by experts obtained a value of 100%, which means it is very valid. The preparation of this material is carried out with repeated revisions until the content and material are truly precise, accurate, and valid. The material presented in this e-module is extracted from credible textbooks and relevant articles that meet the criteria. The second stage in the development of this e-module is product design. Starting with choosing the form of material delivery consisting of images, text, and videos, designing formative and summative test instruments with indicators of creative thinking skills, and compiling the composition of each e-module page using storyboards and navigation buttons to make it easier to use. Product development can be seen in the Figure 2 and Figure 3.

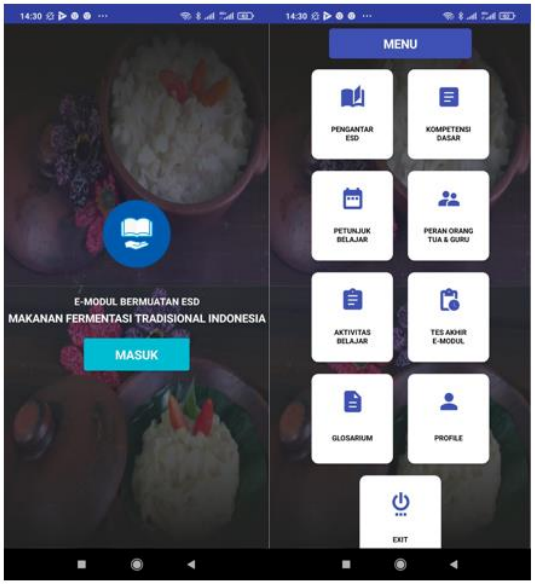

Figure 2. E-modul ESD

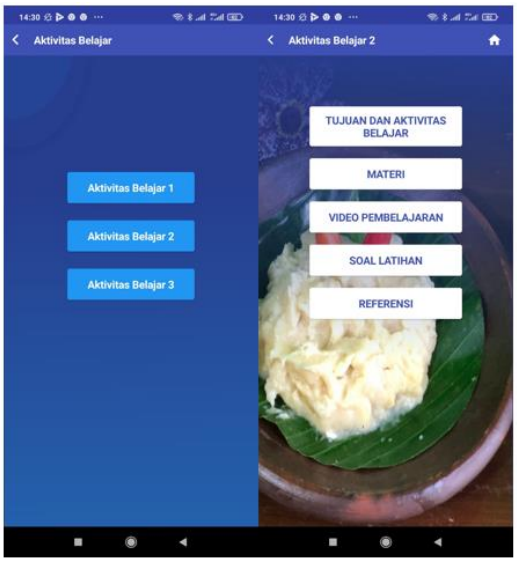

Figure 3. E-modul ESD

After designing the e-module, the next stage is development. At this stage, the e-module design will be realized in the form of an e-module application. The e-module was developed by containing aspects of Education for Sustainable Development, creative thinking skills, and sustainability awareness that are inserted into materials, information, assignments, exercises, and videos. After realizing this e-module product, assessment validation was carried out by experts both in terms of mapping ESD aspects, and media. The purpose of this validation is to determine the validity of the ESD-loaded e-module that has been developed. The results of this validation are in the form of values and suggestions. The value of score obtained from the expert is converted into quantitative data with a scale of 5 in determining the validity of the e-module that has been developed. Based on the development of the ESD-loaded e-module that has been carried out, the data obtained from the validation of the material on the mapping of ESD aspects and creative thinking skills are presented in the following table.

Tabel 4. The results of material expert validation on mapping ESD aspects, creative thinking skills and sustainablility awareness

No	Aspect	Percentage of material expert 1	Category	Percentage of material expert 2	Category
1	Aspect 1	93.3%	Excellent	93.3%	Excellent
2	Aspect 2	85%	Excellent	85%	Excellent
3	Aspect 3	87.5%	Excellent	77.5%	Good
4	Aspect 4	85%	Excellent	85%	Excellent
5	Aspect 5	70%	Excellent	70%	Good
6	Aspect 6	85%	Excellent	85%	Excellent

Based on the table above, it can be seen that all of the assessed aspects indicate excellent and good category. There are 6 main aspects contained in the e-module consisting of (1) esd in general (2) environment (3) socio-cultural (4) economics (5) creative thinking skills (6) sustainability awareness. From the assessment given by the

expert, it can be seen that aspects 1,2,3,4,6 get an average value of >85% which indicates that the ESD aspect in this e-module is valid. The aspect of creative thinking skills got a score of 70%. This shows that the developed e-module with ESD content has met the criteria. With the fulfillment of the ESD criteria in this e-module, students can learn ESD as a whole through the theme of traditional Indonesian fermented foods. As revealed by Hassan et al.,(2010) and Michalos et al., (2011) students must act as agents in the family to convey information about sustainable development. This is because students are the closest group to reading material (books, magazines, and also internet access). They have to carry out discussions and read activities, then apply them in their daily practice.

ESD material experts also provide suggestions for e-modules including correcting typos, adding page numbers to each material, changing a few sentences in learning activity 1 to be closer to students, and emphasizing conventional biotechnology concepts. All suggestions provided by these material experts have been fixed. In developing an e-module product, it is important to pay attention to the sentences used in a material so that students can easily understand it. According to Kizilaslan et al., (2021) and Kizilaslan (2019) that discourse on a teaching material must be easily understood by students and able to accommodate the various difficulties experienced by students in understanding science material and it is equally essential to design materials and activities to be as simple as possible.

The integration of aspects of the values of Education for Sustainable Development that is inserted through materials, exercises, and videos is believed to have a role in the high value of the validity of this e-module. This ESD aspect provides opportunities for students to think about the future with the principle of sustainability, think creatively, and grow a sustainable attitude. In line with the statement that ESD can increase students' values in terms of sustainability and future thinking (Sagdıç & Şahin, 2016) and (Arbuthnott, 2008).

Furthermore, the results of the validation in terms of the appearance of the e-module media are presented in the following table:

Tabel 5. Media expert validation results on e-module ESD

No	Experts	Percentage	Category
1	Media expert 1	88%	Excellent
2	Media expert 2	73.3%	Good

Based on the table presented above, it can be seen that the categories obtained are excellent and good. If the average of the two media experts is calculated, the results are 80.65% which shows a good category. Several aspects assessed in this media validation include the placement of balanced and attractive images and videos with a value of 90%, the display of material and learning activities presented is consistent in each lesson and can provide a conception of a better future in sustainable development. the value of 90% is excellent, and the ease of using the navigation buttons provided gets a value of 80%. The existence of a learning video in the form of a simulation presented in this e-module aims to increase students' understanding of processing certain fermented food products. This is in line with Koto (2020) who states that learning through video can improve student performance in terms of procedural knowledge rather than factual

and conceptual knowledge and Rachmawati et al., (2020) learning that is equipped with structured and clear simulation videos will make it easier for students to understand a concept.

Media experts also provide suggestions, including improving the font type in the information box, bolding important words, and correcting typos. The suggestion has been corrected. In addition to providing advice, media experts also gave positive comments on e-modules, namely the e-modules that were developed are generally good and interesting because they introduce the concept of ESD and integrate it into digital learning media and use communicative and humanist language. This positive comment is in line with the opinion of Segera (2015) that through ESD students will know how to maintain environmental sustainability for the future by exploiting nature properly for human consumption. Based on the validation results, it was found that the e-module containing ESD with the theme of Indonesian traditional fermented food was suitable for use both in terms of material and media and was feasible in a limited trial so that it could be used for wide-scale implementation in improving students' creative thinking skills and sustainable awareness.

When compared with other relevant research related to the development of teaching materials containing ESD, it is known that the teaching materials used are mostly printed modules and printed worksheets that do not add sustainability values to the material presented (Rahman et al., 2019). So that the new thing from this research is that the developed ESD module is made in the form of an e-module that provides information about ESD values. The implications of this research are (1) the developed ESD e-module can be used in science learning, especially conventional biotechnology materials (2) the e-module can motivate students to learn because it is directly involved with learning activities, (3) this e-module can create students know the principles of sustainable living and think creatively through the information and evaluations presented.

▪ CONCLUSION

First, ESD e-modules are teaching materials that can be used online, flexibly, and independently which are compiled based on ESD aspects and creative thinking skills so that they can facilitate students' creative thinking skills and thoughts about sustainable awareness. Second, based on the data analysis that has been carried out, the ESD-loaded e-module is feasible in terms of mapping the ESD values on the material presented and the media display to be implemented in the form of a limited trial or on a wider scale.

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