Development of E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material

Husna Arifatun Najwa*, Suhartini[2]

[1] Master of Biology Education Program, Faculty of Mathematics and Natural Science, Yogyakarta State University, Yogyakarta.
[2] Departement of Biology Education, Faculty of Mathematics and Natural Science, Yogyakarta State University, Yogyakarta.

Abstract: This study aims to develop an E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material and determine the practicality and feasibility of the developed product. This research is a type of Research and Development (R&D) research using the Design and Development Research (D&DR) development model. The development procedure in this development model consists of 6 stages, namely identify the problem, describe the objectives, design and develop the artifact, test the artifact, evaluating testing results, and communicate the testing results. The subjects in this study were lecturer validators of material experts and media experts, biology teachers and students of class XI IPA SMA. The instruments used in this study were questionnaire instruments for validation of material experts and media experts as well as questionnaires for responses from biology teachers and students. Based on the tests that have been carried out, the media expert assessment gets a score of 76.7% with the category "feasible". The material expert assessment scored 98.3% with the category "very feasible". Biology teacher assessment scored 95% with the category "very practical", and student assessment scored 87.98% with the category "very practical". Based on the tests that have been carried out, it is known that the E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material developed is feasible and practical to use as teaching material.

Keywords: Education for Sustainable Development (ESD), E-Module, Enviromental Change

Introduction

The global environmental crisis is an important issue being discussed today. The occurrence of environmental crisis is closely related to the fulfillment of human needs on earth. The abundance of natural resources on earth has important implications for the amount of environmental degradation that occurs. Rapid development and economic growth such as urbanization and industrialization will increase the consumption of natural resources (Ahmed et al., 2020). This causes the prosperity of life to be prioritized over paying attention to how the current environmental conditions are. This is also exacerbated by the amount of world population growth that has increased every year,

which means that the fulfillment of human needs is getting higher. This causes the number of world population growth to be inversely proportional to the world's ecological footprint (Mochtar et al., 2014).

The poor ecological footprint of the world is shown by the high negative impact received by the environment. A variety of severe environmental impacts result from mismanagement of natural resources, such as uncontrolled waste disposal that result in heavy metal contamination of water, soil, and plants (Vongdala et al., 2019), waste disposal in water areas will lead to an increase in marine litter (Tuahatu & Tujumury, 2022), and combustion results in increased emissions of CO, CO_2, NO, PM_{10}, SO and other pollutant emissions that can affect the atmosphere (Wiedenmyer et al., 2014).

These things cause serious environmental pollution which will eventually lead to environmental changes. The above supports the worsening of the world's ecological footprint so that every year the world experiences problems regarding the lack of availability of natural resources, energy, clean water and food (Mochtar et al., 2014).

The global environmental crisis due to demand-side measures is exacerbated by the fact that the world has lost 50% of its tropical forests. Today, tropical forests cover less than 6% of the earth's land area, whereas they originally covered 12% of the earth's land area. Tropical deforestation is a major environmental crisis that threatens the Earth's ability to support human life (Interfaith, 2019). The amount of deforestation that occurs also affects the concentration of CO2 in the atmosphere. Currently, more than 25% of the CO2 concentration in the atmosphere has increased, causing extreme climate change, extinction of flora and fauna, destruction of natural habitats, and pollution (Prabawani et al., 2017).

In addition to deforestation, the large amount of CO_2 emissions in the atmosphere is also caused by the large use of fossil fuels. Based on the Intergovermental Panel on Climate Change (IPCC) evaluation report, it is known that global warming due to increase CO_2 in the atmosphere continues to increase and this is related to the large use of fossil fuels. Although many countries have made a joint policy related to rising global temperatures, the high emissions of CO_2 has not decreased and stil makes this time the most critical period in increasing the earth's temperature (Aktar, 2021). Coal is one example of the use of fossil fuels as an energy source that is predicted to increase in the near future to power production and manufacturing (Ahmad & Dongdong, 2020). Increasing global energy demand will cause the world's ecological footprint to worsen and global warming to continue (Aktar et al., 2021).

The worsening global climate change is also reinforced by the facts of the Covid 19 pandemic. Saadat & Rawtani (2020) explained that Covid 19 had a real impact on reducing energy consumption and needs. This is also reinforced by McGrath (2020) who explained that Covid 19 caused a sharp decline in global energy demand, especially in coal, gas, and oil, which resulted in a decrease in CO2 emissions. Although global energy demand has decreased, the fact is that CO_2 gas emissions in 2020 continued to be released and CO_2 levels are still the highest on record in the atmosphere (Stylianou et al., 2020). CO_2 emissions during Covid 19 pandemic were caused by increased electricity demand due to lockdowns and increased plastic production for Personal Protective Equipment (PPE) (Sylva et al., 2021). Aktar et al. (2021) explained that reduction in CO_2

emissions due to the Covid 19 pandemic will only have a small impact on the total concentration of CO_2 in the atmosphere so that the climate crisis will continue. Some of the facts presented above reinforce that sustainable development needs to be implemented to address and resolve environmental changes.

Sustainable development is one of the main focuses in national development principles. The concept of sustainable development was initiated in view of the increasing population growth and the decreasing natural resources to full fill the needs. Sustainable development is developed on the basis that humans can interact with the environment and the environment can be utilized for future generations. Sustainable development is expected to improve the standard of living of humans while not having a negative impact on the sustainability of ecosystems and the environment (Mensah, 2019). According to UNESCO (2020), education is the main focal point in implementing sustainable development and underlies the achievement of 17 sustainable development goals with 169 achievements called Sustainable Development Goals (SDGs). Education is a great hope to achieve development goals and design a sustainable future, especially to overcome various environmental crises (Purnamasari, 2021). With the hope of resolving environmental problems and other issues faced today and in the future, an idea called Education for Sustainable Development (ESD) was created (Primasti, 2021).

ESD is a major element in the plan to achieve sustainable development goals (SDGs) targeted until 2030. ESD is expected to create quality education to advance a sustainable society (Kioupi & Voulvoulis, 2019). Education is expected to manage human resources to be able to meet needs through the use of the environment while preserving the environment. In addition, through education, people's knowledge and skills in caring for the environment can be improved (Wang, 2016). Education has an important role to change students' mindset, attitude and behaviour through sustainability values. Through the implementation of ESD, students will be equipped with knowledge, skills, values, attitudes and behaviours that can create a sense of responsibility, be able to direct students actively and create awareness to students that they are subjects who can realize the goals of sustainable development. Through the implementation of ESD, individuals will be transformed into a better and sustainable direction (UNESCO, 2020). Clarisa et al. (2020), mentioned that by integrating ESD in learning, students will be taught to imagine a more positive and sustainable future, so that it can improve students' skills in solving problems and increase awareness of

protecting and respecting the surrounding environment. The implementation of ESD can be done through integration into the curriculum of each level of education or integrated into various fields of study (Sund & Gericke, 2020).

Based on the explanation above, ESD can be implemented in the learning content of biology subjects. Biology learning taught at this time refers to the implementation of the Merdeka curriculum. The curriculum has learning outcomes that at the end of phase E, students are expected to have the ability to be responsive to global issues and be able to provide problem solving, all of which are directed at achieving sustainable development goals (SDGs). One of the contents of biology learning that can be integrated with the urgency of sustainable development is environmental change material.

Based on observations and interviews conducted with biology teachers, it was found that the independent curriculum is a new curriculum implemented with very limited preparation. So that in its implementation, teachers often experience difficulties. One of the difficulties experienced by teachers is due to the lack of clear material boundaries in each topic in biology material. One of the topics whose material boundaries are less clear is the material on environmental change. The teacher explained that in the teaching materials used by the teacher, the content of environmental change material only contains global warming material. According to the teacher's explanation, the scope of the material is still not broad enough and the boundaries are not clear enough to be conveyed to students. Through these interviews, it is also known that teachers have not been able to create and develop teaching materials tailored to the characteristics of students in the field. In their learning, teachers still adapt teaching materials from schools that are ready to implement the Merdeka curriculum.

Based on observations made to students, it was found that students experienced learning loss after online learning due to the Covid 19 pandemic. During learning, many students were not focused and fell asleep. After further investigation, this happened because during the Covid 19 pandemic, learning was carried out online and students did learning by utilizing smartphones or laptops, so learning became more interesting for students. Meanwhile, when learning returns to offline, students experience boredom when learning in class. Based on the results of observations and interviews conducted, it was found that there is a need to develop technology-based teaching materials that can motivate and increase student engagement in learning. In addition, based on observations made, it is known that 62.04% of students have not understood and

implemented attitudes in the context of sustainable development.

Based on the results of these interviews and observations, E-Modules are suitable teaching materials to be developed. According to Sunismi & Halim (2015), E-Modules are very appropriate to be used as teaching materials by students, because e-modules can maximize individual student learning efficiently and can meet individual student interests. Based on the description above, there is an urgency to develop an E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material.

Method

This research is a type of Research and Development (R&D) research using the Design and Development Research (D&DR) development model. The purpose of this research is to develop an E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material and determine the practicality and feasibility of the developed product. The development procedure in this development model consists of 6 stages, namely identify the problem, describe the objectives, design and develop the artifact, test the artifact, evaluate testing results, and communicate the testing results (Elis & Levy, 2010). The subjects in this study were lecturer validators of material experts and media experts, biology teachers and students of class XI IPA SMA / MA.

The development of E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material begins with identifying problems through observation, interviews and analyzing the needs of teachers and students. Based on the identification of the problem, then the description of the object or purpose is carried out. Then the design and development of the artifact is carried out, which includes the stages of building a conceptual framework, developing products and compiling instruments. After the product has been developed, artifact testing will be carried out including feasibility testing by material experts and media experts, practicality testing by teachers and students and field testing. The results of the testing process will be evaluated and then reported. In testing the artifact, four prototypes will be obtained based on the results of testing by material experts, media experts, teachers and students. Each prototype will be evaluated and revised to get the final product development. This research was only conducted up to the feasibility and practicality test stages.

Development of E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material will be tested for

feasibility to media expert lecturers and material experts and will be tested for practicality by teachers and students. The instrument used to conduct the test is a questionnaire instrument for validation of material experts and media experts as well as a questionnaire for the responses of biology teachers and students. The types of data obtained in this study are quantitative data and qualitative data. Quantitative data is obtained based on the results of filling out the questionnaire, and qualitative data is obtained based on the suggestions given. The results of the data obtained from filling out the questionnaire will then be analyzed for each aspect and converted into product quality categories (each aspect) guided by Table 1.

Table 1. Guidelines for product quality categories in each aspect

Score Range	Criteria
Mi + 1.5 SDi ≤ x ≤ Mi + 3.0 Sdi	Very Good
Mi + 0 SDi ≤ x ≤ Mi + 1.5 Sdi	Good
Mi – 1.5 SDi ≤ x ≤ Mi + 0 Sdi	Less
Mi -3 SDi ≤ x ≤ Mi + 1.5 Sdi	Very Poor

In addition, the number of test scores through the questionnaire will also be determined on average to conclude about the feasibility and practicality of the product using the following formula (Purwanto, 2012) :

$$P = \frac{\sum x}{\sum xi} \times 100\% \qquad (1)$$

Description :
P   = Validation result
$\sum x$ = Total validation assessment score
$\sum xi$ = Total maximum score
100%   = Constant

Table 2. Product quality conclusion category guidelines

Rentang Skor	Criteria
80 < P ≤ 100%	Very Feasible/Practical
60 < P ≤ 80%	Feasible/Practical
40 < P ≤ 60%	Reasonably Feasible/Practical
20 < P ≤ 40%	Not Feasible/Practical
0 < P ≤ 20%	Very Unfit/Practical

The test results using the Formula 1 will then be adjusted using the criteria in the Table 1 (Purwanto, 2012).

Result and Discussion

This study aims to develop an E-Module Integrated with Education for Sustainable Development (ESD) on Environmental Change Material that is practical and feasible for use in learning. The integration of ESD in learning will provide information and knowledge that environmental problems are always changing, how the risks are and what causes them. This can increase student's ability to take responsibility for their environmental conditions (Agbedahin, 2018). Furthermore, ESD will encourage students to think about the future of the environment, so that student's critical, creative and systemic thinking will develop. In addition, students are also invited to improve their cooperation skills and decision making skills (Pratiwi et al., 2021). This opinion is also reinforced by Mahat & Idrus (2016)who explained that the implementation of the ESD concept is effective in raising awareness in students to maintain environmental sustainability for future generations. Based on this, the development of a teching material integrated with ESD is considered important to do. Based on previous studies, it is known that teaching materials with sustainable principles and values are still relatively difficult to find (Mohammadnia & Moghadam, 2019). This fact is also reinforced by the exposure of Fitria & Hamdu (2021), which states that there are not many ESD based learning tools found. Product development in this study adopted the D&DR development model with 6 stages of development procedures, namely identify the problem, describe the objectives, design and develop the artifact, test the artifact, evaluating testing results, and communicate the testing results.

Identify The Problem
The first stage in product development is problem identification. Problem identification is carried out through preliminary study activities by conducting observations, interviews and distributing questionnaires. Based on the identification, it was concluded that there is a need to develop a teaching material that can increase students' motivation and interest in learning, which is integrated with ESD content in independent curriculum learning materials.

Describe The Objectives
Based on the identification of the problems found, it is necessary to develop an E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material. A teaching material that is developed must be based on the characteristics and interests of students. The preparation of teaching materials must be adjusted to the curriculum and student needs (Yuliana & Barlian, 2021). The content and content of teaching materials must be able to provide systematic and programmed knowledge and information to students, so as to realize learning objectives according to curriculum demands (Kosasih, 2021).

Design and Develop The Artifact

The first stage in designing a product is building a conceptual framework. The planning of the conceptual framework in this study refers to the analysis of the learning outcomes of the independent curriculum biology. Based on the results of this analysis, learning objectives will be determined which are adjusted to the concept of environmental change material. The next stage of design is to analyze the concept map and scope of material. The scope of material included in the E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material. The E-Module is a material on environmental pollution, environmental change and efforts to overcome environmental pollution and change that will be integrated with the content of ESD themes, namely education on climate change, sustainable lifestyles, water and sustainable population movements. Through these themes, appropriate environmental issues will be presented in the designed product.

The next stage is product development. The product is developed in the form of an application that can be accessed by students using either a smartphone or laptop. This e-module is accompanied by menu features that can be explored by students. The initial stage of the development of E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material is the creation of a cover page (Figure 1). After clicking the start button, students will be shown the login page (Figure 2). On the login page, students will fill in their identity. After login, students will be shown the main menu page (figure 3) which contains the introduction menu, learning materials, activity sheets, evaluation, glossary, and information. The content of this ESD integrated E-Module on environmental change consists of 3 topics, namely environmental pollution, environmental change and efforts to overcome pollution and environmental change. In addition to material descriptions, these topics are also equipped with videos and biological info (Figure 4 and Figure 5) which aims to improve ESD components namely transformation and change, critical thinking and reflection, partnership for change, lifelong learning for all, and systemic thinking.

The material content of the E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material is integrated with ESD themes (Figure 6). Providing knowledge in the form of case studies of real conditions in the field in the learning process is very important to do because it can improve learning outcomes and increase awareness and active role of students (Riefani, 2019). Through these case studies, students are invited to better recognize the

conditions of the surrounding environment, determine attitudes to overcome problems that have occurred, and determine preventive solutions so that these problems do not get worse. At the design and develop the artifact stage, the stages of preparing instruments in the form of media expert and material expert feasibility validation sheets as well as biology teacher and student response questionnaires for practicality assessment of the products developed were also carried out.

Figure 1. Cover page

Figure 2. Login page

Figure 3. Main menu page

Figure 4. Video page

Figure 5. Biology info page

Figure 6. Example of exposure to issues based on ESD themes

Test The Artifact

There are several stages in testing the artifact. The first stage is the trial of the ESD integrated E-Module on environmental change material which is carried out through product feasibility assessment by media experts and material experts, and product practicality assessment by biology teachers and students on product use (limited trial).

Evaluate The Testing Result and Communicate The Testing Result

The results of the product feasibility test by media experts and material experts as well as the results of the practicality test by biology teachers and students will be

divided into quantitative data and qualitative data. Quantitative data will be analyzed to determine the feasibility and practicality of the product, while qualitative data will be used as a reference for product development revisions. The results of product testing are as shown in Table 3.

Table 3. Results of media expert feasibility assessment on each aspect

Assessment Indicator	Score	Category
Display Quality	16	Very Good
Language	3	Good
Ease of Operation	8	Good
Product Reliability	9	Good
Illustration Quality	10	Very Good
Ease of Use	3	Good

Table 4. Assessment results of media expert feasibility conclusion

Assesment	Percentage %	Category
Media Expert	76.7	Feasible

Table 5. Results of material expert feasibility assessment on each aspect

Assessment Indicator	Score	Category
Feasibility of Material	16	Very Good
Accuracy of Material	20	Very Good
Didactics	28	Very Good
Construction	34	Very Good
Technical	20	Very Good

Table 6. Assessment results of the material expert's feasibility conclusion

Assessment	Percentage %	Category
Media Expert	98.30	Very Feasible

Based on the product feasibility assessment above, it can be seen that the feasibility of the product according to the media expert is in the "feasible" category and by the material expert is in the "very feasible" category. Depdiknas (2008) explains that proper teaching materials must include components of content, presentation, linguistic and graphical feasibility. The four components have been included in the ESD integrated E-Module on environmental change material developed. In addition to obtaining the results of the feasibility assessment by material experts and media experts, suggestions for improvement were also obtained which were used as a reference for product revision. Suggestions from media experts (prototype 1) include improving product links, simplifying and streamlining menu displays, clarifying instructions for use and clarifying worksheet content. Suggestions from material experts (prototype 2) include clarifying instructions for use and instructions on the evaluation menu.

In addition to being tested for feasibility, the resulting product was also tested for practicality by biology teachers and by students of class XI IPA in a limited trial. The results of the practicality trial are as follows.

Table 7. Results of biology teacher practicality assessment on each aspect

Assessment Indicator	Score	Category
Material (Content)	16	Very Good
Language	10	Very Good
Media	22	Very Good
Learning	25	Very Good

Table 8. Assessment results of practicality conclusions by biology teachers

Assessment	Percentage %	Category
Biology Teacher	95	Very Practical

Table 9. Results of students' practicality assessment on each aspect

Assessment Indicator	Score	Category
Presentation	21.17	Very Good
Language	3.70	Very Good
Ease of Operation	7.43	Very Good
Ease of Media	27.93	Very Good
Attractiveness and Visual Communication		
Usefulness	17.43	Very Good

Table 10. Assessment results of practicality conclusions by students

Assessment	Percentage %	Category
Student	87.98	Very Practical

Based on the assessment of product practicality above, it is known that in terms of practicality, the product is in the very practical category, both according to biology teachers and students. In this test, the teacher explained that the resulting product was very interesting and teaching materials should be designed like this, while students commented that the e-module display was very attractive and practical because it could be accessed using a smartphone. In addition, according to students, learning using the e-module is interesting because they are given new facts about the environment that students do not know.

Susilo (2018) explained that when students are given an environmental fact that has not been known before, students will go through the process of teaching for thinking instead of teaching about thinking so that students will form their thinking abilities through various critical, creative, problem solving, awareness, and self-management skills. This also in accordance with the opinion of Kioupi & Voulvoulis (2019), which states that learning by providing new facts will encourage students to think systematically in creating solutions to environmental problems. It is considered relevant to improve students' sustainability competencies so that they can effectively encourage sustainable change.

Based on the research conducted, it is known that the developed products is feasible and practical for use in learning. This is accordance with Arafah et al. (2023), that if the product assessment by material experts, media experts, teachers and students is in the good category, then they agree that the product is good and feasible to implement in learning. In addition to obtaining the results of practicality assessment, teachers and students also provide suggestions for improvement that can be used as a reference for revision. Suggestions for improvement given by teachers include (prototype 3) there are several buttons that cannot be clicked and there are several writing errors. Meanwhile, based on student responses, no suggestions for revision were obtained, and students said it was very fun to learn using the developed E-Module. According to Raqzitya & A (2022), E-Modules can be developed with an attractive, communicative design and systematic evaluation activities can also be developed. This can make students achieve the expected competencies because learning can adjust technological developments so as to increase student learning motivation.

E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material is developed in the form of an application that can be accessed by students using smartphones. Based on the research that has been conducted, it is known that students are interested in the products produced. Amaly et al. (2021) explained that application development can make learning more interesting, so it will have a positive effect on learning activities. In addition, through the use of applications, learning can be done anywhere and anytime. This is also in accordance with Miranda & Wibowo (2023) explanation, that learning media designed in the form of applications that can be accessed using smartphones have the advantage of being easy to carry everywhere and can display a variety of content including images, videos, animations and so on that are effective in increasing student interest and motivation to learn.

Conclusion

Based on the tests that have been carried out, it is concluded that the E-Module Integrated with Education for Sustainable Development (ESD) on Enviromental Change Material developed is feasible and practical to use as teaching material.

Acknowledgments

Author Contributions

Husna Arifatun Najwa contributes to conceptualizing the research idea, developing products, analizing data, and writing articles. Suhartini is a supervisor in research activities to article writing, reviewed and edited.

Funding

Conflicts of Interest

The authors declare no conflict of interest.

References

Agbedahin, A. V. (2018). *Sustainable development, education for sustainable development, and the 2030 agenda for sustainable development : emergency, efficacy, eminence, and future*. WILEY Sustainable Development. https://doi.org/10.1002/sd.1931.

Ahmad, T., & Dongdong, Z. (2020). A critical review of comparative global historical energy consumption and future demand : the story told so far. *Elsevier : Energy Reports, 6*, 1973–1991. https://doi.org/10.1016/j.egyr.2020.07.020.

Ahmed, Z., A., M. M., M., M. N., & N, K. (2020). Moving towards a sustainable environment ; The dynamic linkage between natural resources, human capital, urbanization, economic growth, and ecological fotoprint in China. *Elsevier : Resources Policy, 67*(101677), 1–11. https://doi.org/10.1016/j.resourpol.2020.101677

Aktar, M. A., A., M. M., & A, A. Q. (2021). Global economics crisis, energy use, CO2 emissions, and policy roadmap amid COVID-19. *Elsevier : Sustainable Production and Consumption, 26*, 770–781. https://doi.org/10.1016/j.spc.2020.12.029.

Amaly, A. M., Muhammad, G., Erihadiana, M., & Zaqiah, Q. Z. (2021). Kecakapan guru pendidikan agama islam dalam mengoptimalkan pembelajaran berbasis teknologi. *Jurnal Pendidikan Agama Islam Al-Thariqah, 6*(1), 88–104. https://doi.org/10.25299/al-thariqah.2021.vol6(1).6712

Arafah, M., Arifuddin, A., Rompegading, A. B., Irfandi,

R., Nur, M., Nasser, M. K. N., Yani, A., Rijal, S., & Upe, A. (2023). Development of macca biology learning media based on android software andromo. *Jurnal Penelitian Pendidikan IPA, 9*(11), 9955–9963. https://doi.org/10.29303/jppipa.v9i11.4638.

Clarisa, G., Danawan, A., Muslim, M., & Wijaya, A. F. C. (2020). Penerapan flipped classroom dalam konteks ESD untuk meningkatkan kemampuan kognitif dan membangun sustainability awareness siswa. *Journal of Natural Science and Integration, 3*(1), 13–25. https://doi.org/10.24014/jnsi.v3i1.8953

Depdiknas. (2008). *Panduan pengembangan bahan ajar*. Depdiknas. https://shorturl.asia/EC12k

Elis, J. T., & Levy, Y. (2010). A guide for novice researchers: design and development research methods. *Proceedings of Informing Science & IT Education Conference (InSITE, 10*, 107–118. https://doi.org/10.28945/1237

Fitria, A., & Hamdu, G. (2021). Pengembangan aplikasi mobile learning untuk perangkat pembelajaran berbasis education for sustainable development. *Jurnal Inovasi Teknologi Pembelajaran (JINOTEP, 8*(2), 134–45. https://doi.org/10.17977/um031v8i22021p134

Interfaith. (2019). *Hutan tropis asset yang terancam*. https://www.interfaithrainforest.org/s/Interfaith_IssuePrimer_TropicalForests_ID.pdf

Kioupi, V., & Voulvoulis, N. (2019). Education for sustainable development : a systemic framework for connecting the SDGs to educational outcomes. *Multidisciplinary Digital Publishing Institute (MDPI, 11*(21), 1–18. https://doi.org/10.3390/su11216104

Kosasih. (2021). *Pengembangan bahan ajar*. PT Bumi Aksara.

Mahat, H., & Idrus, S. (2016). Education for sustainable development in Malaysia: A study of teacher and student awareness. *Geografia, 12*(6). Retrived from https://shorturl.asia/Dy2r8

McGrath, M. (2020). *Climate change and coronavirus : five charts about the biggest carbon crash*. Retrieved from https://www.bbc.com/news/science-environment-52485712.

Mensah, J. (2019). Sustainable development : meaning, history, principles, pillars, and implications for human action : literatur review. *Cogent Social Sciences, 5*, 1–21. https://doi.org/10.1080/23311886.2019.1653531

Miranda, D., & Wibowo, Y. (2023). Pengembangan media pembelajaran berbasis aplikasi android pada materi sistem pernapasan kelas XI SMA. *Jurnal Edukasi Biologi, 9*(1), 77–89. https://doi.org/10.21831/edubio.v9i1.18146

Mochtar, N. E., Gasim, H., Hendarman, Indrastuti, N.,

Wijiasih, A., Suryana, C., Restuningsih, K., & Santi laila tartila. (2014). Pendidikan untuk pembangunan berkelanjutan. In *Komisi Nasional Indonesia untuk UNESCO (KNIU) Kementerian Pendidikan dan Kebudayaan*. Jakarta: Komisi Nasional Indonesia untuk UNESCO (KNIU) Kementerian Pendidikan dan Kebudayaan. Retrieved from https://shorturl.asia/sIpJw

Mohammadnia, Z., & Moghadam, D. (2019). Textbook as resources for education for sustainable development : a content analysis. *Journal of Teacher Education for Sustainability*, *21*(1), 103–114. https://doi.org/10.2478/jtes-2019-0008

Prabawani, B., Hanika, I. M., Pradhanawati, A., Budiatmo, A., Musfirowati, I., Pradhanawati, A., & Budiatmo, A. (2017). Primary schools Eco-Friendly education in the frame of Education for Sustainable Development. *International Journal of Environmental & Science Education*, *12*(4), 607– 616. Retrived from https://eric.ed.gov/?id=EJ1144855

Pratiwi, N. L. P. W., Dantes, N., & Divayana, D. G. H. (2021). Pengembangan modul elektronik berbasis education for sustainable development menggunakan flip pdf professional pada muatan pelajaran IPA tema lingkungan sahabat kita untuk siswa kelas V. *Jurnal Teknologi Pembelajaran Indonesia*, *11*(2), 157–169. https://doi.org/10.23887/jurnal_tp.v11i2.661

Primasti, S. G. (2021). Implementasi program Education for Sustainable Development di SMA Tumbuh. *Jurnal Spektrum Analisis Kebijakan Pendidikan*, *10*(3), 80–100. https://doi.org/10.21831/sakp.v10i3.17465

Purnamasari, S. (2021). Education for Sustainable Development (ESD) dalam pembelajaran IPA. *Jurnal Kajian Pendidikan IPA*, *1*(2), 69–75. https://doi.org/10.52434/jkpi.v1i2.1281

Raqzitya, F. A., & A, A. A. G. (2022). E-Modul berbasis Pendidikan karakter sebagai sumber belajar IPA siswa kelas VII. *Jurnal Edutech Undiksha*, *10*(1), 108–116. https://doi.org/10.23887/jeu.v10i1.41538.

Riefani, M. K. (2019). Validitas dan kepraktisan panduan lapangan "keragaman burung" di kawasan pantai Desa Sungai Bakau. *Jurnal Vidya Karya*, *34*(2), 193–204. Retrieved from https://shorturl.asia/XqpVJ

Saadat, S., & Rawtani, D. (2020). Enviromental perspenctive of Covid 19. *Elsevier : Science of The Total Environment*, *728*(138870), 1–6. https://doi.org/10.1016/j.scitotenv.2020.138870.

Stylianou, N., Guibourg, C., Dunford, D., Rodgers, L., Brown, D., & Rincon, P. (2020). *Climate change : where we are in seven charts and what you can do to help*. Retrived from https://www.bbc.com/news/science-environment-46384067.

Sund, P., & Gericke, N. (2020). Teaching contributions from secondary school subject areas to education for sustainable development–a comparative study of science, social science and language teachers. *Environmental Education Research*, *26*(6), 772–794. https://doi.org/10.1080/13504622.2020.1754341

Sunismi, & Halim, A. (2015). Pengembangan e-modul kalkulus 1 sebagai panduan mahasiswa untuk mengoptimalkan individual learning. *Jurnal Pendidikan Matematika*, *1*(2), 192–204. Retrieved from https://riset.unisma.ac.id/index.php/jpm/article/download/820/808/2174

Susilo, M. J. (2018). Analisis potensi lingkungan sekitar sebagai sumber belajar biologi yang berdayaguna. *Proceeding Biology Education Conference*, *15*(1), 541–546. Retrieved from https://shorturl.asia/ZQeij

Sylva, A. L. P., Prata, J. P., Walker, T. R., Duarte, A. C., Ouyang, O., Barcelo, D., & Santos, T. R. (2021). Increased plastic pollutions due to Covid-19 pandemic : challenges and recommendations. *Elsevier : Chemical Engineering Journal*, *405*, 1–9. https://doi.org/10.1016/j.cej.2020.126683

Tuahatu, J. A., & Tujumury, N. C. (2022). Sampah laut yang terdampar di pesisir pantai hative besar pada musim peralihan 1. *Jurnal TRITON*, *18*(1), 47–54. https://doi.org/10.30598/TRITONvol18issue1page47-54.

UNESCO. (2020). *Education for Sustainable Development: A Roadmap*. UNESCO. Retrieved from https://unesdoc.unesco.org/ark:/482

Vongdala, N., Tran, H. D., Xuan, T. D., Teschke, R., & Khanh, T. D. (2019). Heavy metal accumulation in water, soil, and plants of municipal solid waste landfill in Vientiane, Laos. *International Journal Environment Research Public Health*, *16*(22), 1–13. https://doi.org/10.3390/ijerph16010022.

Wang, X. G. (2016). Civil law expression of environmental rights and interest – refrelctions on the greening of civil code. *People Rule Law*, *3*, 25–27. Retrieved from https://shorturl.asia/XIJhs

Wiedenmyer, C., Ykelson, R. J., & Gullet, B. K. (2014). Global emissions of trace gases, paticulate matter, and hazardous air pollutans from opening burning of domestic waste. *Enviromental Science & Technology*, *48*, 9523 – 9530. https://doi.org/10.1021/es502250z.

Yuliana, F., & Barlian, I. S. (2021). Pengembangan bahan ajar digital interaktif dengan pendekatan kontekstual pada mata kuliah teori ekonomi mikro. *Jurnal Profit : Kajian Pendidikan Ekonomi Dan Ilmu Ekonomi*, *8* *91*, 36–46. https://doi.org/10.36706/jp.v8i1.13875