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E-Module of Physics Science Integrated with Sustainable Development Goals to Enhance Students' Environmental Literacy

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Abstract

This study aims to produce a product of an electronic module on the subject of energy to enhance students' environmental literacy. This research was a research and development (R&D) using the ADDIE development model which includes: 1) the initial needs analysis stage to determine the needs of students and teachers, 2) the design stage which included collecting references, instruments and designing and creating an e-module of the science of physics integrated Sustainable Development Goals (SDGs), 3) the development of e-modules was carried out using the Canva application, Fliphtml and validation of material and media experts, 4) small-scale trials conducting interviews with students and teachers to obtain qualitative data in-depth, 5) evaluation from users, namely students and subject teachers. The assessment included 1) a Media expert test; 2) a material expert test; 3) user tests; 4) a small-scale test. The results of this study showed that: (1) the SDGs integrated science e-module was produced to enhance students' environmental literacy (2) the quality of the science e-module for students was developed according to material experts and media experts to have very good quality (VG) with the ideal percentage of each 83.00% and 98.00%. (3) the teacher's response to the student module is Very Good (VG) with an ideal percentage of 98%. Meanwhile, the student's response to the student's science e-module is Strongly Agree with an ideal percentage of 83.00%. Based on the results of this study, it can be concluded that the Science E-Module Integrated to SDGs has met the criteria of being feasible and effective for enhancing students' environmental literacy skills seen from the responses of media experts, material expert responses, students' responses and trials.

Keywords: Environmental Literacy; Science E-Module; SDGs

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INTRODUCTION

Technology continues to develop along with time. Integrating technological tools in teacher learning is the application of technology utilization. As learning agents, teachers must master and apply

information and communication technologies to learning. UNESCO (1996), through its journal "The International Commission on Education for the Twenty-First Century," supports continuing (lifelong) education, which is carried out based on four principles of the learning process, namely: learning to know (learning to master knowledge), learning to do (learning to know skills), learning to be (learning to develop oneself), and learning to live together (learning to live in a community), in realizing the four principles of education in the current era of information globalization (Maslin, 2021; Metekohy et al., 2021; Setyaningsih et al., 2023).

In the 2013 curriculum, science subjects were further developed to become integrative science studies. It is an application-oriented education that fosters thinking, study, curiosity, caring, and a responsible attitude towards the natural environment. However, due to the low participation of students in environmental management, there is a need for science learning innovations in schools to overcome the lack of awareness and participation of students in environmental management. One of the factors is the lack of learning motivation. Science is an accumulation of knowledge in the form of facts, concepts or principles, and an invention that pertains to discovering something about nature clearly and understandably (Nofiana, 2017; Poultsakis et al., 2021).

The attitude expressed in everyday life to avoid and prevent environmental damage is an attitude of caring for the environment. A person has environmental competence if they can act on environmental issues. Individual environmental literacy can be measured by four factors (Ratna, 2001); (1) environmental knowledge, including environmental basics; (2) attitudes of caring for the environment, environmental conditions, and feelings towards the environment, including environmental perspectives; (3) cognitive, including environmental issues, environmental analysis and planning; skills, and (4) behavior, including specific behavior towards the environment. These four factors are the references used to determine a person's literacy level, especially students.

Education for sustainable development is geared toward a whole-system perspective and learning transformation. In practice, this has meant a greater focus on cross-curricular and subject areas approaches to teaching and a greater effort to link classroom learning to real-world applications. Education Sustainable Development (ESD) puts forward a view of quality education that focuses not only on measurable learning outcomes and national standards but also on promoting lifelong learning and developing students' skills, values and competencies to become change agents. ESD employs active and participatory learning methods that offer experiential education and problem-solving (Didham & Ofei-Manu, 2020).

In Indonesia, the concept of SDGs is enshrined in Law Number 20 of 2003, which states that the goal of the national education system is to form human beings who have noble character ability to solve various problems and become human beings who can utilize nature for current needs without reducing future needs; therefore, it is necessary to apply the SDGs in the learning process (Setyaningrum & Gunawan, 2020). Learning has a role in the SDGs; one of which is science. The relationship between science and SDGs is that many products are closely related to science (Rosana, 2018). Many natural science values, including Energy and Environment materials, can be implemented against the SDGs. Teacher's role in implementing sustainable development in learning activities is

namely teachers must have the ability to analyze science materials and learning objectives with the concept of SDGs to find solutions to issues that threaten sustainable earth. One of the missions of the SDGs is to create quality education, empower natural resources and sustainably care for the environment. Education is widely recognized as one of the most important tools for achieving sustainable development. This can encourage people to develop knowledge and awareness about sustainable development and change their behavior, so that they act in ways that address the sustainability challenges facing humans (Okubo et al., 2021). The actions include creating quality education, empowering natural resources and caring for the environment sustainably. Education is widely recognized as one of the most important tools for achieving sustainable development. This can encourage people to develop knowledge and awareness about sustainable development and change their behavior, so that they act in ways that address the sustainability challenges facing humans (Okubo et al., 2021)—creating quality education, empowering natural resources and caring for the environment in a sustainable manner. Education is widely recognized as one of the most important tools for achieving sustainable development. This can encourage people to develop knowledge and awareness about sustainable development and change their behavior, so that they act in ways that address the sustainability challenges facing humans (Okubo et al., 2021).

The era of the industrial revolution 4.0 is where almost everything is controlled by technology, including the world of education. The influence of the 4.0 revolution era in the world of education is that more and more technology-based learning media make it easier for educators to convey material without face-to-face contact (Ichsan et al., 2018). This technology-based learning medium facilitates the learning process in terms of effectiveness and efficiency. Audio, visual, and audio-visual media are technology-based learning media used to support the learning process (Firmadani, 2020). According to Hamalik in Arsyad (2011), learning media can foster a desire and interest in learning and increase student insight into the teaching and learning process. Flipbook is a learning media that can be used for science in class (Harahap & Siregar, 2018).

Much research related to e-modules has been carried out, especially in the science field (Darmaji et al., 2019; Wijaya, 2021). There has also been a lot of research on SDGs in technology (Rashid, 2019). However, SDGs e-module research is still not visible. So based on the description above, researchers developed alternative learning media in the form of flipbook-based e-modules. To simplify operation, the features developed are integrated into the SDGs and adapted to the needs of students and teachers. The research will focus on energy materials for class VII in junior high school.

METHOD

This study uses the Research and Development (R&D) method. Developing products and media according to student's needs is the goal of the R&D method. The model used is ADDIE (Analysis, Design, Development, Implementation and Evaluation) (Muruganantham, 2015). The ADDIE model development model chart can be seen in Figure 1.

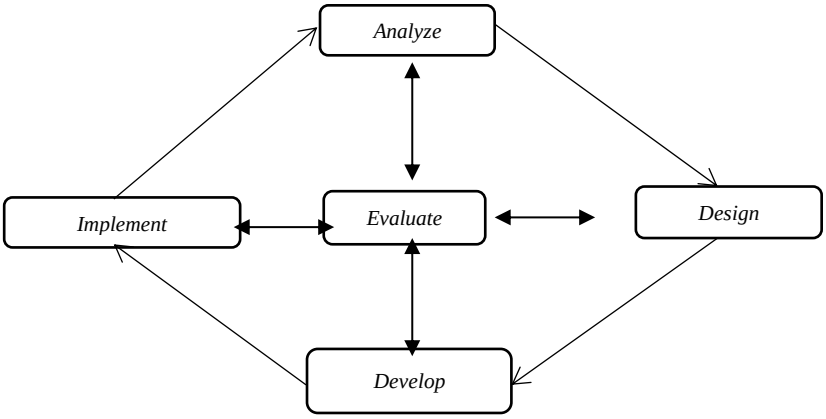

Figure 1 ADDIE development model chart

The Analyze stage is to determine and identify the learning needs of students. Meanwhile, the Design stage aims to design or classify the designed learning programs.

In the Development stage, there were two activities: modifying teaching materials or learning materials and testing validation. Then, in the Implementation stage, small-scale trials were conducted for teachers and students to fill out a response questionnaire. Then, the Evaluation stage aims to assess the quality of the developed products and determine the increase in students' environmental literacy while using an e-module of physics science integrated with SDGs during the teaching and learning processes.

The subjects of this research were students of class VII in one of the junior high schools in Malang Regency. In this study, the research method analyzed student needs, validating e-modules, student response questionnaires and student worksheets. The e-Module was validated by three validators: a media expert, a material expert and a junior high school science teacher.

RESULT AND DISCUSSION

This research resulted in a product in the form of an electronic module. This e-module was developed using the Canva application and then created in the form of a flipbook via the Flip PDF HTLM5 application. In the learning media developed as a Flipbook-based Science E-Module integrated with the SDGs, there are materials on types of energy, energy concepts, energy sources and changes in energy forms. A description of the material can be seen in Figure 2.

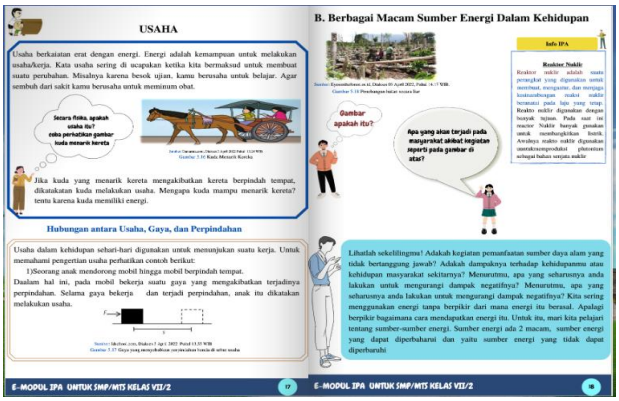

Figure 2 Description of the materials

The researchers obtained students' responses to the Physics Science e-module from the questionnaire after the students used the e-module and filled out the questionnaire. The data was then analyzed using descriptive analysis. The results of the analysis were based on student responses to the developed modules. The results of the trial assessment of the flipbook-based e-module have a percentage of 82% in the "Very Good" category and due to 3.31. This shows that the response of students to the development of the alternative learning medium on energy materials has been very good, so it can be concluded that aspects of material presentation, students' worksheets, evaluation, instructional quality as well as aspects of appearance and quality of e-modules are interesting in Flipbook-based e-module as a support for learning process activities that can be accessed anywhere and anytime because they are presented online.

In the teacher's response questionnaire, the researchers gave one of the teachers at Singosari 6 Public Junior High School the required module quality assessment through a response questionnaire. The teacher's response to the Science e-module achieved an average score of 3.92 with an ideal percentage of 98% with the very good category (VG) used as an alternative learning medium. Thus, the Flipbook-based Science e-Module integrated with SDGs is very feasible to be used as an alternative learning media.

When students learn about renewable natural resources and observe the SDGs video on hydroelectric power, their environmental literacy significantly improves, particularly in environmental planning indicators. Combining SDGs videos with an environmental approach to learning is essential for enhancing students' environmental literacy. Thus, students will have a greater awareness and understanding of the significance of protecting and conserving the environment.

Environmental literacy has three indicators that can be used to measure students' enhancement in environmental literacy; environmental care indicators, environmental sustainability, and actions towards the environment. The average value of the three environmental literacy indicators is different. The following is the average environmental literacy score of Singosari 6 Public Junior High School students for each indicator presented in the bar graph in Figure 3.

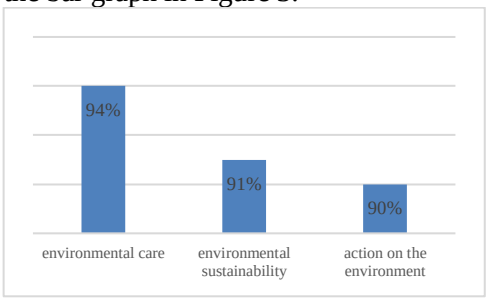

Figure 3 Enhancement of students' environmental literacy

Issues arriving from unwanted human activities, such as air pollution, can cause adverse effects on the environment, especially for health. The attitude of caring for the environment supports the SDGs system about caring for the environment; therefore, students are expected to create a simple strategy or media that can prevent human activities that can damage the environment. A study conducted in Malaysia investigated the potential and challenges of implementing solar paver technology. This study is based on the perceptions of officials in the Malaysian industrial sector. A solar paver is a photoelectric cell panel that utilizes sunlight to produce renewable energy and is installed as a concrete paver for road infrastructure. Using sonar pavers is part of a strategy to preserve the environment. The Sustainable Education Agenda (SDGs) published by the United Nations has 17 sustainable goals (SDGs), one of which is energy and the environment,

specifically regarding affordable energy to ensure access to affordable, sustainable and clean energy achieved through the development of solar power technology. Solar power provides socio-economic and practical solutions for environmental sustainability, especially in developing countries (McGain et al., 2020; Teh et al., 2021).

There was a significant increase in the indicator of environmental care. This was because all students knew how to care for the environment. Before the SDGs incorporated Flipbook-based Science e-module was presented to students, there was not a significant increase. The students were also instructed to care more about the environment by decreasing their use of environmentally unfriendly materials. Consistent with (Muret) implementing preventative measures including avoidance, reduction, and recycling. The impact of these activities on achieving a clean environment can also bring us and others comfort (Tarpani et al., 2020).

In contrast, in the indicator of being aware of environmental sustainability prior to implementing the Science Physics e-module, literacy skills were quite good, as it had been implemented at school so students were required to be sensitive to the surrounding environment. It is evidenced by many school regulations requiring students to maintain cleanliness. Studies that present a deeper understanding of how to take advantage of an environmentally responsible attitude. Numerous human activities threaten environmental sustainability. There are also environmental challenges that must be addressed in order to save the earth and those who live there. The responsibility begins with the design phase, where human comfort and health are incorporated. Environmental sustainability is a major concern in modern society. The government and educators or teachers continue to encourage to find ways to impact the environment through their activities negatively. Reducing energy consumption, recycling, and reducing waste are ways to attain environmental sustainability (Ajibike et al., 2021).

In the school environment, students and teachers participate in this program, meaning that environmental education for sustainability allows students to evaluate, understand and examine the relationship between personal lifestyles. Schools also equip their students with understanding, critical thinking and behavior towards the environment and natural resources, which are part of the shared wealth and world heritage (Gottlieb et al., 2012).

In contrast, students' environmental literacy skills are severely deficient in relation to indicators of action planning for the environment. This is caused by the fact that students are not provided with special lessons or information about how to work in a polluted environment, the effects of refuse, or how to dispose of it. After presenting the e-module and displaying videos that support the increase in students' environmental literacy in indicators for environmental planning, there has been a significant increase. Therefore, it is necessary to implement environmental learning strategies to improve students' environmental literacy to understand the significance of protecting and preserving the environment. Increasing environmental consciousness may diminish the pleasure associated with the consumption of products for which eco-friendly substitutes are available. This implies that when deciding to purchase and utilize an item, consideration must be given to whether its characteristics are consistent with the level of environmental care and environmental sustainability. Everyone is educated on how to use environmentally favorable products, and environmental concerns are raised (Reznichenkoa et al., 2021)

Adding environmental education in the classroom can promote environmentally responsible student behaviour and build a solid societal foundation. However, conventional teaching alone is insufficient to promote environmental behavior in the present or the future. Consequently, additional variables, such as the school environment, are required to foster this behavior (Kamil, et al, 2020) and family (Spiteri, 2023).

CONCLUSION

E-module of Physics Science based on Flipbook integrated with SDGs to enhance students' environmental literacy on the topic of energy, developed with development procedures including 1) analysis of the needs of the science e-module; 2) analysis of student needs; 3) analysis of KI and KD as well as indicators and formulation of learning objectives; 4) collection of materials from science books and the internet; 5) creating e-module designs; 6) validating e-modules by experts; 7) conducting revisions; 8) conducting field trials; and 9) finalizing the e-module. The e-module of Physics Science based on Flipbook integrated with SDGs on energy is feasible. Based on the assessment results by media and material experts, the quality of the e-module is very good (VG). Media experts say the ideal percentage for e-module quality is 85.00%, while material experts recommend 87.60%. The students' responses to the e-module of Physics Science based on Flipbook integrated with SDGs in the pilot trial received a Very Good response (VG) with an ideal percentage of 82.00%. Meanwhile, the teacher's response to the physics science e-module integrated with SDGs is Very Good (VG) with an ideal percentage of 90%. The e-module of Physics Science based on Flipbook integrated with SDGs on effective energy in improving students' environmental literacy skills showed an increase in overall test results. The magnitude of the increase in the environmental literacy skills of students using the e-module of Physics Science based on Flipbook integrated with SDGs on the subject of energy in terms of N-gain calculations. The average score for increasing environmental literacy skills of the 20 students tested was 0.

REFERENCES

Ajibike, W. A., Adeleke, A. Q., Mohamad, F., Bamgbade, J. A., Nawi, M. N. M., & Moshood, T. D. (2021). An evaluation of environmental sustainability performance via attitudes, social responsibility, and culture: A mediated analysis. *Environmental Challenges*, 4(March), 100161. https://doi.org/10.1016/j.envc.2021.100161

Darmaji, D., Astalini, A., Kurniawan, D., Parasdila, H., Irdianti, I., Susbiyanto, S., ... & Ikhlas, M. (2019). E-module based problem solving in basic physics practicum for science process skills. *International Journal of Online and Biomedical Engineering*, *15*(15), 5.

Didham, R. J., & Ofei-Manu, P. (2020). Adaptive capacity as an educational goal to advance policy for integrating drr into quality education for sustainable development. *International Journal of Disaster Risk Reduction*, 47(March), 101631. https://doi.org/10.1016/j.ijdrr.2020.101631

Firmadani, F. (2020). Media pembelajaran berbasis teknologi sebagai inovasi pembelajaran era revolusi industri 4.0. *Prosiding Konferensi Pendidikan Nasional*, 2(1), 93–97. http://ejurnal.mercubuana-yogya.ac.id/index.php/Prosiding_KoPeN/article/view/1084/660

Gottlieb, D., Vigoda-Gadot, E., Haim, A., & Kissinger, M. (2012). The Ecological footprint as an educational

tool for sustainability: a case study analysis in an israeli public high school. *International Journal of Educational Development*, 32(1), 193–200. https://doi.org/10.1016/j.ijedudev.2011.03.007

Harahap, M., & Siregar, L. M. (2018). Mengembangkan sumber dan media pembelajaran. *Educational*, January 2–3. https://doi.org/10.13140/RG.2.2.19282.86721

Ichsan, I. Z., Dewi, A. K., Hermawati, F. M., & Iriani, E. (2018). Pembelajaran IPA dan lingkungan: Analisis kebutuhan media pembelajaran pada sd, smp, sma di tambun selatan, bekasi. *JIPVA (Jurnal Pendidikan IPA Veteran)*, 2(2), 131. https://doi.org/10.31331/jipva.v2i2.682

Kamil, P. A., Putri, E., Ridha, S., Utaya, S., & Utomo, D. H. (2020). Promoting environmental literacy through a green project: A case study at adiwiyata school in Banda Aceh City. *IOP Conference Series: Earth and Environmental Science*, 485(1), 012035. IOP Publishing.

Limani, Y., Hajrizi, E., Stapleton, L., & Retkoceri, M. (2019). Digital transformation readiness in higher education institutions (HEI): The case of kosovo. *IFAC-PapersOnLine*, 52(25), 52–57. https://doi.org/10.1016/j.ifacol.2019.12.445

Maslin, N. M. (2021). Impact of modern technology. *HF Communications*, 3, 165–182. https://doi.org/10.1201/b12574-14

McGain, F., Muret, J., Lawson, C., & Sherman, J. D. (2020). Environmental sustainability in anaesthesia and critical care. *British Journal of Anaesthesia*, 125(5), 680–692. https://doi.org/10.1016/j.bja.2020.06.055

Metekohy, B., Sahertian, N. L., & Ming, D. (2021). Contribution of Token Type Cooperative Learning Models for in the Haruru Christian Middle School. *Psychology and Education*, *58*(2), 982-994.

Muruganantham, G. (2015). Developing of e-content pcakge by using ADDIE Model. *International Journal of Applied Research*, 1(3), 52–54. www.allresearchjournal.com

Nofiana, M. (2017). Profil kemampuan literasi sains siswa smp di kota purwokerto ditinjau dari aspek konten, proses, dan konteks sains. *JSSH (Jurnal Sains Sosial dan Humaniora)*, *1*(2), 77-84.

Okubo, K., Yu, J., Osanai, S., & Serrona, K. R. B. (2021). Present issues and efforts to integrate sustainable development goals in a local senior high school in japan: A case study. *Journal of Urban Management*, 10(1), 57–68. https://doi.org/10.1016/j.jum.2021.02.002

Poultsakis, S., Papadakis, S., Kalogiannakis, M., & Psycharis, S. (2021). The management of digital learning objects of natural sciences and digital experiment simulation tools by teachers. *Advances in Mobile Learning Educational Research*, 1(2), 58–71. https://doi.org/10.25082/amler.2021.02.002

Rashid, L. (2019). Entrepreneurship education and sustainable development goals: A literature review and a closer look at fragile states and technology-enabled approaches. *Sustainability*, 11(19), 5343.

Ratna, F. (2018). Integrasi PBL-STEM pada mata kuliah kimia lingkungan untuk meningkatkan literasi lingkungan dan kreativitas mahasiswa calon guru kimia [Universitas

Pendidikan Indonesia]. http://repository.upi.edu/34409/

Reznichenkoa, S. I., Nartova-Bochavera, S. K., & Irkhina, B. D. (2021). Do Authentic People Care about the Environment? A View from Two Paradigms. *Psychology in Russia: State of the Art*, 14(3), 81–102. https://doi.org/10.11621/pir.2021.0306

Rosana, M. (2018). Kebijakan pembangunan berkelanjutan yang berwawasan lingkungan di Indonesia. *Kelola: Jurnal Sosial Politik*, 1(1), 148-163.

Setyaningrum, T. W., & Gunansyah, G. (2020). Praktik Pembelajaran Ekoliterasi Berorientasi Pendidikan untuk Pembangunan Berkelanjutan di Sekolah Dasar Negeri Kota Surabaya Bagian Barat. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, *8*(2), 375–384.

Setyaningsih, A., Manoppo, Y., Solissa, E. M., Solong, N. P., & Hendrajaya, H. (2023). The strategy of principle leadership in elevating teaching learning process in school. *Journal on Education*, *5*(3), 7036-7042.

Spiteri, J. (2023). Intergenerational learning: Environmental literacy in the family and beyond. In Educating for Sustainability in a Small Island Nation: Voices from Early Childhood Education (pp. 191-207). Cham: Springer International Publishing.

Tarpani, R. R. Z., Alfonsín, C., Hospido, A., & Azapagic, A. (2020). Life cycle environmental impacts of sewage sludge treatment methods for resource recovery considering ecotoxicity of heavy metals and pharmaceutical and personal care products. *Journal of Environmental Management*, 260(January), 109643. https://doi.org/10.1016/j.jenvman.2019.109643

Teh, P. L., Adebanjo, D., & Kong, D. L. Y. (2021). Key enablers and barriers of solar paver technologies for the advancement of environmental sustainability. *Heliyon*, 7(10), e08189. https://doi.org/10.1016/j.heliyon.2021.e08189.

Wijaya, B. R., Setyawan, A., & Citrawati, T. (2021). Validity of practicum module based on guided inquiry to facilitate students'science process skills. CITRA: International Journal of Community service, Informatics, Technology, Research in education, Art and humanities, 1(1), 89-99.