ABSTRACT
This study underscores the significance of E-books centered on Education for Sustainable Development (ESD) for junior high school students, highlighting the value of interactive and multidirectional learning resources to foster sustainability awareness. The research objectives are to (1) find out the necessity of ESD-based E-books for enhancing sustainability awareness among students, 2) to prove the advantages and disadvantages of ESD-based learning compared to traditional learning, and (3) compare ESD-based learning with traditional methods. Using interviews, and literature study, the study finds traditional printed science textbooks insufficient in engaging students, often reducing their enthusiasm for learning. Interviews reveal that conventional textbooks are the primary learning medium, but students find them uninspiring. E-books, however, show promise in boosting student engagement through features like accessibility, searchability, and interactivity. Challenges exist in integrating ESD into the curriculum, primarily due to educators' limited understanding of sustainability concepts. Nonetheless, ESD-based E-books are seen as effective tools for developing a sustainable culture and enhancing students' awareness of sustainability issues. The literature study indicates a clear need for ESD-based E-books for students, emphasizing their role in preparing the next generation for sustainable development. The study recommends rigorous testing and comparative analysis of STEM-ESD E-books versus traditional resources to evaluate their effectiveness in raising sustainability awareness among junior high school students. The ultimate aim is to promote self-directed learning and greater awareness of sustainability.
aligns with the United Nations' Sustainable Development Goal (SDG) 4, which aims to ensure inclusive and quality education for all, fostering a deeper understanding of scientific principles crucial for sustainable development across diverse communities. Moreover, a well-grounded grasp of science contributes to various other SDGs, including SDG 3 (Good Health and Well-being), SDG 6 (Clean Water andSanitation), and SDG 7 (Affordable andCleanEnergy), among others, underscoring its pervasive role in addressing global challenges and promoting sustainable practices.

The Sustainable Development Goals (SDGs), also known as sustainable development, are part of the United Nations (UN) agenda. Their primary aims involve socio-economic development within the environment and addressing global challenges such as climate change and biodiversity loss (Sebestyén et al., 2020; Coscieme et al., 2020). Referring to Sustainable Development Goal (SDG) number 4, which emphasizes quality education, it can be explained that this target aims to ensure inclusive, equitable, and lifelong learning opportunities for all members of society. The overarching goal of quality education, as outlined by Rieckmann (2017), aligns with the concept of Education for Sustainable Development (ESD) proposed by the UN in 2005 as a comprehensive paradigm for global societal living. ESD aims to lay the foundation for sustainable development, with its fundamental concept emphasizing meeting human needs without compromising the ability of future generations (Biase et al., 2021). ESD can be understood as education that empowers individuals to understand and address issues that may threaten life on Earth (Cars & West, 2014; Zowada & Belova, 2021; Zidny et al., 2021). Individuals experiencing positive and negative feelings related to the environment may be prompted to demonstrate affection for it by safeguarding and conserving it. Currently, human interaction with the environment has led to substantial environmental damage such as heightened waste production, air pollution, deforestation, and subsequent issues like flooding (Septian et al., 2016; Mufidah et al., 2023). One strategy to enhance environmental quality involves incorporating sustainability awareness into the learning process.

Sustainability awareness is a continuous form of consciousness related to the environment, involving attitudes of care and appreciation towards it. Attitudes, as expressions of behavior and tendencies towards specific actions, can be cultivated through personal experiences that play a pivotal role in shaping an individual's perspective of particular subjects (Albarracin & Shavitt, 2018; Abun et al., 2023). Sustainability awareness represents an individual's actions that demonstrate how to appreciate environmental issues and other aspects of life (Isaias et al., 2020; Fang et al., 2022). Establishing this awareness early on is considered crucial to support sustainable development, reflecting an innovative approach in environmental education.

As per the 2017 Environmental Quality Index (Indeks Kualitas Lingkungan Hidup/IKLH) and the Indonesian Environmental Status (Status Lingkungan Hidup Indonesia/SLHI) report released by the Indonesian Ministry of Environment, approximately 30% of Indonesia's water has been reported as contaminated. Similarly, the deterioration of air quality has been attributed to the reduction in green spaces, increased air pollution, and the accumulation of more waste. These findings indicate a notably low level of environmentally friendly practices in Indonesia (Sugiarto & Gabriella, 2020).

Sustainability awareness is a crucial prerequisite for transforming mindsets and behaviors to preserve the environment (Alsaati et al., 2020). The lack of environmental awareness among students, stemming from their limited understanding of their surroundings, poses a challenge for educators to enhance students' sustainability consciousness. Vosniadou (2019) and Pristianti & Prahani (2023) emphasizes the necessity of scientific reasoning among students to link concepts with everyday phenomena. One of the contributing factors to students' low sustainability awareness is the absence of teaching materials that can shape their understanding. Many available teaching materials solely focus on content, lacking contextual relevance, appearing monotonous, and often lacking scientific knowledge to address problems.
within the materials (Nurhasnah & Sari, 2020). Moreover, the predominant use of conventional
print media in teaching materials leads to a lack of student engagement, creativity, and the
absence of materials fostering a favorable attitude towards the environment (Aswirna et al.,
2022). Ecocentric education can help elucidate the complex factors such as national and
institutional contexts, ideology, ethics (like ecocentric orientation), and pedagogical skills
(such as didactic qualities) that contribute to ensuring a sustainable future (Molina-Moltos,
2019; Kopnina, 2020). The contributors explore how various educational programs have
shaped students’ worldviews and highlighted moral issues concerning the environment and our
collective future. Unlike the predominant approaches of environmental education and
education for sustainable development (ESD), ecocentric education focuses on the teachings
of environmentalism and addresses the underlying power structures within society. A key
objective of ecocentric education is to foster a connection with nature, benefitting both future
learners and the planet (Pedersen, 2019; Spannring, 2019).

According to Ardan’s research (2016), teachers tend to rely more on printed books or
conventional teaching materials to interpret and understand the subject matter, resulting in
limited and narrowly focused content. Engaging teaching materials create enthusiasm among
learners in acquiring knowledge or information (Rahmani et al., 2021). The current weakness
in the learning process not only stems from insufficient teacher competence but also from the
lack of innovative learning resources/materials, hindering students’ comprehensive mastery of
the subject matter (Farhana et al., 2021). Educators’ ability to enhance student involvement
while curbing disruptive conduct is crucial for fostering a secure and productive learning
atmosphere (Febriansyah et al., 2021; Octavia et al., 2022). The inventiveness exhibited by
teachers significantly contributes to accomplishing educational objectives (Sihombing et al.,
2022; Simatupang et al., 2023). Employing suitable teaching tools is a viable strategy for
educators to elucidate complex scientific ideas (Fitriah & Irawan, 2021; Sihombing et al., 2023).
Utilizing technological resources in education, specifically through e-book, has been identified
as an effective teaching material aiding students’ comprehension of subjects (Haleem et al.,
2022). An example of this technological integration is the e-book, which represents a digital
transformation of traditional books, accessible via computer screens, laptops, e-readers, PDAs,
and even smartphones, offering students convenience in seeking information (Santoso et al.,
2018). E-books enable direct reading and enjoyment on screens, replacing paper as a medium.
They surpass printed books with features such as search options, page flipping, location
markers, bookmarks, and annotations (Possatti et al., 2018). Leveraging information and
communication technology (ICT) in educational innovation can be achieved by creating
innovative teaching materials that integrate Sustainable Development Goals (SDGs) (Aswirna
et al., 2022).

In response to these challenges, the government has implemented the Kurikulum
Merdeka planning in accordance with the Kurikulum Merdeka Process Standards based on
Regulation No. 16 of 2022 by the Minister of Education and Culture of the Republic of
Indonesia. This curriculum emphasizes a multidirectional learning pattern involving
interactions among teachers, students, the community, the environment, and various learning
resources or media. This shift aims to transform the learning paradigm from a passive approach
to one that is active, critical, and innovative (Retnaningrum et al., 2023; Hadi et al., 2023).
Considering these issues, a study of literature was conducted to explore suitable learning media
as a solution to enhance the sustainability awareness of junior high school students.

The novelty of this study lies in its holistic approach to integrating ESD principles into
an interactive and multidirectional STEM-ESD e-book, with a focus on addressing specific
environmental challenges in Indonesia. The comparative analysis with conventional learning
resources adds an evaluative dimension, contributing to the understanding of the potential
impact of innovative educational materials on sustainability awareness among junior high
school students. Furthermore, this literature study has the potential to yield insights into the
effectiveness of implementing Education for Sustainable Development (ESD)-based learning in elevating sustainability awareness among junior high school students, particularly in the realm of science education. Research questions from this study include:

1. How does the literature support the concept of the need for ESD-based E-books as the primary solution to enhance sustainable awareness among junior high school students?
2. What are the advantages and disadvantages of ESD-based learning compared to traditional learning, especially in the context of enhancing sustainable awareness among junior high school students?
3. What are the differences between ESD-based learning and traditional learning for junior high school students?

METHODS

The research methods employed in this study primarily comprised with two aims: (1) to find out the necessity of ESD-based E-books for enhancing sustainability awareness among students, (2) to prove the advantages and disadvantages of ESD-based learning compared to traditional learning, and (3) compare ESD-based learning with traditional methods. The objective was to improve students' sustainability awareness by investigating their needs and challenges. The research tools used included teacher interview tests, and observation sheets to assess the specific requirements of students in a Junior High School setting. The data collected from these sources were analyzed to identify prevalent issues, their root causes, and potential solutions based on the insights derived from the literature study.

The study, focused on learning using E-book based on ESD and its impact on students sustainability awareness, conducted a literature study using secondary data from journals from national and international scale (Popenoe et al., 2021; Kraus et al., 2022; Libório et al., 2023; Pristianti & Prahani., 2023) sourced from Google Scholar and Scopus. Justified by Scopus' comprehensive multidisciplinary coverage (Bordignon, 2019; Martin-Martin et al., 2021), data collection spanned from 2019 to 2023. Employing a qualitative methodology, specifically descriptive qualitative analysis (Busetto et al., 2020; Rosairo, 2023), the study adapted Miles et al., (2014) stages of data analysis, outlined in Figure 1. The analysis aimed to identify prevalent issues, their root causes, and potential solutions, presenting results based on insights derived from the literature study. The findings reflect the majority opinions of participants involved in the research.

The analysis of qualitative data encompasses four key phases, namely:

1. **Data Collection:** The initial phase in qualitative data analysis involves gathering the necessary information from diverse sources, including both journal studies and trials. This step is crucial for achieving the research goals.

2. **Data Reduction:** In this phase, researchers summarize and select key elements from the collected data. The objective is to simplify the dataset, focusing on crucial elements and making it more accessible for subsequent analysis.

Figure 1. Qualitative Data Analysis Chart

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3. Data Presentation: The most frequently employed form of presenting qualitative data involves using narrative text. This can take the form of succinct descriptions, charts, and the exploration of relationships between individuals. This phase aims to convey a clear picture of the findings.

4. Verification and Conclusion: The final phase centers on verifying and drawing conclusions from the data. It specifically addresses novel discoveries that contribute new insights to the existing body of knowledge, marking the culmination of the qualitative analysis process.

RESULTS AND DISCUSSION

The first results are based on the observations in several Junior High School, according to researchers' observations at a Junior High School, the current teaching method still utilizes a direct instruction system, focusing predominantly on teacher-centered learning. In contrast, the Implementation of the Kurikulum Merdeka, guided by Regulation No. 16 of 2022 from the Minister of Education and Culture of Indonesia, emphasizes a multidirectional learning pattern involving interactions among teachers, students, the community, the environment, and various learning resources. Despite the importance of this multidirectional approach in fostering sustainability awareness, some Junior High Schools have yet to effectively implement it. The lack of this approach might impede the holistic development of students' sustainability awareness, which thrives on interactions among teachers, students, the community, the environment, and diverse learning resources.

ESD is an approach that engages holistic and interdisciplinary characteristics, critical thinking, participation in decision-making, application, local relevance, pedagogical pluralism, and nurturing values that support sustainable development. The primary goal of ESD is social empowerment and building personal capacities with forward-thinking orientations and actions (Firth & Smith, 2018). The significance of education on sustainable development aims to safeguard the Earth from pollution and destruction while responding to recurring natural disasters as part of the global commitment towards sustainable development (Mardiyevna & Ugli, 2023; Javanmardi & Xie, 2023).

Based on interviews to some of students, findings reveal that the predominant learning media utilized are conventional science textbooks. Students expressed that the use of printed book media tends to dull their enthusiasm for learning, indicating a necessity for more interactive learning resources. This requirement becomes more pertinent amid the Covid-19 pandemic restrictions, limiting face-to-face learning interactions, hence emphasizing the demand for suitable mediums to facilitate the implementation of the ESD approach, benefiting both teachers and students. To facilitate an effective learning environment, educators are tasked with establishing favorable conditions that cultivate enthusiasm among learners, as highlighted by Aswirna (2018); Aswirna et al., (2022). This involves the use of teaching materials that not only capture the interest of students but also promote independent learning. The objective is to shift the focus from a traditional teacher-centered approach to a more student-centered one, as advocated by Nurhasnah et al., (2020). By employing engaging and stimulating instructional materials, educators can encourage a shift in the learning process, placing learners at the center and fostering a more interactive and participatory educational experience (Sihombing et al., 2023). An effective solution found within this context is the implementation of E-books. E-books are designed as educational tools with comprehensive materials and evaluation components, enabling independent study (Kusumayuni, 2021). The evolution of the digital era
has significantly empowered technology's role in education, enhancing the learning process's appeal for students. Sun & Pan (2021) regard E-books as interactive electronic teaching materials distinct from printed materials. They have become increasingly popular learning resources, particularly among students, facilitated by the widespread adoption of mobile reader devices in the early 21st century (Sihombing & Hasruddin, 2023).

Several advantages of E-books, such as easy accessibility, eliminating the need to visit libraries, simplified topic searches, availability anytime and anywhere, enhanced display, cost-effectiveness, and space efficiency (Santoso et al., 2018). Almunawaroh (2020) added to these benefits by emphasizing that E-books serve as effective tools to captivate students' interest, assist in motivating them to complete assignments, and offer engaging features that enhance literacy skills and leisure reading experiences. E-books excel over printed books due to features like search capabilities, page flipping, bookmarking, and annotations (Possatti et al., 2018). Innovative learning through Information and Communication Technology (ICT) can be achieved by creating innovative teaching materials integrated with SDGs (Aswirna et al., 2022; Kiswanda et al., 2022). The implementation of Education for Sustainable Development (ESD) aligns with its characteristics, encompassing pedagogical innovation, interactive teaching, student-centered approaches, and supporting experiential learning. ESD aims to enhance students' knowledge, skills, values, and attitudes to foster individuals with sustainable and fair cultures. In this context, innovative teaching materials based on E-book and ESD can serve as a solution. These instructional materials can facilitate active interaction with the content, enhance comprehension, and engage students in problem-solving and the development of scientific skills.

By integrating aspects of ESD focusing on the environment into the school learning process, it is anticipated that the learning will acquire deeper significance and encourage students to become more aware of sustainable values (sustainability awareness). Previous research by Michael et al., (2020) and Kaur & Kaur (2022) affirms that students engaged in ESD-based learning experience an increase in sustainability awareness, encompassing sustainability practice awareness, behavioral and attitude awareness, as well as emotional awareness. These findings are supported by other studies (Kemper, 2021; Rahmayanti et al., 2021), stating that the effective utilization of ESD-based learning tools helps students comprehend subject matter and enhances their awareness of the importance of environmental conservation.

Incorporating ESD programs into the curriculum with the aim of application within the learning process is undeniably a challenging and demanding task. Presently, many educators in schools still possess inadequate understanding of the concept of "sustainability" (Wilhelm et al., 2019). Most educators tend to focus more on local and national environmental issues but pay less attention to ongoing global problems such as climate change, waste management, depletion of energy resources, and other related issues. Table 1 presents a comparison between the ESD approach and the conventional approach in the context of the learning process, referring to the studies conducted by Otieno (2007), UNESCO (2008), and Lipin et al. (2021).
Table 1. Differences Between ESD and Conventional Approaches/Traditional Education

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Education For Sustainable Development</th>
<th>Conventional Approaches/Traditional Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essence</td>
<td>Social wellbeing</td>
<td>Market service</td>
</tr>
<tr>
<td>Function</td>
<td>Education as life</td>
<td>Education as training for economic activity</td>
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<tr>
<td>Aim</td>
<td>Enhancement of the complete human</td>
<td>Creation of an expert in a specific field or</td>
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<tr>
<td></td>
<td>subjective experience</td>
<td>discipline</td>
</tr>
<tr>
<td>Method of</td>
<td>Adjustment of individuals to the</td>
<td>Adjustment of humans to meet the present</td>
</tr>
<tr>
<td>Implementation</td>
<td>conditions and demands of the world.</td>
<td>demands and needs of their surroundings.</td>
</tr>
<tr>
<td>Thinking</td>
<td>Rational thinking</td>
<td>Instrumental thinking</td>
</tr>
<tr>
<td>Goal-setting</td>
<td>Creating strategic goals</td>
<td>Choice of effective means</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Culture of “ignorance”</td>
<td>Ready to use “useful” knowledge/information</td>
</tr>
<tr>
<td>Time</td>
<td>Involvement in the past, present and</td>
<td>Involvement in the “tyranny of the moment”</td>
</tr>
<tr>
<td></td>
<td>future</td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>Heterotopia</td>
<td>Dystopia</td>
</tr>
<tr>
<td>Creativity</td>
<td>Imagination</td>
<td>Arbitrary fantasy</td>
</tr>
<tr>
<td>Worldview</td>
<td>Viewing the world from the perspective of the human race</td>
<td>Observing the world from an individual's perspective based on their personal interests.</td>
</tr>
<tr>
<td>Sustainability</td>
<td>Fundamental education centered on</td>
<td>Practical and theoretical education aimed</td>
</tr>
<tr>
<td></td>
<td>providing knowledge, skills, values,</td>
<td>at fundamental survival skills and their</td>
</tr>
<tr>
<td></td>
<td>and viewpoints aimed at enabling</td>
<td>integration with diverse facets of progress</td>
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<td></td>
<td>individuals to lead sustainable</td>
<td>and growth.</td>
</tr>
<tr>
<td></td>
<td>lifestyles.</td>
<td></td>
</tr>
<tr>
<td>Values</td>
<td>Incorporates lifelong learning of</td>
<td>Learning based on values, highlighting</td>
</tr>
<tr>
<td></td>
<td>principles, skills, perspectives, and</td>
<td>sustainability principles across all aspects</td>
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<tr>
<td></td>
<td>values concerning sustainability</td>
<td>of life, facilitated by community elders to</td>
</tr>
<tr>
<td></td>
<td>across social, environmental, and</td>
<td>foster harmonious living.</td>
</tr>
<tr>
<td></td>
<td>economic domains.</td>
<td></td>
</tr>
<tr>
<td>Information</td>
<td>Well-informed populace and</td>
<td>Dissemination of relevant information to</td>
</tr>
<tr>
<td></td>
<td>communities with extensive knowledge</td>
<td>communities through village council</td>
</tr>
<tr>
<td>Skills</td>
<td>Educating every sector of the</td>
<td>gatherings, musical expressions, dancing,</td>
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<td></td>
<td>workforce to equip them with the</td>
<td>and interactive role-playing.</td>
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<tr>
<td></td>
<td>essential knowledge and skills required</td>
<td>Apprenticehips programs designed to</td>
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<tr>
<td></td>
<td>to conduct their tasks in a manner</td>
<td>improve expertise and abilities in various</td>
</tr>
<tr>
<td></td>
<td>that promotes sustainability.</td>
<td>vocations like masonry, carpentry, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>traditional medicine.</td>
</tr>
<tr>
<td>Cultural</td>
<td>Addressing various social, economic,</td>
<td>Deeply embedded in the tested and</td>
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<td></td>
<td>and environmental circumstances in</td>
<td>longstanding indigenous knowledge systems,</td>
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<td></td>
<td>ways that are relevant and culturally</td>
<td>yet adaptable and responsive to</td>
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<td></td>
<td>suitable, considering indigenous</td>
<td>accommodate emerging challenges and</td>
</tr>
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<td></td>
<td>cultures and their knowledge systems.</td>
<td>developments.</td>
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</table>

The traditional education system was holistic, offering both practical and theoretical training. In this context, education and culture were closely connected, focusing on creating, transmitting, and preserving the knowledge, skills, and values of various societies. Cultural practices heavily influenced child-rearing, resulting in different views on quality childcare across cultures (Otieno, 2007; Sharma, 2020; Ogbo & Ndubisi, 2021). This education system prioritized practical skills and theoretical knowledge crucial for survival and harmonious development. Community elders played a significant role in value-based learning, teaching principles of sustainability to foster harmonious living. Learning was integrated into daily life through village meetings, songs, dances, and role-plays. Apprenticeships were also common, helping individuals acquire skills in trades like masonry, carpentry, and traditional medicine. Rooted in indigenous knowledge, this system was both time-tested and adaptable to new challenges.

In contrast, Education for Sustainable Development (ESD) focuses on providing knowledge, skills, values, and perspectives that encourage sustainable living. ESD integrates...
principles related to sustainability across social, environmental, and economic domains, promoting lifelong learning. It aims to develop informed citizens and communities capable of addressing diverse challenges in culturally relevant ways (Lipin et al., 2021; Perwitasari et al., 2023). ESD also emphasizes the need to train the workforce to perform their duties sustainably, respecting indigenous cultures and knowledge (Nousheen et al., 2020; Druker-Ibáñez & Cáceres-Jensen, 2022).

ESD’s features-being interdisciplinary, holistic, values-driven, problem-solving, multi-method, participatory, and locally relevant—mirror the principles of traditional education shaped by culture. This suggests that ESD is essentially a return to foundational educational practices, validating the effectiveness of traditional methods in addressing current sustainability challenges. This broad approach to education highlights the importance of combining cultural values and indigenous knowledge with modern educational methods to promote sustainable development and ensure the comprehensive growth of all society members.

Through an analysis of the needs of both students and teachers in the science field at a Junior High School, it becomes evident that a diverse array of reading materials is crucial to facilitate independent study and foster an increased awareness of sustainability. The development of an E-book emerges as a pivotal solution, offering an interactive and captivating reading resource for students, actively engaging them in the learning process. This interactive involvement encompasses various elements like video observations, reading texts linked to everyday occurrences, problem-solving worksheets, accessible online quizzes via smartphones, and the submission of assignments through online platforms. These engaging features collectively contribute to a more dynamic and immersive learning experience for students. Aswrina et al., (2022) corroborates the efficacy of the STEM SDGs science E-module, highlighting its positive influence on students’ scientific literacy and environmental attitudes, and based on Simatupang et al., (2022) research, that said that STEM teaching books and e-learning content were very suitable to be used in classes. This resource not only aids in advancing scientific literacy skills but also plays a crucial role in cultivating environmentally conscious attitudes among students, aligning with the goals of sustainable development.

CONCLUSION

Given the challenges outlined earlier, there is a necessity for students to have access to educational materials in the form of e-books that align with Education for Sustainable Development (ESD). These e-books should focus on illustrating the relationship between living organisms and their environment, connecting these concepts with real-life examples relevant to the students’ daily experiences. The content should be presented in an engaging, adaptable, and multidirectional format, aimed at fostering independent learning among students. This approach is anticipated to not only enhance students’ understanding but also contribute to the elevation of their sustainability awareness. The researcher recommends not only creating an e-book centered around Education for Sustainable Development (ESD) but also advocating for its integration with STEM, resulting in an innovative learning resource known as STEM-ESD e-book. It is essential for this e-book to undergo rigorous testing to assess its effectiveness in enhancing the educational process. Comparisons should be made between the outcomes of using this new e-book and the utilization of conventional learning resources or media currently employed in Junior High Schools. This evaluation aims to gauge the potential advantages and impact of integrating STEM and ESD in educational materials for students.

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