

Implementation of Google Sites in Developing Environmental Education Based on Socio-Scientific Issues and Islamic Integration to Enhance Environmental Literacy

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ABSTRACT

Environmental education is increasingly recognized as an essential thing from preschool to higher education. Environmental sustainability is vital for the survival of humans and all living organisms. The use of digital technology tools such as Google Sites can serve as an effective learning medium in environmental education. This study adopts the ADDIE development model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. This study aimed to develop a Google Sites-based medium for environmental education based on Socio-Scientific Issues and Islamic Integration. The study was conducted with first-semester students in the biology education program. The validity assessment of the Google Sites media for environmental education showed a highly valid category in both material and design aspects. The implementation of Google Sites media produced significant results in enhancing students' environmental literacy. Students rated the Google Sites media very good as an environmental education based on Socio-Scientific Issues and Islamic Integration. In particular, the 'Environmental Creation' feature received positive feedback. These findings suggest that environmental education using Google Sites can be further developed to enhance students' creativity and assessment literacy, for learning media at school and higher education levels and can be combined with the TPACK framework, project and problem based learning.

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INTRODUCTION

Environmental education has become essential in preschool through to higher education, as environmental aspects are critical for the sustainability of humans and other living organisms. Environmental issues that often receive attention include water management, flooding, waste management, air pollution, waste disposal, climate change, green school programs, and the Adiwiyata program. These concerns have made environmental programs a focus for educational institutions and practitioners to support a healthy and sustainable environment, while also aiming to develop students' environmental literacy. Samur & Akman (2023) emphasized that the role of teachers in educating future generations to become environmentally literate individuals is crucial for maintaining a sustainable environment. Therefore, every preservice teachers needs to have environmental literacy that can be put into practice in schools.

Social developments and issues in science education need to be part of an interesting and inspiring learning resource, to create a meaningful learning experience. Çam (2023) stated that science continuously interacts with the social environment. Science develops in line with social needs, and society evolves and changes with scientific progress. These changes and developments can create dilemmas in society. Therefore, preservice teachers need to teach about the importance of science, the relationship between science and social issues, and examples of phenomena related to these issues. El Arbid & Tairab (2020) explained Socio-Scientific Issues (SSI) are significant topics in the science curriculum related to teaching practices. Science teachers who have acquired knowledge about SSI have the opportunity to apply it in their teaching. Understanding SSI allows science teachers to recognize the connection between enhancing students' science literacy, promoting their argumentation skills, and improving their decision-making abilities. As such, further research on SSI in specific contexts is necessary

The future of SSI-based education should be explored using a project-based and interdisciplinary approach, with a focus on gender-specific engagement patterns. Further studies should examine the impact of SSI-based learning on students' attitudes, understanding, and behaviors, as changes in environmental impact can provide deeper insights into critical thinking, scientific literacy, and active citizenship. Students also need to be equipped with the skills and mindsets to effectively address global challenges by laying the foundation for leadership and environmental responsibility (Baltikian et al., 2025). Solving problems on socio-scientific topics will encourage students to use knowledge from science issues and socio-scientific knowledge in

science education as part of citizenship education (Lee et al., 2012). Therefore, SSI becomes the foundation in environmental education, making the development of Google Sites media essential, considering the need for efforts to improve environmental education.

Learning that develops environmental literacy in students is necessary, given the increasing environmental damage. The results of the study indicate that high school students' environmental literacy is in the moderate category, knowledge and cognitive skills are in the high category, while attitudes and behavior towards the environment are in the moderate category, knowledge has a significant relationship with cognitive skills (Hermawan et al., 2022). The research, using survey technique assessment, has not developed media to improve environmental literacy. This shows that environmental literacy is necessary for students to develop a balance between cognitive knowledge, attitudes and behavior in protecting the environment.

The use of digital technology tools can be a key consideration in the learning process, as well as a source of learning. Therefore, using Google Sites as a learning medium can be applied in environmental education. Ernest & Putra (2023) stated that 21st-century learning requires innovation by utilizing technology as a learning resource for students. Integrating technology into learning plays an important role in enhancing students' skills. One form of technology integration is the use of electronic modules based on Google Sites, which serve as a learning resource in science education. The use of Google Sites can support digital literacy, enabling students to gain broader insights through the internet, which can align with improved learning outcomes.

The practice of environmental education can either be a separate discipline, such as a specific course, or integrated into other subjects like biology or Islamic studies. Currently, environmental education often relies on traditional media such as books or learning modules, while the use of digital media in this context remains limited. Munawaroh et al. (2021) developed a bulletin media for teaching air pollution, while Rosadi (2025) created environmental education media using modules as local content teaching materials in elementary schools. These modules are applied to support the learning process and instill environmental conservation values among students.

Research on teaching practices that integrate Islam and science is important to conduct, as it can provide bottom-up information about the implementation of science and Islam integration in schools and madrasahs. Additionally, this information can inspire other teachers and researchers regarding the integration of science and Islamic learning. On the other hand, if science education is not introduced with the integration of science and Islam, students may develop separate

(independent) understandings of science and Islam (Jamaludin et al., 2022). It is expected that religion will serve as a source of inspiration, confirmation, and motivation to strengthen education based on the integration of science and religion, particularly in enhancing environmental education, thus fostering knowledge, skills, and attitudes that support environmental preservation.

Environmental education based on SSI, integrated with Islamic values, represents an innovative approach in this study. Environmental education is expected not only to serve as a source of knowledge but also as an opportunity to foster creativity and innovation in building a more sustainable and resilient environment. The environment remains a crucial area of development, as it is part of the Sustainable Development Goals (SDGs) agenda established by UNESCO (United Nations Educational, Scientific and Cultural Organization). Therefore, the development of Google Sites media in environmental education based on socio-scientific issues (SSI) and islamic integration in teaching practices.

RESEARCH METHODS

The development of Google Sites media for environmental education based on Socio-Scientific Issues (SSI) and Islamic integration employs a development research method using the ADDIE model, which includes Analysis, Design, Development, Implementation, and Evaluation (McGriff, 2000; Branch, 2009). Jamaludin (2025) emphasized the ADDIE model can encourage continuous improvement in teaching by collecting feedback and data on the effectiveness of training programs, leading to the development of quality educational content and more effective teaching strategies.

Media development on Google Sites for environmental education addresses socio-scientific issues, Islamic perspectives on environmental issues, and environmental literacy. The Google Sites media development phase involved analysis, design, and expert validation for improvement, implementation in learning, and evaluation. Media quality analysis uses a percentage validation technique with a rating scale of 1-5 (Table 1), using the following formula:

$$\text{Validity Value} = \frac{\text{item score obtained}}{\text{maximum score}} \times 100\%$$

Table 1. The rating scale and categories

Scale	Category
1	Very Poor
2	Poor
3	Sufficient
4	Good
5	Very Good

The validity criteria are determined based on the validity value obtained, in accordance with the conditions listed in Table 2, adapted from Yulianti et al., (2021)

Table 2. Validity of criteria

Percentage (%)	Validity of Criteria
$0 < x \leq 20$	Invalid
$20 < x \leq 40$	Less Valid
$40 < x \leq 60$	Quietly Valid
$60 < x \leq 80$	Valid
$80 < x \leq 100$	Highly Valid

The use of Google Sites media in Environmental Education (EE) was implemented with first-semester students of the Biology Education program at the Faculty of Tarbiyah, IAIN Kudus, with a sample of 26 students. These students were then asked to assess the trial use of Google Sites media in environmental education based on Socio-Scientific Issues (SSI) and Islamic integration, both in regular lectures and practical environmental education activities. The final stage involved evaluating the students' environmental literacy skills, which include a) knowledge, b) affect, c) cognitive skills, and d) behavior, adapted from Nastoulas et al. (2017). Environmental literacy assessment, including ecological knowledge and cognitive knowledge, was evaluated using essay assessments, while verbal commitment (affect) and actual commitment (behavior) were assessed using an attitude scale.

RESEARCH RESULT

The results of the Google Sites media research in the development of environmental education based on SSI and Islamic integration, using the ADDIE model research design, which consists of five stages, which are explained as follows.

Analysis

Several stages of analysis have been carried out as needs assessment in development research as follows.

- Material analysis includes a review of environmental education materials developed through textbook sources requiring materials that are related to social and scientific issues that are developing in real time and require a study of the integration of Islamic science with environmental education through digital learning. Several studies related to environmental education by developing bulletin and module media. Wihardjo & Rahmayanti, (2021) developed the environmental education books, Munawaroh et al., (2021) developed Socio-Scientific Issues

- (SSI) through bulletin media in air pollution learning. Rosadi, (2025) developed environmental education media by using modules as local content teaching materials in elementary schools.
- b. Analysis of preservice teachers at Islamic Religious Higher Education shows that environmental education materials should be easily accessible through digital learning and can enhance the creativity of preservice teachers and students, while also providing skills in integrating science and religion. Therefore, the development of Google Sites media can be applied to preservice teachers in undergraduate education programs.
 - c. Analysis of learning objectives shows that the development of Google Sites media in environmental education aims to cultivate a healthy and sustainable environment and raise awareness of environmental care. These objectives require learning media that can be used to select studies in the field of environmental education.

Design

Google Sites is an electronic media used in designing learning media, because it has several interesting features and can be connected directly to several web-based networks such as Google Forms or YouTube, making it easy to use in teaching. The design stage in Google Sites media plays a role in compiling the content framework and creating a prototype of learning media. The environmental education media developed using Google Sites covers main topics including Environmental Education, Environmental Creation, and Environmental Literacy Assessment, with the following subtopics: 1) Basic Principles of Environmental Education, 2) Waste Management, 3) Environmental Perspectives in Islam, 4) Environmentally-based Schools/Madrasahs, 5) Environmental Awareness Campaigns, 6) Environmental Creation, and 7) Environmental Literacy Assessment, with the site available at <https://sites.google.com/iainkudus.ac.id/plh>. The Google Sites media design is equipped with several interesting environmental themes, accompanied by studies of scientific, social and religious issues through actual case studies to be used as studies in discussions, project planning and development of environmental literacy skills including aspects of knowledge, attitudes and behavior.

The design of environmental education materials with a focus on science and social issues, such as the creation of biopores and infiltration wells (Figure 1). An example of a social issue developed in Google Sites includes the trend of paving or plastering yard areas in multi-story homes or schools, which many people now choose to do. The main reason is to make the yard

look neat and facilitates smoother traffic. Some students agree with it, considering the neatness of the yard in homes or schools, while others provide a more critical response, pointing out the limited infiltration area and the need for special infiltration spaces such as biopores or infiltration wells.



Figure 1. Environmental Creation through the Creation of Biopores and Infiltration Wells with a Study on Science and Social Issues Context.

The inspiration for environmental education is partly based on the advice from Allah's words in Quran Surah Ar-Rum 41, which states, 'Corruption has appeared throughout the land and sea by what the hands of people have earned. (Through this), Allah makes them taste some of the consequences of what they have done so that they may return (to the right path).' This verse can also serve as a trigger question regarding the role of humans in environmental management, while also providing solutions to environmental issues. Therefore, environmental education can be a stimulus to continuously safeguard and improve the environment to ensure its sustainability. This foundation makes environmental education not only based on science and social issues but also rooted in Islamic knowledge (Figure 2).

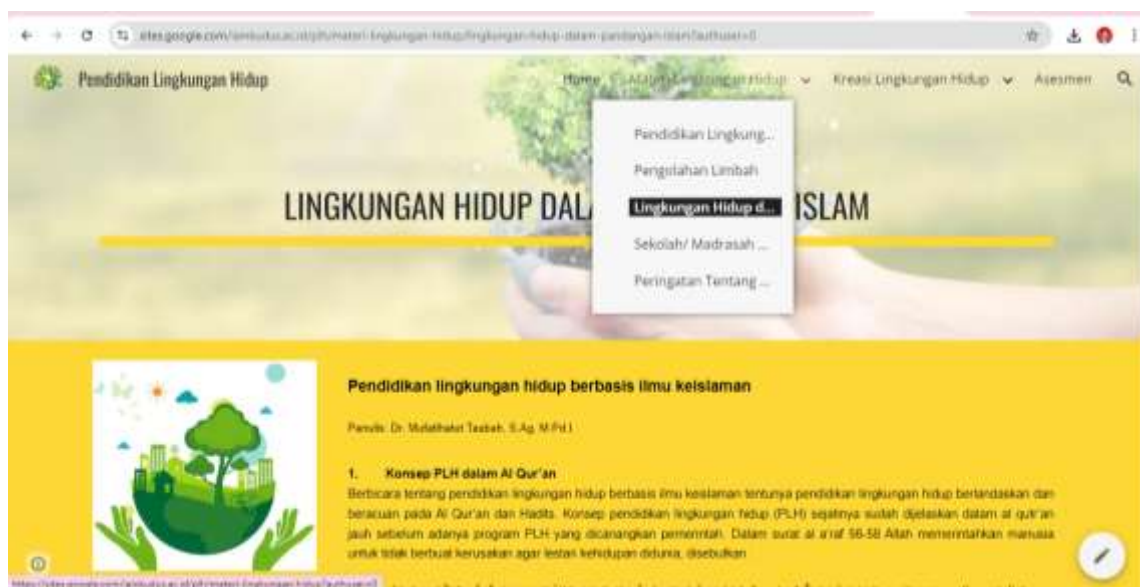


Figure 2. Environmental Content from an Islamic Perspective

Development

The development phase of the Google Sites media, based on Socio-Scientific Issues (SSI) and Islamic values, included validation conducted by four expert validators. The validity assessment was carried out using the criteria outlined in Table 1 and the interpretation guidelines in Table 2. The results indicated that the media achieved a highly valid rating in both material content and media design aspects. Therefore, the Google Sites media is considered suitable for further implementation in environmental education (Table 3).

Table 3. Validation results of the google sites for environmental education

Aspect	Validator Assessment				Average	Description
	I	II	III	IV		
Material Content	90%	73.33%	83.33%	93.33%	85%	Highly Valid
Media Design	96%	76%	80%	96%	87%	Highly Valid

Further development of the Google Sites media, based on suggestions from validators, includes adding an assessment of student projects on environmental issues based on Socio-Scientific Issues (SSI), such as YouTube-based presentations created by biology education students. Additional suggestions include increasing font size and making written narratives more concise. The environmental literacy assessment menu is shown in Figure 3. The environmental literacy assessment menu in the development of Google Sites is an innovation featured in the media.

The assessment includes project-based evaluation, environmental awareness attitudes, and environmental knowledge ranging from basic knowledge suitable for preschool, elementary school levels to case study knowledge appropriate for junior and senior high school (SMP/MTs and SMA/MA). This is intended to ensure that the outcomes of environmental education can be measured effectively. Environmental literacy assessment is not only knowledge-oriented but also encourages students to adopt sustainable lifestyles and practical environmental management skills in their surroundings.

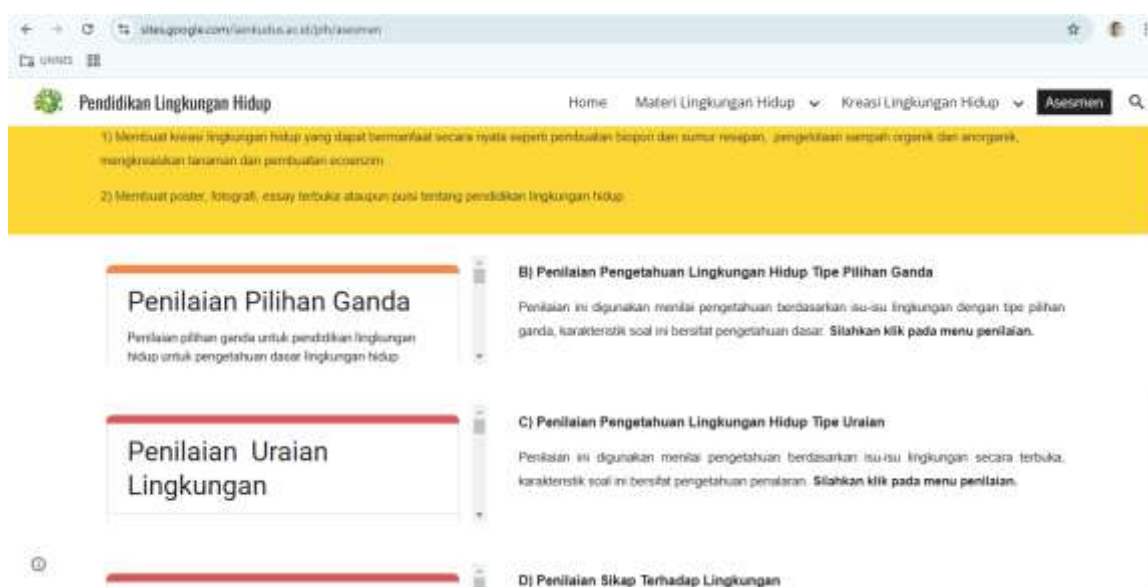


Figure 3. Environmental Literacy Assessment Menu on Google Sites Media

Implementation

The implementation of Google Site media based on SSI and Islamic integration was carried out on first semester biology education students with two types of learning activities, the first being about learning case studies on the environment, and the practice of environmental creativity. The environmental education not only strengthens knowledge but also enhances creativity in environmental management. The responses after the Google Sites trial showed varying levels of preference (Table 4), as follows:

Table 4. Student responses to the use of google sites for environmental education based on SSI and islamic integration

No.	Questionnaire Item	Respondent Assessment				
		Very Good	Good	Sufficient	Poor	Very Poor
1.	Use of website page design	59.26%	37.04%		3.70%	
2.	Selection of colors on the website	48.15%	33.33%	18.52%		

No.	Questionnaire Item	Respondent Assessment				
		Very Good	Good	Sufficient	Poor	Very Poor
3.	Selection of font size and type	59.26%	29.63%	11.11%		
4.	Use of images and videos of environmental materials	74.07%	25.93%			
5.	Explanation of environmental materials Basic	85.18%	11.11%	3.71%		
6.	Explanation of environmental materials with science and social issues	77.77%	22.23%			
7.	Explanation of environmental materials with Islamic integration	85.18%	14.82%			
8.	Explanation of environmental creation materials	85.19%	7.41%	7.41%		
9.	Use of environmental literacy assessments	66.67%	33.33%			

The evaluation of the use of Google Sites for environmental education shows that more than 50% of respondents rated it as very good, except for the selection of design colors, which received a rating of 48.15%. This is due to the limitations of Google Sites in terms of color selection and limited page design menu options. Responses after the Google Sites trial showed engaging learning experiences including:

1. The creation of biopores can increase water absorption, reduce puddles and flooding, and maintain groundwater availability.
2. The material on Reuse, Reduce, Recycle (3R) can be easily understood and applied.
3. The material on environmental creativity applies the 3 R system, which involves collecting and recycling to produce attractive plant pots.

Evaluation

The evaluation stage in development research uses environmental literacy instruments available on the Google Sites page, through verbal and actual commitment attitudes (Table 4) and cognitive and environmental knowledge through pretest and posttest assessments (Table 5) with hypothesis testing.

Table 4. Assessment of verbal and actual commitment attitudes toward the environment

No.	Indicator	Percentage				
		Yes	Mostly Yes	Not Sure	Mostly No	No
A. Verbal Commitment for the Environment						
1.	Efficient use of water for energy saving	100%				
		(26)				

No.	Indicator	Percentage				
		Yes	Mostly Yes	Not Sure	Mostly No	No
2.	Walking to reduce pollution	84.60% (22)	11.54% (3)		3.86% (1)	
3.	Reducing plastic for environmental conservation	100% (26)				
4.	Planting trees to reduce global warming	100% (26)				
5.	separation of waste (organic and inorganic) for Sustainability	84.62% (22)	15.38% (4)			
6.	Water absorption is important for sustainable environmental management	84.60% (22)	11.54% (3)		3.86% (1)	
7.	Environmental programs for character building	94.14% (25)	3.86% (1)			
B. Actual Commitment for the Environment						
1.	I am active in maintaining a healthy environment	69.23% (18)	30.77% (9)			
2.	I save water efficiently	65.38% (17)	34.62% (9)			
3.	I reduce plastic waste	57.69% (15)	36.62% (9)		7.69% (2)	
4.	I use waste for further use, such as gallon plastic for plant pots or organic waste for fertilizer	88.46% (23)	11.54% (3)			
5.	I do reforestation to reduce pollution	73.08% (19)	23.07 (6)	3.86 (1)		
6.	I care about groundwater catchment areas	73.08% (19)	19.23% (5)	7.69% (2)		
7.	I separate organic and inorganic waste for Sustainability	46.13% (12%)	46.15% (12)		3.86% (1)	3.86% (1)

Table 5. Results of normality test and average difference in the experimental class

Assessment	Analysis	Score
Pretest	Mean	58.85
	Stad Deviation	8.32
	Asymp. Sig. Normal	0.05
Posttest	Mean	80.00
	Stad Deviation	13.76
	Asymp. Sig. Normal	0.02
Asymp. Sig. (2-tailed) Wilcoxon		0.00
N		26

The results of the evaluation of the ecological knowledge and cognitive knowledge aspects in the implementation of Google Sites media for environmental education, in the pre-test and post-test of the experimental class, showed significant results ($0.00 < 0.05$) using the Wilcoxon

test, with an average pre-test score of 58.85 increasing to 80.00. Therefore, the use of Google Sites media has significantly improved environmental literacy in the knowledge aspect.

DISCUSSION

Environmental education is a process used to explain the relationship and interaction between living organisms and the natural environment. This education aims to raise public awareness about the importance of protecting and maintaining environmental balance. Environmental education strives to preserve and create a sustainable environment that supports a healthy and balanced ecosystem. It not only provides knowledge but also enhances awareness, participation, and concern for the environment. Utami (2019) explained that environmental literacy refers to an individual's understanding of everything related to the environment, including identifying existing problems, seeking solutions, and addressing environmental issues in the surrounding area.

The environment education is part of the Sustainable Development Goals (SDGs) agenda established by UNESCO, which relates to clean water and sanitation, Sustainable Cities and Communities aimed at making cities and settlements livable, responsible consumption and production, climate change mitigation, and the conservation of marine and terrestrial ecosystems. Therefore, the basic principles of environmental education are crucial to be continuously practiced and developed in a sustainable manner. Environmental education needs to develop knowledge, attitudes and behavior to demonstrate real action and concern for the environment. Genç & Acar (2021) explained scientific attitude is important in education, because students who have a high scientific attitude have a higher awareness and opinion on socio-scientific study issues than students who have a low scientific attitude.

Several studies on environmental education show that it is generally not taught as a standalone subject but is integrated into other subjects or included as part of institutional policies to foster environmental awareness. Nugroho (2022) explained that the integration of environmental education material and concepts in madrasahs can be developed starting from the management level, through policies that promote the creation of environmentally-conscious madrasahs or by involving all teachers to actively instill environmental concepts and materials to their students. Widiawati et al. (2022) stated the implementation of environmental education at the elementary school level does not include a specific environmental education subject, but is integrated into thematic lessons. For instance, teachers introduce and explain to students the

importance of maintaining a clean environment, which is then practiced in daily life through activities like classroom duties, clean Friday, and planting trees in the school garden.

SSI-based environmental education is expected to align the learning process with various environmental issues that frequently occur, while also keeping up with the evolving trends in environmental management to become a subject of study in education, and, if possible, be implemented directly in the learning process. Koçoğlu et al. (2022) explained that learning based on the SSI theme is directed towards concrete and current activities related to daily life and social needs, which can contribute to a better understanding for the students. Islanda & Darmawan (2023) showed that the Google Sites-based learning website consists of several menus, including Home, Learning Objectives, Materials, Videos, Simulations, and Evaluation. Improvement in learning outcomes can occur gradually as the use of learning media is enhanced and revised according to students' needs and teaching methods are adjusted. This data suggests that Google Sites-based learning media has the potential to improve students' academic performance.

Based on this, environmental education needs to be developed into a systematically structured material that involves both scientific and social issues, using learning media that can serve as a reference, one of which is Google Sites. The use of Google Sites media has also significantly developed environmental literacy skills in the knowledge aspect, and can explore students' attitudes and behavior of environmental awareness. Environmental education based on Socio-Scientific Issues (SSI) becomes a consideration for developing ideas and concepts, as well as creating innovations that can promote a more beautiful and sustainable environment. Furthermore, SSI-based environmental education serves as a means to reflect on environmental management in the surrounding area, aiming for better progress.

Environmental education based on Socio-Scientific Issues (SSI) is considered an approach to develop ideas and concepts, as well as to create innovations that can serve as a driving force for making the environment more beautiful and sustainable. Additionally, SSI-based environmental education provides a means to reflect on environmental management in the surrounding area, fostering better progress. The environment is part of the Sustainable Development Goals (SDGs) agenda set by UNESCO, which includes issues such as clean water and sanitation, sustainable cities and communities aimed at making cities and settlements more livable, responsible consumption and production, climate change mitigation, and the preservation of ocean and terrestrial

ecosystems. Therefore, the fundamental principles of environmental education are crucial to continuously practice and developed sustainably according to the needs of school levels.

The current elementary curriculum program aims to provide students with knowledge about the natural environment and raise awareness of environmental issues that impact life on Earth. Students' understanding of environmental topics often lacks reinforcement of practical skills and actionable knowledge, thus underpreparing students to engage critically and responsibly with real-world environmental issues (Ishaque et al., 2025). Studies indicate that the use of Google Sites is an effective learning platform for Gen Z or Alpha. As digital natives, these learners are comfortable when technology is incorporated into the classroom. The use of Google Sites can effectively assist students in understanding science concepts easily and improve their academic performance. However, some students may lack the necessary devices to support online learning. There must be systematic efforts to ensure that students are provided with the appropriate devices to participate and engage in their learning, thereby improving academic performance (Ramasundrum & Sathasivam, 2022).

Future educators need a more holistic curriculum that emphasizes critical thinking, community engagement, and sustainable practices, which equips them to effectively address environmental challenges and increase ecological awareness in environmental education. Recommendations for improving the curriculum with practical applications to foster ecological literacy and sustainable practices among preservice teachers (Ishaque et al., 2025). The socioscience-based problem-based learning model is able to create an active and challenging learning atmosphere, students can think critically and discuss to provide solutions to problems that occur in everyday life based on the concepts that have been learned, so that it is effective in improving students' argumentation skills (Mu'minin & Fauziah, 2022). This shows that environmental education must be able to encourage critical thinking, involve students and the community and be oriented towards ESD (Education for Sustainable Development).

The application of the relationship between science and religion in teaching practice can use an integrated approach. Environmental education can be developed in an integrated learning approach, ecotheological-based learning and strengthening morals towards the environment. The role of religion in environmental education is to serve as a reminder, inspiration and motivation to protect and improve the environment in a sustainable manner. The relationship between the environment and religion is explained in Qur'an Surah Ar-Rum 41 and Surah Al-A'raf 56-58. These

verses prohibit humans from causing damage to the earth, instead, Allah commands His servants to care for all of His creations, such as rivers, oceans, land, and forests. Efforts to protect the environment and preserve nature will benefit not only humans but also all living things. Every human being is obliged to care for their environment. This is to maintain ecosystem balance so that every organism within the ecosystem can function normally and optimally. Clean water and fertile soil are valuable assets that must be preserved for future generations to benefit from. Furthermore, preserving nature enhances beauty and provides invaluable aesthetic value. Mountains, forests, and oceans provide places for relaxation and recreation. Protecting the environment is also a regular contribution to efforts to address global climate change. Important steps to creating a sustainable environment include energy conservation, the use of renewable resources, and reducing greenhouse gas emissions, such as carbondioxide.

Students' argumentative skills in the field of science and religion consist of three types in different contexts: first, science, second, religious education, and third, the interdisciplinary context of science & religious education. Knowledge in a context is used to be able to engage both curriculum subjects and the interdisciplinary space of scientific studies. This reveals several interesting challenges and opportunities to support student argumentation in science learning (Guilfoyle et al., 2021). Weaknesses in students' ideas in the perspective of science and religion, with a tendency to reject religion using scientific arguments. This requires a relationship between science and religion towards a more contextual approach that allows students to make connections across disciplines in a curriculum (Torres et al., 2021). Therefore, building the skills of prospective teachers in integrating science and religion in a learning context is something that is needed.

An example of environmental education linked to religion can be related to religious knowledge or verses, then connected to the existence of plastic waste and air pollution. What are the lifestyle solutions that support the prevention of plastic waste and the reduction of carbon emissions (CO₂). Baltikian et al. (2025) explained that students determined that climate change was urgent, but there was a perceived disconnect between positive climate behavior and increased awareness. Therefore, it is necessary to develop actionable educational measures related to climate change to help students transform awareness into action and proactive environmental management.

Environmental literacy assessment in the aspects of attitude (affect) and behavior (behavior) is crucial for self-assessment in students, as part of their scientific attitude. Genç & Acar (2021) emphasized that students' interpretation, evaluation, and proposed solutions to Socio-Scientific

Issues (SSI) may change according to their scientific attitude scores. Students with a high scientific attitude typically provide more detailed, varied, and comprehensive views on SSI issues. Therefore, developing a socio-scientific perspective for individuals to think logically, make decisions, and generate creative solutions to all types of issues and problems they face is essential. Thus, SSI can be discussed in the curriculum from an interdisciplinary perspective, enabling activities that enhance the socio-scientific aspects of students in the learning process.

An example of environmental knowledge based on SSI includes the issue of global warming. According to the 2015 Paris Climate Agreement, world leaders committed to efforts aimed at limiting the long-term global temperature rise to 1.5 degrees Celsius. This threshold is considered critical to avoid the most severe consequences of climate change (<https://www.bbc.com>). Why does global warming occur, and could it happen in Indonesia? Another issue concerns the responses of agreement/disagreement regarding government policies on the construction of infiltration wells, which have led to accidents, as reported by news outlets. These questions address analytical skills, critical thinking, creative thinking, and problem-solving, serving as opportunities to practice and develop environmental literacy.

The implementation of Google Sites as a learning media is expected to develop skills in hands-on and minds-on learning activities, which can combine thinking and physical activities synergistically in learning. Therefore, future teachers need to pay attention to how easily learning technology can be used effectively and efficiently. The Technological Pedagogical and Content Knowledge (TPACK) framework can serve as a reference for using Google Sites in environmental education, providing guidelines to better synchronize knowledge of technology, pedagogy, and content in effective teaching practices, as well as support work guidelines (worksheets) for students. Jamaludin et al., (2024) emphasized that the TPACK framework is an approach to explain the effectiveness, evaluation, and reflection on the use of learning technology, including the type of content material and pedagogy used, such as teaching models and student assessments.

Ishaque et al., (2025) explained the environmental education curriculum and emphasized the need for practical improvements, including improvements in important topics such as climate change, sustainability and biodiversity in the curriculum. Practical training modules, field work activities and case studies should be included to address the gap between theory and real-world challenges. Regular professional development activities should be conducted to enhance teachers' knowledge and equip them with effective strategies for delivering environmental education

content. In addition, there is a need to adopt best practices from successful international programs and establish mechanisms for continuous assessment and feedback in environmental education, so as to enable teachers to effectively teach critical environmental issues, foster responsible behavior and sustainable mindsets among students, thereby contributing to long-term environmental sustainability.

The material content and environmental literacy assessment is also developed for basic-level knowledge through multiple-choice questions and higher-order thinking or reasoning through essay questions, considering that environmental education is necessary for preservice teachers or teachers. Tran et al., (2022) explained that preschool teachers emphasize the need to actively improve environmental literacy and self-efficacy in environmental education through various resources such as books, videos, the internet, and active participation in environmentally-related community organizations and activities. Environmental education is expected to integrate environmental education materials into learning and implement environmental teaching activities. Organizing environmental competitions, such as designing and implementing teaching aids made from recycled and natural materials, reduces carbon emissions, and protects the environment.

The attitude assessment of environmental literacy is adapted from the Middle School Environmental Literacy Survey (MSELS) (Nastoulas et al., 2017), which explains that commitment to the environment includes both verbal commitment and actual actions in environmental aspects. The results of verbal commitment to the environment show that commitment to water conservation, plastic reduction, and tree planting has full support of up to 100% from students' commitments. However, when tracing the actual actions towards the environment, the support decreases in percentage for water conservation, plastic reduction, and greening efforts (Table 4). Therefore, the attitude assessment of environmental literacy can be an important factor in fostering a belief in the attitude, followed by actual actions that show care for the environment. Badaruddin et al. (2024) explained that problem-based learning should be implemented to improve students' environmental literacy and problem-solving skills, thereby fostering their awareness and responsibility for sustainable development. The use of technology and learning resources is necessary to provide students with opportunities to conduct research and communicate with experts, thereby developing more positive environmental literacy skills.

The attitudes and behavior show a significant relationship, while attitudes and knowledge show an insignificant relationship. This indicates that environmental literacy empowerment

through educational institutions is not optimal, therefore, it is necessary to evaluate local-based and operational environmental education policies, such as integrating environmental literacy content with local culture in the learning process (Hermawan et al., 2022). Development of the Google Sites media for environmental education is that the materials are not limited to knowledge acquisition. Instead, they also aim to foster students' creativity, environmental management skills, and the development of environmentally responsible attitudes.

Kumar et al., (2024) stated that teachers can enhance critical thinking, argumentation, perspective-taking, and decision-making skills while fostering a deeper understanding and engagement with environmental challenges. Environmental Socio-Scientific Issue (ESSI)-based learning as a way to enhance the learning experience, utilizing place-based contexts, interactive teaching materials, and appropriate assessment methods can contribute to more effective and meaningful learning experiences. Future teacher education programs can better equip future teachers to effectively teach environmental socio-scientific issues, promote critical thinking, and empower students to become active and environmentally conscious citizens.

Further research in improving students' environmental literacy needs to be introduced to the surrounding nature or learning outside the classroom, observing problems that disrupt the environment and behaviors that can have a positive impact on the environment, all of which must be adjusted to the existing material so that it is possible to increase the level of students' environmental literacy (Santoso et al., 2021). The environmental creation menu provided on Google Sites media such as making biopores, greening programs such as vertical gardens, 3 R programs (Reuse, Reduce and Recycle) and waste processing can provide experience and skills as well as creativity for students or students in environmental education programs, Adiwiyata Program or Green School and conservation campuses.

CONCLUSION

Environmental education is crucial at all levels of education, from preschool to higher education, because environmental issues are essential for the sustainability of humans and other living organisms. The use of digital technology tools can play a key role in the learning process and serve as valuable learning resources. Therefore, Google Sites can be used as an effective medium for environmental education. The validity assessment of Google Sites for environmental education indicates that it is highly valid, particularly in terms of content and design. The implementation of Google Sites has significantly improved environmental literacy, and overall, students have rated it

very positively for environmental education based on SSI and Islamic perspectives. The environmental creativity features, such as the creation of biopores and the 3R program (Reuse, Reduce, Recycle), have received positive responses from students. Based on this, environmental education through Google Sites can be further developed to enhance students' creativity and literacy assessments, providing them with real-life experiences in everyday life. These findings suggest that environmental education using Google Sites can be further developed to enhance students' creativity and assessment literacy, for learning media at school and higher education levels and can be combined with the TPACK framework. Further research recommendations are needed to utilize Google Sites media for environmental education by using problem-based learning models or projects with more specific environmental themes, such as climate change prevention, biopore creation, waste management, and campus or school greening, so that environmental literacy can be developed sustainably.

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Appendix

Table 1. Validation of google sites media for environmental education based on socio-scientific issues and islamic integration

No.	Questionnaire Item	Rating Scale				
Material Content		1	2	3	4	5
1	Framework of Environmental Education Material					
2	Suitability of content to the learning objectives					
3	Explanation of environmental education					
4	Explanation of environmental education based on Socio-Scientific Issues (SSI)					
5	Explanation of environmental education based on Islamic Integration					
6	Explanation of environmental education assessment					
Amount						
Media Design						
7	Use of page design					
8	Selection of page colors					
9	Use of educational images					

10	Use of educational videos
11	Use of font type and size
	Amount

Rating Scale Description

(1= Very Poor; 2=Poor; 3= Sufficient; 4= Good; 5= Very Good)

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