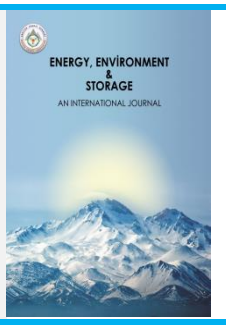
Energy, Environment and Storage

Journal Homepage: www.enenstrg.com



Implementation of Green Product Challenge Campaign Based on Education for Sustainable Development through Kamishibai Media

Tia Muliawati[1], Indriyani Rachman[2*], Toru Matsumoto[3]

[1]*SMKN 1 Cibadak, Sukabumi, Indonesia*

[1]*Program Studi Pendidikan IPA, Sekolah Pascasarjana, Universitas Pakuan, Indonesia*

[2]*Program Studi Pendidikan IPA, Sekolah Pascasarjana, Universitas Pakuan, Indonesia*

[2.3]*Graduate Programs in Environmental Systems, Graduate School of Environmental Engineering, Kitakyushu University, Japan.*

ABSTRACT Environmental education based on Education for Sustainable Development (ESD) demands a contextual, participatory, and action-oriented learning approach. This study aims to describe the implementation of the ESD-based Green Product Challenge Campaign through kamishibai media integrated with the Science Project Learning in Vocational High Schools. The study uses a qualitative descriptive approach with a reflective practice design, involving grade X students across majors in a series of activities that include ESD socialization, kamishibai media development, and presentations at the peak of the environmental campaign. The results of the study indicate that the kamishibai-based campaign is able to improve students' understanding of waste management, foster environmental awareness, and develop psychomotor and social skills through project-based learning. Kamishibai acts as a visual storytelling medium that helps students connect science concepts with real environmental problems in schools. In addition to being a learning medium, kamishibai functions effectively as a school-based environmental campaign medium that supports the implementation of ESD. This study concludes that kamishibai media has the potential to be an alternative pedagogical medium in implementing ESD-oriented project-based learning in vocational secondary education and contributes to the achievement of SDGs 8, SDG 12, and SDG 13.

Keywords: *Education for Sustainable Development; Kamishibai; Environmental Campaign; IPAS Project; SDGs*
Article History: Received: 31.12.2025; Revised: 13.01.2026; Accepted: 15.01.2026; Available Online: 08.02.2026
Doi: https://doi.org/10.52924/FRZS1793

1. INTRODUCTION

Global environmental issues, such as increasing waste volume and climate change, are serious challenges that require an active role in the education sector. The growing concerns about resource depletion, environmental degradation, and the adverse effects of climate change call for immediate attention from all sectors of society, particularly the education system [1-2]. Schools, as educational institutions, have a strategic role in fostering environmentally friendly awareness and behavior through the Education for Sustainable Development (ESD) approach. ESD aims to equip students with the knowledge, critical thinking skills, and values and attitudes necessary to address global challenges, including environmental degradation, climate change, and the increasing risk of disasters [3-4].

Although ESD has been recommended to be integrated into learning in secondary schools, its implementation still faces various obstacles, including limited institutional support, minimal cross-disciplinary collaboration, the dominance of conventional learning methods, and a lack of contextual and participatory learning media [5-6]. Therefore, pedagogical innovation is needed that is able to bridge ESD objectives with student characteristics.

Various studies have shown that visual story-based learning media are effective for use in environmental education. Rachman et al. [7] reported that kamishibai (Japanese paper theater) is a learning medium capable of enhancing students' understanding and retention of environmental concepts through the integration of narrative, visual elements, and direct interaction. Similarly, that visual storytelling increases student engagement and supports more meaningful comprehension of complex issues [8-9]. Recent studies have also highlighted the potential of kamishibai as a medium for environmental education and disaster mitigation within the framework of Education for Sustainable Development (ESD). However, its application in the context of school-based environmental campaigns and its integration with project-based science learning remain relatively limited [10].

Based on this gap, the environmental campaign "Green Product Challenge" was designed and implemented in schools as a concrete ESD action integrated with the Science Project learning. This campaign not only focuses on delivering information, but also encourages students to

*Corresponding author: rachmanindriyani@gmail.com

produce kamishibai media with the theme of waste processing and environmentally friendly products, and present them in the culminating activity of the campaign. This study aims to describe the implementation process and the impact of the campaign on students' learning and environmental awareness. The novelty of this study lies in the use of kamishibai not only as a learning medium, but as a school-based environmental campaign medium integrated with the Science Project learning within the framework of Education for Sustainable Development (ESD) in vocational secondary education.

Kamishibai is a traditional Japanese visual storytelling technique that combines illustrated cards with oral narration, presented sequentially using a small stage-like frame. In educational settings, kamishibai functions as a visual–narrative medium that supports students' verbal expression, creativity, confidence, and comprehension by integrating visual cues with structured storytelling. Previous studies have shown that kamishibai-based learning can enhance student engagement, learning motivation, and understanding of complex concepts through interactive and contextualized narratives [7,8].

Within the framework of Education for Sustainable Development (ESD), storytelling media such as kamishibai offer meaningful opportunities to connect scientific concepts with real-life environmental issues. By presenting sustainability challenges through narratives, students are encouraged to reflect on environmental problems, propose solutions, and communicate sustainability messages in ways that are accessible and engaging. This narrative-based approach aligns with the ESD principles of contextual learning, participation, and action-oriented education.

Based on this gap, the "Green Product Challenge" environmental campaign was designed and implemented as a concrete ESD action integrated with Science Project Learning. Unlike previous studies that primarily position kamishibai as a classroom learning medium, this study emphasizes its role as a school-based environmental campaign tool. The novelty of this study lies in the integration of kamishibai with project-based science learning as a medium for environmental campaigns that promote sustainability awareness, student participation, and real-world action in vocational secondary education.

In line with this, the importance of integrating sustainability knowledge into education has been highlighted in various studies. For instance, recent research conducted in Eastern Indonesia showed that university students' understanding of the Sustainable Development Goals (SDGs) and their carbon reduction practices are closely connected, although a gap still exists between knowledge and action. This gap underlines the need for more effective educational strategies that not only impart knowledge but also encourage practical, real-world environmental actions [11]

2. RESEARCH METHODS

This research uses a qualitative descriptive approach with a reflective practice study design. This approach was chosen to describe in depth the implementation process of an Education for Sustainable Development (ESD)-based environmental campaign through kamishibai media (Japanese theater paper) in the context of real-life learning in schools.

2.1 Research Subjects and Setting

The research subjects consisted of 176 tenth-grade students at SMK Negeri 1 Cibadak, Sukabumi, Indonesia, from various vocational majors, namely Agricultural Product Processing Agritechnology (APHP), Food Crop and Horticulture Agribusiness (ATPH), and Visual Communication Design (DKV). The study was conducted during the odd semester of the 2025/2026 academic year within the school environment, encompassing both classroom learning activities and the culminating event of the Green Product Challenge campaign.

Fig. 1. Map of Indonesia and the city of Sukabumi where the research was conducted.

2.2 Activity Stages

The research activities were conducted through the following stages:

1) ESD socialization and orientation, which involved strengthening students' understanding of sustainable education, school waste issues, and their relationship to Science Project learning using kamishibai media;

2) Introduction to kamishibai media, including its concept, narrative structure (problems, causes, impacts, and solutions), and examples of its application as an environmental education medium;

3) Production of kamishibai by students working in groups, focusing on themes of waste management and environmentally friendly products;

4) Presentation and campaign activities, in which students presented their kamishibai during the peak event of the Green Product Challenge campaign, organized in the form of presentations and group competitions.

2.3 Data Collection

Data were collected through participant observation, documentation (photographs, videos, and student-produced kamishibai media), as well as written and oral reflections derived from student discussions and teacher reflections.

In this study, observations focused on students' participation, collaboration, and engagement during the implementation of the Green Product Challenge campaign and kamishibai activities. Reflection questionnaires were designed to capture students' perceptions, understanding, attitudes, and learning experiences related to environmental awareness, waste management, and project-based learning. Documentation in the form of photographs, videos, and student-produced kamishibai media was used to support and validate observational and reflection data.

Although the reflection questionnaire was distributed to all participating students, only 50 students submitted complete responses. Referring to Sugiyono (2013), a minimum of 30 respondents is considered adequate for descriptive research; therefore, the number of responses obtained in this study was deemed sufficient to capture students' perceptions. The reflection data were used to obtain an in-depth qualitative understanding of student experiences rather than to represent the entire population statistically.

2.4 Data Analysis Technique

Data analysis was conducted qualitatively through an iterative process of data reduction, data display, and conclusion drawing [12,13]. Reflection responses were first read and grouped into thematic categories related to cognitive understanding, attitudes toward the environment, and learning experiences. Observational notes and documentation data were then compared with reflection data to identify recurring patterns and to strengthen the credibility of the findings. Quantitative data in the form of percentages were analyzed descriptively to support qualitative interpretations rather than for statistical generalization. Triangulation was achieved by comparing data from observations, student reflections, and documentation to ensure consistency and trustworthiness of the findings.

3. RESULTS AND DISCUSSION

3.1 Participant Profiles and Activity Implementation

The Green Product Challenge campaign involved 176 tenth-grade vocational high school students, comprising 87 boys and 89 girls. The participants were drawn from four classes: one class of Agricultural Product Processing Agritechnology (APHP), one class of Food Crop and Horticulture Agribusiness (ATPH), and two classes of Visual Communication Design (DKV). The campaign was conducted during the odd semester of the 2025/2026 academic year and was integrated with Science Project learning.

Student reflections on the campaign and learning activities using kamishibai media were collected through an online questionnaire administered via Google Forms and distributed to all students involved in the study. However, only 50 students returned complete responses. Referring to Sugiyono (2013), a minimum of 30 respondents is considered sufficient for descriptive research; therefore, the number of responses obtained in this study was deemed adequate. The reflection data were used to obtain an overview of students' perceptions, understanding, and attitudes toward the campaign. In addition to questionnaire data, observations conducted during the activities and documentation in the form of photographs and videos of the kamishibai creation and presentation process were used to support and enrich the findings.

3.2 Results and Reflection of Campaign Implementation

3.2.1 Results of Campaign Implementation

The results of the Green Product Challenge campaign demonstrated improvements in students' cognitive, affective, psychomotor, and social aspects. These improvements were observed throughout the stages of ESD socialization, kamishibai media production, and presentations conducted during the culminating campaign event.

Kamishibai media served as the primary medium for conveying environmental messages and representing student learning outcomes [14, 15]. Through Kamishibai storytelling, students presented environmental problems within the school context, analyzed their impacts, and proposed creative solutions related to waste management and environmentally friendly products.

The development of kamishibai narratives illustrates students' ability to systematically represent the learning process within the ESD-based Science Project Learning. The narratives typically began with the identification of environmental problems in the school environment, followed by the design and implementation of solutions through recycling activities and the creation of environmentally friendly products. This process reflects students' growing environmental literacy and their ability to connect scientific concepts with sustainability contexts.

During the campaign implementation, students worked collaboratively in groups to design storylines, create visual illustrations, and present kamishibai media to their peers. The presentations were followed by peer and teacher feedback, which focused on clarifying environmental messages, improving narrative structure, and enhancing visual elements. At the peak of the campaign, kamishibai presentations were delivered to a wider audience through school-based exhibitions and environmental events, generating high levels of engagement and positive responses.

Using a kamishibai, the teacher explained how the Green Product Challenge Campaign Based on Education was conducted and explained the story to the students. Afterward, the students understood the importance of green products. Then, the students created their own kamishibai, using the theme of their green product.

The students' work was presented in a kamishibai and read aloud to an audience of their classmates from different grades. The results were very satisfying, with all students paying close attention and listening attentively.

The students also gained a deeper understanding of green products. Photos of the implementation of the *Green Product Challenge* Campaign activities are presented as supporting documentation for the process of making and presenting kamishibai media by students in Fig. 2

Table 1. Kamishibai Presentation Media

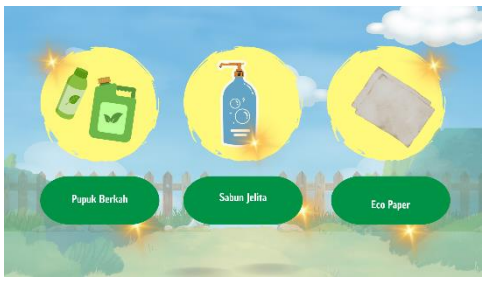
Picture	Narration
	**Rani**: *"Oh my, look! Our school is so dirty!"* **Dika**: *"Yeah, the trash is from the cafeteria and the backyard, it looks like they haven't cleaned it yet."* **Rani**: *"If this keeps up, it'll smell bad and be full of flies!"*
	**Ria**: *"Guys, let's clean up this trash together. It smells and there are lots of flies."* **Rafi**: *"Come on, I'll take the trash to the landfill."* **Gani**: *"There's also a lot of grass, onion, and oil waste, right? Let's just collect it."*
	**Gani**: *"Wow, there's a lot of grass waste, huh!"* **Ria**: *"Yeah, look, there's a lot of waste from harvesting onions too."* **Rafi**: *"We also use a lot of used oil to make donuts, especially in the school cafeteria."* **Gani**: *"How about we put it to good use? We're discussing Substances and Their Changes in Science Project Learning class right now. How about we discuss it with Ms. Tia?"* **Everyone**: *"Let's go!"*
	**Rafi:** *"Ma'am, there's a lot of trash at our school, especially grass, onion skins, and used cooking oil."* **Bu Tia:** *"Do you think that trash can't be reused?"* **Rani:** *"Grass is made of fiber, ma'am. It can be made into paper, just like wood."* **Gani:** *"Used cooking oil can probably be processed into soap so it doesn't pollute the environment."* **Ria:** *"Onion skins can be used as liquid fertilizer for plants, ma'am."*
	The students were divided into three groups. The first group tried making liquid soap from used cooking oil and lemongrass. The second group made liquid fertilizer from onion skins. The third group made paper from dried grass. **Dika**: *"Wow, the soap smells so good, even though it's made from used cooking oil!"* **Rani**: *"Look, the paper from the grass turned out so smooth!"*
	After several trials, all the products were finally finished. The students named their products: "Jelita Soap," "Eco Paper," and "Pupuk Berkah." They learned about the physical and chemical changes that occur during the manufacturing process. **Miss Tia:** *"You're amazing! You've just proven that science can help protect the environment."*

Fig. 2. Photos of the implementation of the Green Product Challenge Campaign activities

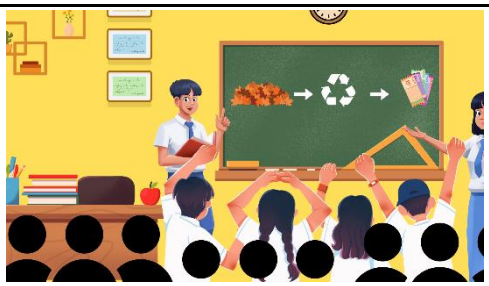
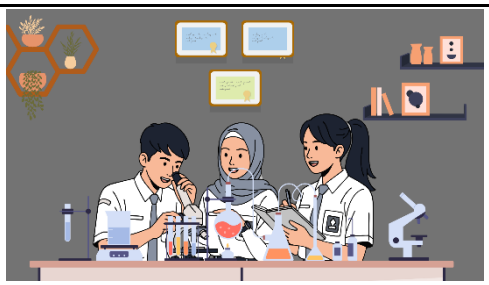
Students' abilities in recycling waste and making cards from dry leaves and grass were tested through the collaborative process of kamishibai. After receiving information and examples of kamishibai from their teachers, students formed groups to develop kamishibai media around selected environmental issues, one of which was processing waste leaves into eco-friendly paper. The development process began with intensive group discussions, followed by consultation with the teacher to determine a storyline and narrative that was communicative and easily understood by all groups.

Student groups designed a storyline illustrating how organic waste, particularly leaves, which are traditionally considered waste, is reprocessed into eco-friendly paper. They documented the simple recycling steps: collecting leaves, drying them in the sun, shredding them, dissolving the leaf powder, and forming sheets of paper using simple tools. During this stage, students also created story wick cards from dry leaves and grass materials that were attached to kamishibai frames as vibrant visual media. The narrative was adjusted to emphasize the value of city cleanliness, waste reduction, and the importance of active participation by all parties.

The kamishibai presentations were given in groups to the entire class, and then received constructive feedback from peers and the teacher for improvement. Feedback included simplifying the language, sharpening the environmental message, and enhancing the visuals to make them more engaging. At the peak of the campaign, kamishibai was presented to a wider audience through school performances and local environmental events, receiving a positive response and high levels of engagement. As a result, students understood that recycling-based creativity can be an effective educational tool and encourage community participation in environmental protection.

Table 2 presents examples of kamishibai narratives created by students, illustrating the stages of problem identification, solution design, implementation, and reflection within the framework of the Education for Sustainable Development (ESD)-based Science Project Learning.

Table 2. Kamishibai Narrative: Student Work in ESD-Based Science Project Learning

Pictures	Narration
	**Student:** "Wow, there's a lot of dry leaf waste at our school, huh? Do you think these dry leaves could be recycled into something useful, usable, and marketable?" **Student:** "I have an idea! What if we turned those dry leaves into recycled paper, which we could then repurpose into more interesting items!" **Student:** "That's a great idea! Let's share it with our classmates so they can all help too!"
	**Students:** "Friends, there are a lot of dry leaves scattered around our school. Well, we both have an idea: how about recycling those leaves into paper? Hopefully, it will be useful, usable, and marketable?" **Everyone:** Agreed! Let's do it together!
	***Student:*** *"Ma'am, we'd like to share an idea about utilizing dried leaves in the school environment."* ***Teacher:*** *"What's that idea, dear?"* ***Student:*** *"We'll recycle the dried leaves into paper, then create useful, marketable products."* ***Teacher:*** *"That's great. I support this as long as it's a positive activity. If there are any problems, please let me know immediately."* ***Student:*** *"Okay, ma'am. Thank you."*
	**Student 1:** "We cut the leaves first, then boil them to soften the fibers." **Student 2:** "Add a little washing soda, then blend them with water." **Student 1:** "The pulp is ready, we mix in starch and dye." **Student 3:** "Wow, we can make paper from leaves." **Student 2:** "Yes, we can see physical and chemical changes."
	***Student 1:*** *"The exhibition has finally begun. Our table is full of flowers and bookmarks made from recycled paper."* ***Student 2:*** *"Yes, the results are amazing. Let's start bidding."* ***Student 1:*** *"Hello, this is a work of art made from dried leaves processed into unique, eco-friendly paper."* ***Student 3:*** *"Lots of people stopped by. It's exciting to have our experiments on display."* ***Student 2:*** *"The exhibition is over. Here are the sales: 7 flowers and 10 bookmarks."*
	***Student 1:*** *"We're announcing the sales results of our Ecopaper products."* ***Student 2:*** *"After deducting expenses, we still made a profit."* ***Friend:*** *"Awesome, our business is successful!"* ***Student 1:*** *"Thank you all for your cooperation and support."* ***Student 2:*** *"Hopefully, we can become more united and environmentally conscious."*

The results of the kamishibai media development show that students are able to systematically represent the learning process of the ESD-based Science Project Learning. The kamishibai narrative begins with the identification of environmental problems in the school in the form of dry leaf waste, which is then responded to through recycling activities into paper and useful products. This process reflects the increase in students' environmental literacy and the ability to connect scientific concepts with the context of sustainability in the real environment.

The use of kamishibai supports collaborative and student-centered learning, with the teacher acting as a facilitator. Visualizations of the stages of recycled paper production demonstrate students' understanding of physical and chemical changes in an applied way, while product exhibitions and sales activities demonstrate the integration of environmental, social, and economic aspects. These findings confirm that kamishibai is effective as a presentation medium and reflection medium for ESD-based Science Project learning, in line with ESD's goal of developing sustainability knowledge, skills, and attitudes [7].

3.2.2 Student Learning Results

In the cognitive domain, students demonstrated the ability to identify types of waste in the school environment, explain their impacts, and relate these issues to concepts of changes in matter and sustainability. As presented in **Table 3**, 93% of students were able to identify types of waste and their impacts. Students' understanding of the importance of environmental protection was categorized as fully understand (48%), understand (40%), and somewhat understand (12%). These findings indicate that project-based learning supported by kamishibai media effectively enhanced students' conceptual understanding of environmental issues

Table 3. Student Learning Outcomes in Cognitive Aspects

Cognitive Indicator	Response Category	Percentage (%)
Ability to identify types of waste and their impacts	Capable	93
	Incapable	7
Level of understanding of the importance of protecting the environment	Fully understand	48
	Understand	40
	Somewhat understand	12

Table 4. Student Learning Outcomes in the Affective Aspect

Attitude and Value Indicators	Percentages (%)
Concern for the environment	90
Cooperation in groups	88
Creativity	84
Responsibility	80
Solving problem skills	78
Change in attitude to be more concerned about waste	100

Table 5. Student Learning Outcomes in Psychomotor Aspects

Psychomotor Skills Indicators	Description of Observation Results
Designing the kamishibai storyline	Students are able to construct a story line that includes problems, causes, impacts and solutions for waste management.
Drawing and compiling kamishibai media	Students are able to create visual illustrations that are relevant to environmental themes.
Integrating science concepts into stories	Students are able to relate the issue of waste to the concepts of changes in matter and sustainability.
Presentation skills	Students are able to present kamishibai confidently and communicatively.
Practical work in groups	Students are able to work together and share roles during the media creation process.

In the affective domain, students showed increased concern for environmental issues, cooperation in group work, creativity, responsibility, and problem-solving skills. As shown in **Table 4**, the highest percentage was observed in students' concern for the environment (90%), followed by cooperation in groups (88%) and creativity (84%). These results suggest that kamishibai-based project learning fostered positive attitudes and values aligned with the principles of Education for Sustainable Development.

In the psychomotor domain, students demonstrated the ability to design kamishibai storylines, create relevant visual illustrations, integrate science concepts into narratives, and present kamishibai media confidently. In addition, students developed social skills through cross-departmental collaboration, role distribution, and effective communication during the media creation process. As summarized in Table 5, these outcomes indicate that the campaign activities supported the development of both practical and communication skills through project-based learning.

The results in Table 5 show that the campaign activities not only improved students' conceptual understanding, but also developed practical and communication skills as part of project-based learning.

3.2.3 Student Reflection on Learning and Campaign

The results of student reflections on the implementation of the Science Project learning and the Green Product Challenge campaign showed a very positive response. Student perceptions of the learning activities are presented in **Table 6.**

Table 6. Results of Student Reflections on Perceptions of Kamishibai-Based Learning

Student Perceptions of Learning Activities	Percentages (%)
Very Interesting	52
Interesting	37
Somewhat Interesting	11

Student reflections revealed predominantly positive perceptions of the Green Product Challenge campaign and kamishibai-based learning activities. As presented in Table 6, 52% of students rated the activities as very interesting, 37% as interesting, and 11% as somewhat interesting. This variation reflects the diversity of students' learning experiences and strengthens the credibility of the reflection data.

Further reflections indicated that the use of kamishibai helped students develop ideas more creatively and systematically in conveying environmental messages. Through the integration of storytelling and visual elements, students were able to articulate environmental problems, propose solutions, and communicate sustainability messages more effectively. These findings confirm that kamishibai functions not only as a learning medium but also as an effective communication tool for school-based environmental campaigns.

3.3 Discussion

Research shows that the Green Product Challenge campaign, based on Education for Sustainable Development (ESD), using kamishibai as a medium, had a positive impact on Science Project learning. Kamishibai improved students' understanding of environmental concepts, social awareness and responsibility, and practical skills. Results indicated improved abilities in identifying environmental issues, collaborating, and creating creative media. In addition to being a learning tool, kamishibai served as a vehicle for an ESD campaign supporting SDGs 8, 12, and 13. Although the findings were limited to a small sample of respondents without a control group, this study confirms the potential of kamishibai in integrating sustainability values into project-based education.

Implementing a green product campaign based on Education for Sustainable Development (ESD) using kamishibai as a medium can be effective if there is a strong alignment between the campaign objectives, the story content, and the characteristics of kamishibai as an interactive visual-narrative medium.

The Success of Green Product Campaigns with Kamishibai, For the "green product challenge" campaign to be truly meaningful, kamishibai cannot simply be used as a "storytelling tool" but must be designed as a pedagogical strategy aligned with ESD competencies: knowledge, values, and action. This means that every picture card, storyline, dialogue, and discussion-provoking question must explicitly guide students toward an understanding of sustainable consumption (reduce, reuse, and recycle, product carbon footprints, local/organic product choices), a critical attitude toward environmentally unfriendly products, and the courage to make decisions about choosing green products in their daily lives.

In the context of the campaign, kamishibai strongly supports the "think globally, act locally" approach, for example by featuring characters and situations close to children's lives: a food stall near school, beverage packaging waste, or the habit of bringing their own shopping bags. This contextualized story helps students connect abstract issues (SDGs, the climate crisis, sustainable consumption) with concrete actions such as choosing refillable products, reducing single-use plastic, and promoting green products in the school environment. If the storyline, visuals, and follow-up activities (discussions, mini-projects, or class campaigns) are designed based on ESD objectives, then kamishibai will not only be engaging but also effective as a campaign medium that fosters ecological literacy and behavior change.

The key to successful implementation lies in the alignment of three things: (1) the ESD learning/campaign objectives, (2) the theme and structure of the kamishibai story, and (3) how educators facilitate the learning process. First, objectives need to be clearly formulated, for example: "students are able to explain the characteristics of green products," "students are able to distinguish between honest green advertising and simple greenwashing," or "students demonstrate a commitment to reducing the consumption of environmentally unfriendly products." These objectives are then translated into the storyline: conflict, environmental problems arising from certain products, the character's

decision-making process, and solutions that reflect sustainable attitudes and actions. Second, the visual content of kamishibai must be simple yet meaningful, so that the message of green products is easily understood by all age groups. The use of color, symbols (e.g., recycling logos, green labels, pollution images), and character expressions help students process information more quickly and retain campaign messages longer, in line with findings that combining text and images improves comprehension and retention (picture superiority effect). Third, the teacher/presenter acts as a facilitator, connecting the story with critical reflection and concrete action: asking open-ended questions, encouraging students to retell the story from different perspectives (consumer, producer, environmental), and even inviting them to design a mini-campaign for green products at school.

As a brief illustration, a kamishibai series about "The Adventures of Refillable Drinking Bottles" might include: a scene of a school cafeteria full of plastic bottle waste, a child character switching to refillable bottles, a dialogue with a vendor about refillable products, and a closing invitation to his friends to join the "7-day challenge without single-use bottles." This type of narrative directly links the story's content to the goals of ESD and the green product campaign, rather than simply providing passive information.

Research findings: kamishibai as a learning medium Various community service activities and research have demonstrated that kamishibai are effective as a learning medium in various contexts, particularly environmental and sustainability education. The Community Service Program at Pakuan University, for example, implemented the use of kamishibai as a learning medium for environmental education in several elementary schools and reported enthusiasm.

The findings of this study indicate that the Green Product Challenge campaign based on Education for Sustainable Development (ESD) implemented through kamishibai media had a positive impact on Science Project learning. This impact is reflected in the strengthening of students' conceptual understanding, the development of sustainability-oriented attitudes and values, as well as the enhancement of practical and social skills.

In the cognitive domain, the results presented in Table 3 demonstrate that most students were able to identify types of waste and their impacts and understood the importance of environmental protection. This finding corroborates the study of Ref.. [7], which reported that kamishibai effectively enhances student understanding through the integration of narrative, visual elements, and interaction. In this study, kamishibai served as a contextual medium that supported students in analyzing environmental problems within the Science Project learning process.

The strengthening of affective and social skills is reflected in increased environmental awareness, cooperation, and responsibility among students, as shown in Table 4. These outcomes align with the principles of action-based ESD learning. In terms of psychomotor skills, observations summarized in Table 5 indicate that students were able to design, create, and present kamishibai media, reflecting the application of learning by doing within a project-based learning framework.

Student reflections presented in Table 6 further indicate that the majority of students had positive perceptions of the use of kamishibai in learning. The variation in student responses reflects the diversity of learning experiences and strengthens the credibility of the reflection findings.

From a broader ESD perspective, these findings extend the work of Ref. [7] by demonstrating that kamishibai is not only effective as an environmental learning medium but also functions as a school-based ESD campaign tool integrated with Science Project learning. This integration supports the achievement of Sustainable Development Goals (SDGs) 8, 12, and 13.

Education for Sustainable Development (ESD) has been implemented through various pedagogical approaches, including project-based learning, service learning, inquiry-based learning, and problem-based learning [16,17, 18]. While these approaches effectively promote critical thinking and real-world problem solving, they may face challenges related to student engagement, sustainability of action, or contextual relevance in school settings. In this study, the integration of kamishibai within project-based learning offers a distinctive contribution by embedding sustainability issues into a visual narrative format, enabling students to communicate environmental messages creatively while engaging with scientific concepts and social responsibility.

Despite the positive findings, this study has several limitations. Student reflections were obtained from 50 out of 176 participants, which may not fully represent the perspectives of all students involved in the campaign. In addition, the reflection data relied on self-reported responses that may be influenced by social desirability and students' perceptions of teacher expectations. Furthermore, the absence of a control group means that the findings should be interpreted as descriptive rather than causal. These limitations, however, are consistent with the exploratory and practice-based nature of qualitative research and provide directions for future studies.

The findings of this study also demonstrate practical contributions to several Sustainable Development Goals (SDGs). The development and exhibition of environmentally friendly products support SDG 8 by fostering students' entrepreneurial skills, collaboration, and creativity. The emphasis on waste management and recycling activities aligns with SDG 12 by promoting responsible consumption and production practices within the school environment. Furthermore, by increasing students' environmental awareness and encouraging action-oriented learning, the Green Product Challenge campaign contributes to SDG 13, which emphasizes climate action through education and community engagement. Future research may explore the long-term impact of kamishibai-based environmental campaigns and compare their effectiveness with other ESD-oriented pedagogical approaches across different educational contexts.

4. CONCLUSION

The Education for Sustainable Development (ESD)-based Green Product Challenge campaign was implemented

through kamishibai as an effective, innovative strategy to support Science Project learning in vocational high schools. Kamishibai, a form of traditional Japanese picture theater, is utilized not only as a visual storytelling medium but also as a contextual and communicative educational tool. Through engaging illustrated stories, students are encouraged to understand the scientific concepts behind waste management, explore sustainability issues, and practice concrete steps in waste management and the use of environmentally friendly products.

This study shows that integrating kamishibai into the learning process can enhance students' conceptual understanding of environmental concepts and strengthen their motivation to act sustainably. Furthermore, the collaborative project activities foster the development of critical thinking skills, communication skills, teamwork skills, and creativity in designing local solutions to environmental problems.

By positioning kamishibai as a school-based environmental campaign tool, this program has the potential to bridge the world of science with real-life practices in an engaging, participatory, and contextual manner. The implementation of this campaign contributes to the achievement of Sustainable Development Goals (SDGs) 8, 12, and 13 by strengthening entrepreneurial competencies, implementing responsible consumption and production patterns, and raising awareness of climate mitigation actions. Overall, these findings confirm that kamishibai can serve as an alternative pedagogical medium for implementing ESD-oriented project-based learning in vocational secondary education, and open up opportunities for further research to assess its long-term impact across various educational contexts.

REFERENCES

[1] [Kurup, P. M., Levinson, R., & Li, X. (2021). Informed-Decision Regarding Global Warming and Climate Change Among High School Students in the United Kingdom. Canadian Journal of Science, Mathematics and Technology Education, 21(1), 166–185. https://doi.org/10.1007/s42330-020-00123-5

[2] Priatna, D., & Khan, S. M. (2024). The importance of education and role of educational institutions in climate change mitigation and achieving UN SDG 13 Climate Action. Indonesian Journal of Applied Environmental Studies, 5(1), 1–5. https://doi.org/10.33751/injast.v5i1.10559

[3] Nokelainen, P. (2022). Education for sustainable development: Integrating critical thinking, values, and competencies for global challenges. Sustainability, 14(18), 11234. https://doi.org/10.3390/su141811234

[4] Venegas-Mejía, D., Maldonado-Mariscal, K., & Vargas-Sánchez, A. (2025). Education for sustainable development in schools: A systematic review of pedagogical approaches and challenges. Sustainability, 17(2), 845. https://doi.org/10.3390/su17020845

[5] Papavasileiou, V., Nikou, S., & Economides, A. A. (2025). Barriers and challenges in implementing education for sustainable development in secondary education. Journal of Cleaner Production, 418, 140265. https://doi.org/10.1016/j.jclepro.2024.140265

[6] Sundstrøm, A., Tøttenborg, S. S., & Ødegaard, M. (2019). Teachers' perspectives on education for sustainable development in secondary education. Environmental Education Research, 25(11), 1545–1561. https://doi.org/10.1080/13504622.2019.1607253

[7] Rachman, A., Sari, D. P., & Lestari, N. (2021). The use of Kamishibai as an environmental education learning media for elementary school students. Journal of Environmental Education and Sustainable Development, 22(2), 115–126. https://doi.org/10.52924/CHDK6603

[8] Susilana, R., Suryani, N., & Riyana, C. (2021). Visual storytelling as an innovative learning media to enhance students' engagement and understanding. International Journal of Instruction, 14(3), 489–504. https://doi.org/10.29333/iji.2021.14328a

[9] Taylor, M., Marrone, M., Tayar, M., & Mueller, B. (2017). Digital storytelling and visual metaphor in lectures: a study of student engagement. Accounting Education, 27(6), 552–569. https://doi.org/10.1080/09639284.2017.1361848

[10] Rachman, A., Andriansyah, R., & Putriani, Y. (2024). Kamishibai as an environmental education and disaster mitigation media based on education for sustainable development. Journal of Environmental Education Indonesia, 13(1), 45–57. https://doi.org/10.14710/presipitasi.v18i3.377-385

[11] Anggraini, N. A., Akrim, D., Muis, R., Hutagalung, I., Tawakkal, I., Al Fariz, R. D., Rachman, I., & Matsumoto, T. (2025). Sustainable development goals and carbon reduction: Insights from universities in Eastern Indonesia. TROPHICO, 5(2), 61–70. https://doi.org/10.32734/trophico.v5i2.22915

[12] Ravindran, V. (2019). Data analysis in qualitative research. *Indian Journal of Continuing Nursing Education*, *20*(1), 40. https://doi.org/10.4103/ijcn.ijcn_1_19

[13] Srivastava, P., & Hopwood, N. (2009). A Practical Iterative Framework for Qualitative Data Analysis. *International Journal of Qualitative Methods*, *8*(1), 76–84. https://doi.org/10.1177/160940690900800107

[14] Environmental Communication Pedagogy and Practice. (2017). Routledge. https://doi.org/10.4324/9781315562148

[15] Shelton, C. C., Warren, A. E., & Archambault, L. M. (2016). Exploring the Use of Interactive Digital Storytelling Video: Promoting Student Engagement and Learning in a University Hybrid Course. TechTrends, 60(5), 465–74. https://doi.org/10.1007/s11528-016-0082-z

[16] Martín-Garin, A., Millán-García, J. A., Leon, I., Oregi, X., Estevez, J., & Marieta, C. (2021). Pedagogical Approaches for Sustainable Development in Building in Higher Education. Sustainability, 13(18), 10203. https://doi.org/10.3390/su131810203

[17] Sam, R. (2024). Systematic review of inquiry-based learning: assessing impact and best practices in education. F1000Research, 13, 1045. https://doi.org/10.12688/f1000research.155367.1

[18] Singha, R., & Singha, S. (2024). Application of Experiential, Inquiry-Based, Problem-Based, and Project-Based Learning in Sustainable Education (pp. 109–128). Igi Global. https://doi.org/10.4018/978-1-6684-9859-0.ch006