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Innovation of Maritime Board Game-Based Learning Media as an Effort to Improve Environmental Literacy and Safety Awareness of Orphanage Children

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ABSTRACT

Children at Yayasan Sosial Roudhotul Jannah in Surabaya required visual and participatory learning materials that connected environmental awareness and basic safety practices with everyday experiences. This community outreach project aimed to develop and implement a maritime-themed board game titled Nusantara Exploration and assess children's engagement and understanding during gameplay. The development process followed an adapted Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model. The game incorporated a map featuring Indonesian cultural and natural destinations, accompanied by double-sided cards containing destination information and environmental or safety-related scenarios. Elementary school-aged children participated in small-group activities facilitated by six facilitators. Data collected through observations, verbal responses, group reflections, and facilitator feedback were analyzed descriptively. During gameplay, children actively took turns, exchanged ideas, identified environmental problems such as improper waste disposal and coastal pollution, and proposed preventive measures. The destination-based scenarios provided concrete contexts for discussing environmental consequences and connecting them to everyday practices. Facilitators read the cards aloud and simplified instructions when necessary, enabling children with varying reading abilities to participate meaningfully in group discussions and decision-making activities. The findings suggested that the board game provided a reusable, nondigital learning medium that supported environmental literacy and basic safety awareness in nonformal educational settings. However, the findings were limited to observed engagement and demonstrated understanding during a single intervention session. Repeated implementation and follow-up assessments are recommended to determine whether children retain the knowledge acquired and translate environmental and safety awareness into sustained everyday practices.

INTRODUCTION

Yayasan Sosial Roudhotul Jannah in Surabaya served as the community partner for this community service program, which targeted elementary school-aged children. The initial needs assessment indicated that existing nonformal learning activities required more visual, participatory, and collaborative educational materials. Topics related to cleanliness, environmental awareness, and basic safety were considered more accessible to children when connected to familiar situations and everyday experiences rather than presented solely through

one-way instruction (Albar et al., 2024). Accordingly, the primary challenge addressed by the program was the limited availability of interactive learning media capable of encouraging discussion, decision-making, and cooperation among children.

Environmental literacy during elementary school is essential because pro-environmental knowledge, attitudes, and behaviors can be strengthened through learning experiences connected to real-world situations. Ardoin et al. (2018) demonstrated that environmental education at the K–12 level was associated with improvements in knowledge, attitudes, dispositions, and environmentally responsible actions, while Otto and Pensini (2017) highlighted the relationships among environmental knowledge, connectedness to nature, and ecological behavior. In Indonesia, waste management remains a relevant environmental concern that can be introduced to children through practical activities, such as proper waste disposal and sorting (Altunbey & Çelikler, 2023; Sumirat et al., 2023). This approach aligns with the principles of Education for Sustainable Development (ESD), which emphasize learners' understanding of the connections among individual actions, environmental sustainability, and social responsibility (UNESCO, 2020).

Game-based learning integrates learning objectives, rules, challenges, feedback, and social interaction into an engaging educational experience (Bilancini et al., 2023; Di Paolo & Pizziol, 2024). A review of board game-based learning indicated that educational benefits could emerge through decision-making, negotiation, collaboration, repetition, and reflection (Bayeck, 2020). Board games have also been implemented as educational interventions across various contexts, demonstrating their potential to enhance knowledge, skills, and social competencies, although their effectiveness depends on the quality of instructional design and evaluation (Noda et al., 2019). More broadly, game-based learning has demonstrated potential to foster problem-solving abilities, communication, creativity, and other 21st-century skills (Clark et al., 2016; Qian & Clark, 2016).

However, the educational effectiveness of games does not depend solely on their entertainment value. Meta-analytic evidence has indicated that gamification and game-based learning can positively influence learning outcomes, although their effectiveness varies according to the alignment among instructional objectives, game challenges, feedback mechanisms, and learner characteristics (Dehghanzadeh et al., 2024; Li et al., 2023; Sailer & Homner, 2020; Tokac et al., 2019). Appropriately designed game elements can strengthen learners' perceived competence and social relatedness (Sailer et al., 2017), whereas an excessive emphasis on points or competition without meaningful connections to learning objectives may lead to superficial engagement (Dichev & Dicheva, 2017; Kalogiannakis et al., 2021). Therefore, contextual relevance, meaningful narratives, and structured reflection should be integrated into the instructional design as essential components of the learning experience rather than treated as merely decorative game features (Krath et al., 2021).

The gap addressed by this community service program was the limited availability of reusable, nondigital educational media that integrated the exploration of Indonesian cultural heritage, environmental literacy, hazard identification, basic risk prevention, and collaborative learning into a single instructional resource suitable for orphanage settings. The proposed innovation consisted of a Nusantara Exploration board game accompanied by double-sided educational cards. The front of each card introduced an Indonesian cultural or natural destination, while the reverse presented an environmental or safety-related scenario requiring players to identify problems, discuss potential consequences, and propose appropriate preventive actions. This design was intended to connect geographical and cultural exploration with practical environmental and safety education through collaborative decision-making. Accordingly, the program aimed to develop an educational board game appropriate for elementary school-aged children, implement it through facilitator-guided group activities, and

assess participants' engagement and demonstrated understanding through observations and verbal responses adapted to their reading abilities.

METHOD

Location and Partner

The community service program was conducted on June 7, 2026, at Yayasan Sosial Roudhotul Jannah in the Tegal Mulyorejo Baru area of Surabaya, Indonesia. The participants comprised approximately 20–25 elementary school-aged children attending educational and mentoring activities at the foundation, most of whom were between 6 and 7 years old. Six facilitators assisted with the program, maintaining an approximate facilitator-to-child ratio of 1:3–4 to support the delivery of instructional materials, explanation of game rules, implementation of the board game, and group discussions. Initial observations revealed variations in participants' reading abilities and comprehension of instructions. To accommodate these differences, children were organized into small groups, and facilitators provided oral instructions, assisted with reading game cards, and offered additional explanations when necessary. These adjustments were intended to promote inclusive participation and facilitate children's understanding of the environmental literacy and basic safety concepts presented during the activities.

Needs Analysis

Needs analysis is the initial stage in media development, referring to the *analyze* stage in the ADDIE model. This activity was carried out through observation of learning conditions in the partner's environment, interviews or guided conversations with the managers/caregivers, and internal discussions of the community service team. The aspects identified included the age characteristics of participants, learning habits and patterns, the availability of learning media, reading ability, initial understanding of cleanliness, the environment, and safety, the types of activities children were interested in, and the condition of the available supporting facilities.

The identification results showed the need for learning media that are not only informative but also able to encourage children's active involvement during the learning process. Therefore, the partner's needs were translated into several design criteria, namely that the media be non-digital, easy to use and move, playable repeatedly, visually attractive, use simple language, support interaction in small groups, and raise problems close to children's daily lives. Differences in reading ability, especially among participants in the early grades of elementary school, were also an important consideration in preparing the cards and the facilitation mechanism. The mapping of partner needs, the solutions developed, and the indicators observed during implementation are presented in Table 1.

Table 1. Mapping of Partner Needs, Solutions in the Board Game, and Observation Indicators

Initial need/problem	Solution in the board game	Observation indicators
Learning activities tend to be one-way and the variety of learning media is still limited.	The game is played in groups with a mechanism of turns, choice of steps, discussion, and feedback from the facilitator.	Activeness in following the game, interaction among participants, courage to answer, and involvement in discussion.
The availability of visual media on the environment and safety is still limited.	Use of a Nusantara exploration-themed game board and double-sided illustrated cards containing information and contextual questions.	Participants' interest in the media, readability of the cards, attention during the game, and ease of understanding the messages.

Initial need/problem	Solution in the board game	Observation indicators
Material on cleanliness, the environment, and safety needs to be linked to situations close to children's lives.	Problem cards contain scenarios on waste, cleanliness, environmental and coastal pollution, use of resources, and simple hazards in daily activities.	Participants' ability to recognize problems, explain simple consequences, and convey appropriate alternative actions.
Participants' abilities to read and understand instructions vary, especially among children in the early grades of elementary school.	Sentences on the cards are made short and the facilitator helps read the instructions or questions when needed.	Participants' fluency in following the rules, understanding questions, giving responses, and completing the stages of the game.
Children need learning activities that provide space to communicate and work together.	The game is designed in small groups with discussion before giving answers or determining actions.	Cooperation, communication among participants, ability to listen to friends' opinions, and participation in decision-making.

Solution Design and Development

Development adapted the ADDIE model, which covers analyze, design, development, implementation, and evaluation. At the analysis stage, the team mapped the partner's needs and learning objectives. The design stage prepared the environmental and basic safety content, destination narratives, game flow, visuals, and trigger questions. The development stage produced the board, cards, pawns/movement devices, instructions, and evaluation instruments. The implementation stage applied the game in groups, while the evaluation stage combined observation notes, participant responses, and pretest–posttest measurement. This flow is shown in Figure 1.



Figure 1. Flow of the community service implementation adapting the ADDIE model.

Implementation and Evaluation

The implementation of the educational board game was carried out after the media had been developed and adjusted to the characteristics of the participants. The activity began with a brief orientation on the learning objectives, an introduction to the game components, an explanation of the rules, and a demonstration of one round of the game. Participants were then divided into small groups, and each group was assisted by a facilitator. Assistance was provided to ensure that participants understood the flow of the game, obtained equal opportunities to participate, and were able to follow the discussion without the facilitator giving answers directly.

During the game, participants were asked to read or listen to the information on the cards, recognize the problems presented, estimate the consequences that might occur, and convey the actions considered appropriate to overcome or prevent the problems. Trigger questions were used to help participants develop their answers and connect situations in the game with daily life. For participants whose reading ability was still developing, the facilitator helped read the cards or explained the instructions simply without directing the content of the answers.

Evaluation was carried out in an integrated manner during the activity through observation of the game process, participants' responses to the problem cards, brief reflection, and feedback from participants and facilitators on the use of the media. The aspects observed included activeness, cooperation, communication, courage to express opinions, ability to follow the game rules, understanding of environmental and safety messages, and ease of use of the media. Participants' understanding was observed through their ability to recognize problems, explain consequences simply, and convey actions appropriate to the context on the cards.

At the end of the activity, a group reflection was carried out by asking participants to restate the main messages obtained during the game. The reflection focused on simple behaviors relevant to daily life, such as maintaining cleanliness, disposing of waste in its proper place, caring for the environment, using resources wisely, and avoiding actions that may cause risks. Facilitators' feedback was also used to evaluate the readability of the cards, the clarity of the game mechanism, children's engagement, and the possibility of reusing the media in subsequent learning activities.

Data Analysis Technique

Data from the activity were analyzed using descriptive quantitative and descriptive qualitative approaches. Descriptive quantitative analysis was used for data that could be quantified from observation sheets or simple responses of participants and facilitators. The score obtained for each indicator was compared with the maximum score and expressed as a percentage to describe the level of achievement of the activity. The achievement percentage was calculated using the formula:

$$\textit{Achievement percentage} = (\textit{obtained score} / \textit{maximum score}) \times 100\% \quad (1)$$

The percentage results were used to provide an overview of the level of participant participation, the achievement of message understanding, and acceptance of the media. If interpretation categories are used, the percentages can be grouped into very good, good, fair, poor, and very poor according to the evaluation criteria used in the activity instrument.

Descriptive qualitative analysis was carried out on observation notes, participants' verbal responses, reflection results, documentation, and facilitators' notes during the game. The data were grouped into several main themes, namely participant engagement, group cooperation and communication, the ability to understand environmental and safety messages, ease of following the game mechanism, obstacles arising during the activity, and responses to the design and use of the board game. The findings from each theme were then interpreted to assess the suitability of the media to the partner's needs and the feasibility of the activity.

To maintain consistency of interpretation, the observation results were not used to conclude long-term behavioral changes, but to describe participants' responses, level of engagement, understanding of the messages emerging during the activity, and the potential use of the board game as a reusable non-digital learning medium in the partner's environment.

RESULTS AND DISCUSSION

Needs Analysis Results

The initial analysis led to three main needs. First, participants needed activities that provide space to move, choose, talk, and work together. Second, environmental and safety material needed to be presented through concrete situations so that children could connect the messages with daily habits. Third, the partner needed physical media that do not depend on gadgets or an internet connection and can be reused. These needs supported the choice of a board game because a single set can integrate visuals, rules, conversation, repetition, and feedback.

The choice of this media is consistent with the character of game-based learning, which places participants as active decision-makers. Empirical reviews show that learning outcomes

are stronger when game activities are directly connected to learning objectives and feedback (Boyle et al., 2016; Clark et al., 2016). Therefore, development did not stop at aesthetics, but mapped each component to the expected environmental, safety, and simple behavioral messages.

Board Game Development Results

The game board was designed as an exploration map with branching paths, four starting points, and icons of Indonesian cultural and natural destinations. The sea, island, path, and landmark areas strengthen the Nusantara context while providing points of interaction with the destination cards. The final board design used as the basis of the media is shown in Figure 2.



Figure 2. Design of the Nusantara exploration board game board.

The cards use a double-sided structure. The front side contains the name of the destination, an illustration, the location, and a brief description, while the back side contains an environmental or safety problem that the players need to respond to. For example, the Borobudur Temple card highlights the problem of visitors' waste and environmental cleanliness; the Fort Rotterdam card links the coastal area with waste and coastal pollution. This structure transforms the cards from mere information into triggers for discussion about causes, consequences, and preventive actions.



Figure 3. Example of the front-side (information) and back-side (problem) design of the Borobudur Temple card.

Table 2. Specifications and educational functions of the product components

Component	Design characteristics	Educational function
Game board	Exploration map, branching paths, four starting points, Nusantara destination icons.	Builds a travel narrative, spatial orientation, turn-taking, and decision-making.
Information card	Destination name, illustration, location, brief description.	Introduces cultural/natural diversity and enriches general knowledge.
Problem card	Environmental or safety scenario and open-ended questions.	Trains problem identification, cause–effect relationships, argumentation, and choice of action.
Pawns/movement devices	Physical components marking position and progress.	Trains understanding of rules, turn-taking, sportsmanship, and group coordination.
Facilitator guide	Objectives, flow, key messages, trigger questions, follow-up.	Maintains consistency of facilitation and enables reuse.

Implementation Results with the Partner

The activity was carried out on June 7, 2026, with approximately 30–35 children and 6 facilitators. Mentoring of one facilitator for approximately five to six children was quite relevant for a game model that relies on dialogue, because facilitators could help explain the rules, read the cards when needed, and ensure that every child got a turn. The series of activities included delivery of initial material, a game demonstration, group play, discussion of problem cards, reflection, and completion of the evaluation instrument.

The documentation shows that the media were used in small groups and participants interacted directly with the board and cards. In the explanation session, environmental material was delivered using visual displays; in the game session, children observed positions on the board, made decisions, read or listened to the cards, and discussed with the facilitators; in the evaluation session, participants filled in the prepared sheets with assistance. The most

representative documentation for the article is shown in Figure 4 because it shows three different phases, not merely group pose photos.



Figure 4. Documentation of the implementation: (a) Game with facilitator assistance; (b) Group photo session; (c) Material explanation session

The integration of the Nusantara cultural context with environmental and safety issues produced a more contextual learning experience. Participants not only obtained information about destinations but were also directed to use their knowledge and daily experiences to recognize problems, estimate consequences, and determine appropriate actions. Thus, the cultural elements in the game do not merely function as visual elements, but become a context that connects the learning material with situations that need to be analyzed by participants. This approach is in line with Meya and Eisenack (2018), who showed that environment-themed games become more meaningful when participants are confronted with situations that demand decision-making and reflection on their consequences. On complex environmental issues, the use of narrative and context is also important so that game elements do not stop at entertainment or competition, but direct participants' attention to the learning substance to be achieved (Fernández Galeote et al., 2021).

The use of double-sided cards strengthens the educational function of the board game through a combination of information and contextual problems. The information side introduces destinations and supporting knowledge, while the problem side encourages participants to discuss cause–effect relationships and alternative actions that can be taken. The turn-based game mechanism also gives participants space to listen to friends' opinions, express reasons, work together, and obtain direct feedback from facilitators. These interactions make the learning process take place not only between participants and the media, but also through the exchange of ideas within the group. This is relevant to the finding of Sailer et al. (2017) that appropriately designed game elements can support the fulfillment of the needs for competence and social relatedness through clear goals, interaction, and feedback during the activity.

Nevertheless, the effectiveness of media use is also influenced by participant characteristics. Differences in reading ability, especially among children in the early grades of elementary school, caused some participants to need assistance in understanding the text on the cards. Therefore, facilitators played an important role in reading the questions, simplifying instructions orally, and providing trigger questions without directing the answers. Such assistance was necessary so that reading ability did not become the main obstacle to understanding the environmental and safety messages contained in the game. This finding also serves as evaluation material for media development, particularly regarding the need to use shorter sentences, adequate font sizes, more dominant illustrations, and questions containing only one main idea.

Documentation and observation results during implementation show that the board game can be used as a group learning medium without dependence on digital devices. This character is one of the advantages of the media for the partner because the game can be reused

in learning activities and educational recreation with relatively simple facility requirements. In addition, participants' involvement in reading or listening to the cards, discussing, waiting for their turn, expressing opinions, and formulating actions shows that the media are able to provide an active and participatory learning space. These findings support the potential of the board game as an alternative non-formal learning medium that integrates aspects of knowledge, communication, and group cooperation.

However, observation results from a single implementation need to be interpreted proportionally. The findings of the activity mainly describe participants' engagement, acceptance of the media, ability to respond to problems, and understanding that emerged during the game process, so they cannot yet be used to conclude long-term behavioral changes. The formation of habits such as disposing of waste in its proper place, maintaining environmental cleanliness, using resources wisely, or applying safe behavior requires repeated observation after the activity. Therefore, subsequent activities can be directed toward periodic use of the media by caregivers, simplification of content based on reading ability levels, and follow-up evaluation to determine the consistency of understanding and application of environmental and safety messages in daily life.

CONCLUSION

This community service program successfully developed and implemented a Nusantara Exploration educational board game as an interactive learning medium to promote environmental literacy and basic safety awareness among children at Yayasan Sosial Roudhotul Jannah in Surabaya. The developed learning medium integrated information about Indonesian cultural and natural destinations with contextual environmental and safety-related issues, including cleanliness, waste management, environmental and coastal pollution, responsible resource use, and basic risk prevention, through a game board and double-sided educational cards. The implementation of the board game in small groups demonstrated its potential to facilitate a more visual, interactive, and participatory learning experience by encouraging children to read or listen to card instructions, engage in discussions, express opinions, collaborate with peers, and identify appropriate responses to presented scenarios. Facilitator support played an essential role in ensuring the active participation of children with varying reading abilities and comprehension levels. Furthermore, the board game's nondigital format, ease of use, reusability, and capacity for expansion through additional educational cards supported its potential for continued implementation by the partner organization. These findings suggested that the Nusantara Exploration board game could serve as an alternative nonformal educational resource to support children's environmental literacy, basic safety awareness, creativity, communication skills, and collaborative participation. Nevertheless, the findings primarily reflected participants' observed engagement and demonstrated understanding during a single implementation session and did not establish sustained knowledge retention or long-term behavioral changes. Future improvements should focus on adapting instructional content to different reading proficiency levels, incorporating locally relevant environmental and safety issues into additional game cards, encouraging regular implementation by caregivers, and conducting follow-up assessments to evaluate knowledge retention and the practical application of environmental and safety principles in children's daily lives.

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CONFLICT OF INTEREST

The authors declare that this study was conducted without any commercial or financial relationships that could be interpreted as a potential conflict of interest.

AUTHORS' CONTRIBUTIONS

Lilik Khoiriya: research conceptualization, methodology design, experiment execution, data collection, data analysis, manuscript drafting, and manuscript revision. M Rizqi Mubarok, Andri Djumiati, Imam Nur Rokhim, and Alif Nur Rochmad: research supervision, validation of research results, provision of scientific input, and manuscript review and revision. All authors have read and approved the final version of the manuscript.

STATEMENT ON THE USE OF GENERATIVE ARTIFICIAL INTELLIGENCE

The authors declare that generative artificial intelligence (AI) was used in the preparation of this manuscript to help improve linguistic clarity, correct grammar, and refine the writing structure. Generative AI was not used to generate, manipulate, or analyze research data. The entire content of the manuscript has been reviewed and verified by the author(s). The author(s) are fully responsible for the accuracy, integrity, and final content of the manuscript.

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