



Building Innovative Climate Communication Through The Board Game “Jagad”

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Abstract

Climate change is a critical issue that requires awareness and active participation from all levels of society. However, scientific information about climate change is often difficult to understand and lacks appeal to the general public. This study aims to establish effective climate communication through the development of an educational board game called Jagad. Jagad presents a dynamic conflict between two opposing sides: the “destroyer,” representing human activities that contribute to carbon emissions, and the “savior,” representing mitigation and adaptation efforts to address climate change. The game was developed using a Research and Development (R&D) approach with the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation. During the design and development stages, the game mechanics, rule system, and visual elements were constructed through iterative prototyping and playtesting. The validation process involved climate education experts, instructional media specialists, and groups of players from both student and general community backgrounds. The validation results indicated that Jagad received positive responses and was deemed suitable for use as an educational medium. The playtesting showed that the game effectively improved players' understanding of climate change issues and enhanced their awareness of the importance of mitigation and adaptation actions. These findings demonstrate that Jagad serves as an effective, interactive, and enjoyable learning medium for communicating complex climate issues in an accessible and meaningful way. This game-based approach has the potential to become an inclusive and impactful strategy for climate communication that fosters public awareness and engagement.

Keywords: ADDIE Model, Climate Change, Climate Communication, Educational Board Game, Jagad

1. INTRODUCTION

Climate change is one of the greatest global challenges of this century. The United Nations Environment Programme (UNEP) includes this issue within the concept of the *Triple Planetary Crisis*, which encompasses climate change, biodiversity loss, and pollution and waste (UNFCCC, 2022). These three crises are interrelated, mutually reinforcing, and pose an existential threat to the sustainability of life on Earth. The Intergovernmental Panel on



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Climate Change (IPCC) (2023) emphasizes that global temperatures have risen by approximately 1.1°C compared to pre-industrial levels and may exceed 1.5°C in the coming decade if significant mitigation efforts are not implemented.

This increase in temperature has triggered various extreme phenomena such as severe weather events, prolonged droughts, massive floods, and biodiversity crises (World Meteorological Organization, 2022). The root cause of accelerated climate change lies in human activities, particularly the use of fossil fuels such as coal, oil, and gas, which account for more than 75% of global greenhouse gas (GHG) emissions, with nearly 90% of them being carbon dioxide (CO₂). If left unchecked, this condition threatens the stability of ecosystems and the sustainability of human life in the future.

As a collective global effort, the Paris Agreement and the outcomes of the 29th Conference of the Parties (COP 29) held in Baku, Azerbaijan (2024), aim to keep global temperature rise well below 2°C, with maximum efforts to limit it to 1.5°C. This commitment also encourages countries to achieve Net Zero Emissions (NZE) by 2050 through measures such as reducing GHG emissions by 40% and increasing renewable energy capacity by up to 30% (UNFCCC, 2024). The success of this commitment relies not only on government and corporate policies but also on public awareness and active participation.

Indonesia has demonstrated a strong commitment to climate action through its clean energy transition roadmap toward NZE 2060 (IEA, 2022). However, behind this ambition lies a serious challenge: the low level of public literacy and awareness regarding climate issues. A global survey conducted by Yale University and Meta (2022), involving 108,000 respondents from 192 countries, revealed that only 18% of Indonesian respondents believe climate change is caused by human activities. In terms of climate knowledge, Indonesia ranks only slightly above Laos and Cambodia in the Asia-Pacific region. Furthermore, only 29% of respondents claimed to have "a lot" or "moderate" knowledge about climate change (The Conversation, 2023).

This data highlights a significant gap between ambitious national policies and low public understanding. Increasing public awareness is therefore a strategic step to ensure active participation in national climate action. In this regard, *environmental communication* plays a crucial role in bridging scientific knowledge with social understanding.

Flor (2004) defines environmental communication as the application of communication principles, strategies, and techniques in environmental governance and protection. Moreover, Lie and Servaes (2015) classify environmental communication as a sub-discipline within development communication and social change, focusing on the interactions between humans and their environment.

The main goal of environmental communication is not only to disseminate information but also to foster awareness, empathy, and behavioral change toward sustainability. However, existing climate communication practices often remain monotonous, relying on lectures, seminars, or mass media campaigns that fail to engage audiences emotionally or

cognitively. Consequently, environmental messages are often ignored or misunderstood (Dupar et al., 2019).

Despite numerous campaigns, the effectiveness of environmental communication remains limited in promoting long-term awareness. One-way educational strategies do not sufficiently encourage active public participation, especially among younger generations who require contextual and interactive approaches. Therefore, innovative, participatory, and audience-relevant communication media are urgently needed (Ouariachi et al., 2017).

One promising innovation in this regard is game-based learning (GBL). Ratnah (2025) defines it as a learning method that utilizes specially designed games or applications to facilitate the learning process through direct experience (*learning by doing*). This approach is rooted in experiential learning theory, which emphasizes that knowledge is constructed through active participation and reflection rather than passive reception. In this context, games serve not only as entertainment but also as interactive tools that allow learners to explore, test, and internalize concepts in a meaningful way.

Raharjo et al. (2024) further argue that the integration of games into learning environments represents an innovative approach to increasing student engagement across various educational settings. Through a comprehensive literature review, they conclude that game-based learning effectively enhances learners' motivation, fosters active participation, and creates an enjoyable learning atmosphere. Moreover, this method encourages the development of essential soft skills such as problem-solving, collaboration, and creativity. Their findings suggest that GBL can serve as a relevant and transformative solution to improve the overall effectiveness of education in modern contexts.

Similarly, Adi and Ramadhani (2025) highlight that game-based learning plays a critical role in addressing the persistent challenges of low student interest and motivation, factors that directly affect academic achievement. Their study emphasizes the importance of adapting teaching methods to students' needs, especially in the post-pandemic era, where engagement and flexibility are crucial. By integrating technology through games, teachers can create more dynamic, enjoyable, and participatory learning experiences. The results demonstrate that GBL not only increases learning motivation but also facilitates faster adaptation to new learning environments.

Taken together, these studies underscore the significance of innovation in educational practice, particularly through game-based learning as a method that embodies the principles of *learning by doing*. This approach bridges cognitive understanding and experiential engagement, making it a powerful strategy for promoting active learning, creativity, and sustained motivation among learners.

Several educational games on climate change have been developed globally. One notable example is *Daybreak*, a cooperative board game designed by Matt Leacock and Matteo Menapace. *Daybreak* positions players as collaborators working to stop climate change by building sustainable technologies and resilient societies. The game presents an



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optimistic vision of the near future and focuses on global sustainability solutions. It also features sustainable materials and original artwork created by diverse artists from around the world (Daybreak Game, 2025).

In the Indonesian context, physical, collaborative, and contextually relevant learning media remain relatively limited. Board games represent a suitable alternative because they encourage direct social interaction, negotiation, and collective discussion, supporting experiential learning proven to enhance empathy toward sustainability issues (Ouariachi et al., 2017).

Based on this need, the educational board game *Jagad* was developed to address climate change through the dynamic conflict between two opposing sides: *the destroyer*, representing human activities contributing to carbon emissions (such as fossil fuel combustion and deforestation), and *the saviour*, representing mitigation and adaptation efforts (such as reforestation, renewable energy use, and waste management).

Through gameplay simulation, players are encouraged to understand the consequences of each decision on global temperature rise and ecosystem sustainability. *Jagad* is also designed using recycled, eco-friendly materials, ensuring that its sustainability values are not merely symbolic but also practical. While *Daybreak* and similar games were developed within a global framework focusing on macro issues and technological solutions, *Jagad* adopts a simpler and more contextual approach, tailored to the social realities of Indonesian society. Its game mechanics are intentionally designed to be more accessible and relatable to everyday life, allowing players to connect each in-game action with real-world behavior.

For instance, the common habit of Indonesians relying on motorcycles rather than walking or using public transportation is depicted within the game dynamics as a factor contributing to carbon emissions and rising global temperatures. In this way, *Jagad* not only communicates the abstract concept of climate change but also invites players to reflect on their own behaviors within a local context. This relatable approach is expected to enhance understanding, foster empathy, and encourage environmentally responsible behavior.

This study aims to develop and validate the *Jagad* board game as an interactive and educational medium for climate communication, while also fostering collective awareness of climate issues in Indonesia. The development process employs a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Validation was conducted by experts in climate education and learning media, while trials involved both students and the general public. The game's effectiveness was analyzed in terms of feasibility, engagement level, and improvements in players' understanding and awareness of climate issues.

By combining scientific accuracy with interactive gameplay, the development of *Jagad* is expected to serve as an alternative, inclusive, and engaging climate communication strategy that strengthens environmental literacy among the Indonesian public.

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2. RESEARCH METHOD

This study employed the Research and Development (R&D) method, aiming to produce an educational product in the form of the *Jagad* board game as an interactive and educational medium for climate communication. According to Seels and Richey (1994), *developmental research* is defined as a systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet the criteria of internal consistency and effectiveness. Thus, this research not only focuses on producing an innovative product but also examines its feasibility and effectiveness through expert validation and user testing.

The development model used in this study adopted the ADDIE framework, consisting of five sequential phases: *Analysis*, *Design*, *Development*, *Implementation*, and *Evaluation* (Branch, 2009).

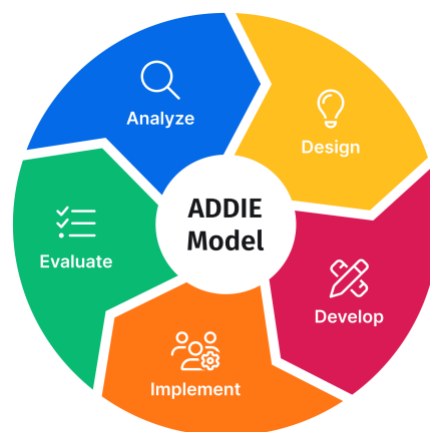


Figure 1. Kerangka ADDIE

Source: (Branch, 2009)

This model was selected because it offers a structured yet flexible framework, allowing iterative revisions at each stage of product development. Compared to more complex models such as Borg & Gall (Rahmatin & et.al, 2025), the ADDIE model provides a systematic and practical approach suitable for developing educational games that require continuous improvement based on expert and user feedback.

Participants and research setting

The participants in this study were divided into two main groups:

1. Expert validators, the environmental education experts, responsible for assessing content accuracy.
2. Target users, consisting of 8 high school students from Institut Indonesia Semarang, selected purposively to represent youth audiences and to test the applicability of the game as a climate communication tool.

The study was conducted between May and July 2025 at the participating school site, which provided permission for the testing session. The participants were chosen to ensure

that the product would be tested in an authentic educational setting and to gather relevant feedback from the intended user group.

Development procedure

The development of the *Jagad* game followed the five stages of the ADDIE (Branch, 2009) model as outlined below:

1) Analysis

This stage involved identifying needs, problems, and goals related to climate education and awareness. The researcher analyzed the gap between learners' current knowledge, skills, and behaviors and the desired learning outcomes, namely, improved environmental literacy and participation in climate action. The analysis also considered learner characteristics, socio-cultural contexts, and the potential of board games as effective and engaging educational tools.

2) Design

In this phase, the conceptual framework of the *Jagad* board game was developed based on educational, interactive, and environmentally sustainable principles. The design components included: (a) the overall game concept and narrative; (b) educational content aligned with climate change themes; (c) game mechanics combining elements of competition and collaboration; and (d) the use of eco-friendly materials, such as recycled paper and non-plastic ink, to reinforce the sustainability message.

3) Development

This stage involved creating the initial prototype of the *Jagad* game and conducting expert validation sessions. Environmental education experts and media design experts evaluated the product for scientific accuracy, visual appeal, instructional clarity, and contextual relevance to Indonesian daily life. Feedback from these experts was used to revise and refine the prototype before user testing.

4) Implementation

The revised prototype was tested in a limited trial with the target user group. Testing was conducted in a classroom setting where participants played the game for approximately 60–90 minutes. Data were collected through direct observation, field notes, and short interviews to capture players' engagement levels, comprehension of climate messages, and emotional responses during gameplay.

5) Evaluation

The evaluation process aimed to assess the feasibility and effectiveness of the product. Data were analyzed using qualitative descriptive analysis, focusing on participants' feedback, comments, and observed interactions.

Validation and product revision

The validation process was conducted in two stages. The first stage involved expert validation, where feedback was collected regarding content accuracy, design coherence, and practical applicability. Based on this feedback, the first revision was made to improve gameplay instructions, educational clarity, and visual quality. The second stage involved field testing with the target users. Observations and player feedback during gameplay were used as the basis for the second revision, resulting in the final version of the *Jagad* board game that met the standards of educational relevance, engagement, and accessibility.

3. RESULT AND DISCUSSION

3.1 Result

The development process of the *Jagad* board game adopted the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), a systematic and flexible framework for learning media development (Rahmatin & et.al, 2025). Each stage was carried out sequentially as follows:

3.1.1 Analysis

The analysis stage began with the identification of the need for effective learning and communication media to enhance climate change awareness among students. Raising environmental awareness and literacy from an early age is a key element in creating a generation that is concerned and responsible for environmental sustainability (Yusup, 2021). Specifically, environmental literacy can be understood as an individual's ability to respond to and take appropriate action based on their understanding and interpretation of their surrounding environmental conditions, with the goal of preserving, restoring, and improving environmental quality (Safitri et al., 2023).

This literacy is reflected in an individual's mastery of basic concepts such as ecosystems, biodiversity, climate change, pollution, and sustainable development (Anggraini & Nazip, 2022). A person with strong environmental literacy not only understands local environmental issues, such as river pollution, but also global issues, such as global warming and climate change.

The problem is that many Indonesians still have misconceptions about climate change. A global survey conducted by Yale University and Meta in 2022 revealed that only 18% of Indonesian respondents believe climate change is caused by human activity. More recent research by the Yale Program on Climate Change Communication, in collaboration with Development Dialogue Asia, Communication for Change, and Kantar Indonesia, compared the knowledge and attitudes of citizens in various countries, including Indonesia, regarding environmental degradation and climate change in 2023 (The Conversation, 2023).

In this context, the majority of Indonesians (76%) stated that they know “a little” about global warming (55%) or “have never heard of it” (20%). On the other hand, 22% of Indonesians said they “know fairly well” about global warming, and only 2% said they “know a lot.” After being asked to self-assess their level of knowledge about global warming and provided with a brief definition, most Indonesians (63%) expressed the belief that global warming is currently happening. Conversely, only 7% believed that global warming is not happening, while 30% were unsure.

These data illustrate that most Indonesians have limited knowledge of the basic concepts of climate change and its impacts. This indicates the urgent need for effective environmental communication media to bridge the literacy gap. This is where the concept of game-based learning plays an important role. Through this approach, information and knowledge are delivered in an interactive, enjoyable, and socially relevant manner.

Game-based learning combines game elements with active learning principles. In the context of environmental communication, this approach provides a participatory and action-oriented learning experience. The Jagad board game was developed as an innovative learning medium that is not only entertaining but also carries a mission to convey critical messages about the climate crisis. In the Jagad board game, players do not merely receive information; they directly engage with simulation scenarios that reflect real-world problems, such as carbon emissions, deforestation, and more. This interactive process encourages players to think, discuss, and seek solutions, the core essence of effective environmental communication.

3.1.2 Design

The Jagad Board Game

The Jagad Game is an educational board game developed as a medium for climate learning and communication. It is designed to enhance players' awareness of climate change issues through experiential learning that is interactive, reflective, and enjoyable. Through simple yet scientifically grounded game mechanics, *Jagad* seeks to connect the concept of global climate change with human behaviors in daily life.

1) General information

Number of Players: 2–4 players

Recommended Age: 12 years and above

Game Duration: 15–25 minutes

Game Type: Cooperative and competitive game

This game can be played in schools, community settings, or other educational activities aimed at strengthening climate literacy and fostering empathy toward the environment.

2) Game components

- **1 Rulebook:** Contains complete guidelines on game rules, gameplay flow, and winning conditions.
- **1 FYI Booklet:** An additional booklet providing concise information on climate change, its global impacts, and eco-friendly lifestyle tips. This booklet serves as a supplementary knowledge source to reinforce the game's scientific context.

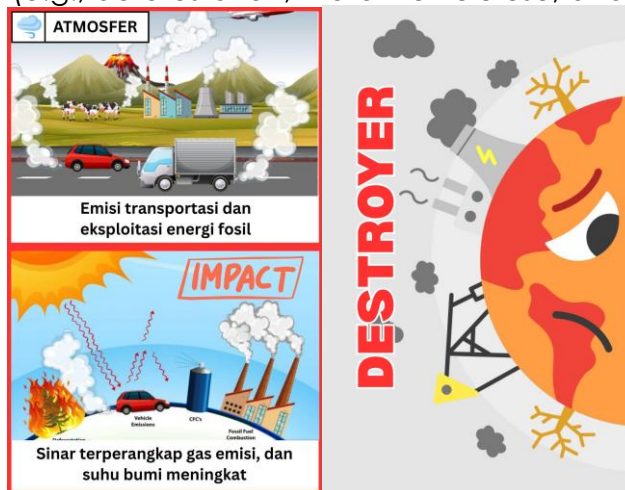
- **1 Game Board:** The main board illustrates the three essential elements of Earth (water, land, and atmosphere). Each element has a *durability limit* representing its threshold against destruction or restoration.



Figure 2. Board Game edukatif "Jagad"

Source: created by the author (2025)

- **36 Playing Cards:**
18 Destroyer Cards: Represent human activities that negatively affect the environment (e.g., deforestation, motor vehicle use, and plastic waste).



(a)

(b)

Figure 3. "Destroyer" Card (a) front view and (b) back view

Source: created by the author (2025)

- **18 Savior Cards:** Depict positive mitigation and adaptation actions (e.g., reforestation, renewable energy use, water conservation, and environmental education).



(a)

(b)

Figure 4. "Savior" Card (a) front view and (b) back view

Source: created by the author (2025)

All game components are designed using recycled materials to support the sustainability values that serve as the game's core theme.

3) Player Roles

In the Jagad board game, players take on the role of either the Destroyer team or the Savior team.

- The Destroyer team represents human activities that are the main drivers of greenhouse gas emissions, such as fossil fuel usage, deforestation, energy waste, and pollution. Their strategy is to expand their influence by putting more pressure on natural elements.
- The Savior team represents groups working to mitigate and adapt to the impacts of climate change. Their strategy focuses on using renewable energy, reforestation, conservation, and environmental education.

4) Game Setup

The elemental board is placed in the center of the table. It consists of several key elements representing the components of Earth: water, land, and atmosphere. Each element has a durability limit (destruction threshold); either 4 or 6 attacks or saves, before it can be claimed by one of the teams.

Savior and Destroyer cards are stacked separately in the center deck.

5) How to Play

The game progresses as follows:

- The Savior team starts by drawing 3 cards from the deck, 2 Savior cards and 1 Destroyer card. The Destroyer team does the opposite, drawing 2 Destroyer cards and 1 Savior card.
- Before playing the cards, players must exchange one face-down card with the opposing team. This adds an element of unpredictability that forces players to

adjust their strategies. It also encourages risk analysis and prediction of the opponent's tactics.

- After exchanging cards, each player places their 3 cards on the elemental board according to the element code written on each card. Every card placed affects global indicators in the context of climate change. For example:
 - a) Savior cards: Reduce emissions, strengthen environmental resilience, or restore ecosystems.
 - b) Destroyer cards: Increase emissions, accelerate ecosystem damage, or worsen natural disasters.

If an opposing card is placed on a player's element slot, that card becomes a defensive card that automatically counterattacks. This mechanism adds strategic complexity, as every offensive move carries the risk of a counter-effect.

6) End of the Game

Each element on the board has a set attack limit. Once the stack of cards on a specific element reaches its limit (4 or 6 cards), that element is claimed by the team that dominates it.

- If the Destroyer team dominates, the element is considered damaged or unsustainable.
- If the Savior team dominates, the element is successfully restored or preserved.

At the end of the game, the global condition of Earth is simulated to show the collective consequences of all players' actions.

- If the Savior team wins, global temperatures stabilize, biodiversity is maintained, and disaster risks are reduced.
- If the Destroyer team wins, temperatures rise, ecosystems collapse, and quality of life declines.

This simulation provides a visual and emotional reflection for players, helping them understand how even small actions can have a major impact on the planet's condition. The Jagad board game is not only entertaining but also delivers important educational messages:

First, the interconnection of actions and consequences, where every decision affects shared conditions. Second, the depiction of real-world dynamics between economic, social, and environmental interests. Third, encouraging players to think critically and understand the complexity of climate change issues. Fourth, providing a memorable learning experience with a lasting impact.

3.1.3 Development

The development of the *Jagad* educational board game originated from concerns about the low level of public awareness in Indonesia regarding climate change issues. Environmental degradation and the declining sustainability of ecological functions have highlighted the need for innovative, participatory, and meaningful communication media. In this context, *Jagad* was developed as an environmental communication and learning



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tool in the form of an educational game that transforms complex climate issues into an engaging and reflective learning experience.

Philosophically, the development of *Jagad* is rooted in the ecological paradigm, a worldview that perceives the Earth as a unified system of life composed of three interdependent components: abiotic, biotic, and cultural (Maknun, 2017). The balance or degradation of the environment is determined by how these three components interact with one another.

The abiotic component represents the physical elements of the environment, such as the atmosphere, land, and water, which serve as the foundation of life. In the *Jagad* game, this component is illustrated as an element that can experience two possible outcomes: destruction through harmful human actions or restoration through conservation efforts.

The biotic component reflects living organisms that are affected by the conditions of the abiotic environment. Declining soil quality, air pollution, and ecosystem damage directly impact biodiversity, habitat quality, and the increasing risk of hydrometeorological and climatological disasters that threaten humans and other species.

Meanwhile, the cultural component represents human behaviors, values, and ethics that determine the direction of environmental sustainability. In *Jagad*, this cultural aspect is embodied through two opposing factions: *the Destroyer* and *the Savior*, each representing different environmental ethics paradigms.

The Destroyer faction symbolizes *anthropocentric behavior*, a worldview that places humans at the center of moral consideration and values nature solely based on its utility to human life. This perspective drives exploitative development patterns such as fossil fuel extraction, deforestation, and industrialization, which produce high carbon emissions. In the *Jagad* game, this paradigm is represented by the Destroyer faction, which seeks to expand its influence by damaging abiotic elements (atmosphere, land, and water), ultimately harming the biotic systems that depend on them.

Conversely, the Savior faction represents *ecocentric behavior*, a perspective that views all ecological components, both living and non-living, as parts of an interconnected system with intrinsic value and function. This viewpoint emphasizes the importance of preserving soil, water, air, and climate as integral to the continuity of life. In *Jagad*, the ecocentric paradigm is reflected in the game mechanics that demonstrate interdependence among elements: damage to the atmosphere affects the land and oceans, ultimately influencing all forms of life on Earth. This principle teaches that protecting the Earth means protecting ourselves as part of the global ecosystem.

Through the interaction between these two factions, the *Jagad* game simulates ethical and strategic choices that mirror real-world environmental dilemmas. Players are encouraged to understand the consequences of exploitative behavior and the urgency of shifting toward a more sustainable and holistic mindset. Thus, *Jagad* functions not only as a medium for climate communication but also as a philosophical reflection tool on how humans should position themselves in relation to nature.

1) Prototype Development and Expert Validation

The development stage involved the creation of an initial prototype and expert validation. The *Jagad* board game prototype consisted of a game board, a set of action cards, and a rulebook. The validation process was conducted by an environmental expert with academic expertise in climate communication and education.

The validation assessed several key aspects: (1) the scientific accuracy of the climate-related content presented, (2) the social relevance to the context of Indonesian society, (3) the clarity of educational messages, and (4) the balance between educational and entertainment elements.

The main feedback from the validator concerned the design and content of the game cards. In the initial version, the cards displayed simple cause-and-effect relationships, such as "cutting down trees → forest destruction." The expert suggested expanding the content to include the context of modern human behavior, long-term impacts, and the underlying causes of such events.

For example:

- Before revision: "Using private vehicles increases air pollution."
- After revision: "The habit of using motorcycles for short distances increases CO₂ emissions, reduces air quality, and accelerates urban temperature rise."

After revisions were made based on this feedback, the validator concluded that *Jagad* had met the criteria for content validity, was contextually and culturally appropriate for Indonesia, and was suitable for further implementation and testing.

2) Results of the Development Stage

The development stage produced a scientifically validated educational game prototype ready for implementation in learning activities. *Jagad* successfully integrates ecological philosophy with a game-based learning approach. The game not only conveys factual knowledge about climate change but also fosters emotional engagement and ethical awareness among players.

Thus, *Jagad* can be categorized as a scientifically grounded and contextually relevant educational medium for Indonesian society, effectively promoting sustainability values and empathy toward the environment.

3.1.4 Implementation

The implementation stage was carried out through a limited trial involving eight students from SMA Institut Indonesia Semarang. The participants were selected purposively, as this age group is considered most representative of the target audience for game-based climate education media. Before the activity began, technical preparations and a briefing session were conducted for facilitators (game masters) to review the game mechanics, role assignments, and observation procedures during gameplay.

The playtest was conducted during school break time, with the classroom transformed into a game arena. The session lasted approximately 30 minutes in a relaxed yet structured atmosphere. Participants were divided into two groups, the *Destroyer Team* and the *Savior Team*, each consisting of four to five players. Before the game began, the facilitator explained the game flow, player roles, use of action cards, and strategies for dominating the elements on the *elemental board*.

1) Gameplay implementation

Once the game began, the classroom atmosphere became lively and interactive. The students appeared enthusiastic, actively discussing and strategizing as they performed their roles. For example, the *Savior Team* tried to defend the atmospheric element from attacks, while the *Destroyer Team* focused on “attacking” the land element using *deforestation* and *energy waste* cards. The card exchange mechanism added surprise and competition, as players had to adjust their strategies in response to unexpected moves from the opposing team.

As the game progressed, the elemental board gradually filled with various action cards. The global indicator in the simulation reflected significant environmental changes. In one session, the *Destroyer Team* managed to dominate by controlling the water and land elements, causing global temperatures in the simulation to rise sharply. However, the *Savior Team* later launched a counterattack using mitigation and conservation cards, restoring part of the Earth's condition. This dynamic triggered critical discussions among players, particularly about how small decisions can have major impacts on the planet's condition.

2) Observation and participant responses

Throughout the session, the researcher directly observed the participants' engagement levels, interaction patterns, and strategic thinking. A short post-game interview was also conducted to gather student feedback and reflections. The data were analyzed descriptively and qualitatively, with findings categorized into three main themes: (1) level of engagement, (2) understanding of climate issues, and (3) changes in environmental awareness or attitudes.

Observation results indicated that:

- Students appeared enthusiastic and actively discussed during the game.
- There was frequent interaction and strategy negotiation between teams in deciding actions that affected the environment on the game board.
- Players demonstrated reflective thinking, especially when discussing the consequences of each action on the Earth's condition.

Some notable student comments included:

- “The game is fun, but it also makes you realize that small things — like using your motorbike all the time — actually have a big impact.” (Abil, Grade XI)
- “The issue of climate change feels closer and easier to understand.” (Fia, Grade XI)

Such spontaneous reflections show that *Jagad* successfully fostered participatory and reflective learning in line with the *learning by doing* principle (Ratnah, 2025). Students were not only playing but also connecting their in-game experiences to real-life behavior. Some even related their reflections to local issues, such as tidal flooding (*banjir rob*) in Semarang's coastal areas, and discussed how mitigation efforts could help reduce such impacts.

Although the trial ran smoothly and received positive responses, several technical challenges emerged. One main issue was time management, as the gameplay occasionally exceeded 30 minutes, potentially overlapping with the next class schedule. Additionally, varying levels of understanding among students required facilitators to provide extra guidance to ensure each group followed the game properly.

Another challenge was the limited number of *Jagad* sets available. With only a few sets, facilitators had to arrange rotation schedules to give all participants a chance to play. Despite these constraints, students' responses to *Jagad* were highly positive. They not only enjoyed the experience but also demonstrated improved understanding of climate issues and stronger motivation to take real action for environmental protection. After the session, several groups even initiated small school projects, such as campaigns to reduce single-use plastics and save classroom energy.

These results indicate that *Jagad* holds strong potential as an effective communication and climate education tool for younger generations. Although this trial was small-scale and qualitative in nature, the findings suggest that educational games can serve as an inclusive, contextual, and enjoyable strategy to foster ecological awareness among Indonesian students.

3.1.5 Evaluation

Although the implementation of the *Jagad* board game at SMA Institut Indonesia Semarang went well and successfully captured students' interest, the evaluation process revealed several areas for improvement for future development.

First, the complexity of the game rules. One of the main issues that arose was the complexity of the game mechanics, especially during the first round. Some students struggled to understand the technical steps, such as the card exchange mechanism or how to interpret the element codes on the elemental board. This caused some groups to need extra time to adapt, which slowed down the game flow and reduced efficiency.

Second, limited game duration. The time available during class sessions was found to be insufficient. Some groups felt they didn't have enough opportunity to explore deeper strategies or test all available cards. As a result, the gameplay experience felt rushed, limiting their understanding of how specific actions affected the climate indicators.

Third, relevance of content to the local context. The game's content was considered too general and did not fully reflect local environmental issues familiar to the students. Some students expressed difficulty in relating the actions on the cards to specific environmental

problems they experience, such as tidal flooding (*banjir rob*) in Semarang or air pollution from motor vehicles. This lack of localized content reduced the emotional connection students had with the messages delivered, making the educational impact less effective than intended.

Fourth, overly dominant competition. While competition is an element that makes the game exciting, the evaluation showed that excessive competition sometimes diverted students' attention from the main goal of understanding climate change concepts. Some students became too focused on "winning" and overlooked opportunities to discuss the meaning behind each action taken. This suggests a need to better balance competitive and collaborative elements in the future design of the game.

The evaluation phase shows that *Jagad* holds strong potential as a game-based learning medium for environmental communication but still requires improvements. These include simplifying the rules, extending the playtime, providing more intensive guidance, and integrating localized issues to make the content more contextual. Additionally, adjusting the gameplay to balance competition and collaboration will be key to creating a more effective and inclusive learning experience.

3.1.6 Summary of Results Based on the ADDIE Model

Stage	Focus of Activities	Key Outcomes
Analysis	Identification of needs and issues in climate communication.	Found low climate literacy among students, indicating the need for interactive learning media
Design	Formulation of the game's concept, mechanics, and content.	Developed the <i>Jagad</i> design based on education and sustainability principles
Development	Expert validation and revision of game content	Content expanded and adjusted to fit the Indonesian social context
Implementation	Limited trial with 8 high school students	Positive responses, high engagement, and improved understanding
Evaluation	Analysis of observations and participant feedback	<i>Jagad</i> deemed feasible and effective, fostering reflective awareness of climate issues

Thus, the results of this study indicate that the development of the *Jagad* board game through the ADDIE model successfully produced a learning medium that is valid, feasible,

and effective in enhancing students' understanding and awareness of climate change issues.

3.2 Discussion

Jagad Board Game as an Environmental Communication Tool for Climate Education

The *Jagad* educational board game is an innovative learning medium designed to integrate elements of entertainment, social interaction, and education to raise awareness about climate change. The game was developed with the primary goal of bridging the gap between scientific knowledge about climate change and public understanding, particularly among students, of the real impacts of human activities on the environment. Through two main roles, *Destroyer* and *Savior*, *Jagad* presents an interactive simulation that illustrates the conflict between destructive behaviors that produce carbon emissions and efforts of mitigation and adaptation to the climate crisis.

The implementation of *Jagad* at SMA Institut Indonesia Semarang demonstrated that the game is effective as a form of *game-based learning*. Students who previously possessed only a general understanding of climate change showed significant improvement in grasping the cause-and-effect relationships between human activities and the Earth's condition. After playing the game, students not only understood the concept of global warming theoretically but were also able to connect it with concrete actions, such as motor vehicle use, energy waste, and deforestation, as major causes of increased carbon emissions. Post-game reflections revealed that students gained deeper awareness of the links between rising global temperatures and real-world consequences such as extreme weather, droughts, and ecosystem disruption.

These findings align with the study of Galeote et al. (2024), which shows that the *game-based learning* approach can transform players' mental models of climate change. Galeote emphasizes that simulation games, including those based on virtual reality, help players understand the causal relationships between human activities, carbon emissions, and rising global temperatures, while also highlighting the consequences of policy and behavioral choices. Such an approach has proven to be more effective than traditional "information deficit" communication models, as it involves active participation, emotional engagement, and deep reflection from participants.

As a tool for environmental communication, *Jagad* simplifies complex scientific concepts into a form that is engaging, understandable, and contextually relevant to Indonesian students. The game mechanics, which require cooperation, decision-making, and collective strategy, make the learning process both active and reflective. Each card played represents not only a symbolic action but also a realistic simulation of the positive or negative impact of human activities on the Earth's systems. For example:

- When the *Destroyer Team* plays emission-increasing cards, the global temperature indicator rises, representing the risk of global warming.

- Conversely, when the *Savior Team* plays mitigation or conservation cards, the negative effects decrease, showing how collective action can slow environmental degradation.

The strength of *Jagad* lies in its ability to offer interactive simulations that connect science with players' social experiences. This approach aligns with Flood et al. (2018), who argue that interactive communication models in environmental education can accelerate social learning processes and promote adaptive actions toward climate change. Thus, *Jagad* functions not only as a cognitive learning tool but also as a medium for fostering affective and social awareness.

Furthermore, *Jagad* excels in cultivating values of collaboration and collective responsibility. Through player interaction, students learn that maintaining environmental balance cannot be achieved individually but requires cooperation and mutual understanding. This reflects the concept of *social learning* in sustainability education, where environmental problem-solving is built through dialogue, reflection, and joint action in real social contexts.

Despite the positive outcomes of the implementation, several challenges remain. Some participants initially struggled to understand the game mechanics, particularly in reading element codes and performing card exchanges. Time limitations also constrained players from developing more complex strategies. Additionally, differences in participation levels among students indicated the need for a more active facilitator role to ensure equal engagement among all participants. Therefore, simplifying the game instructions, extending playtime, and increasing the number of facilitators are essential aspects for further development.

Evaluation results showed that *Jagad* successfully enhanced students' conceptual understanding of climate issues and fostered reflective awareness of how daily behaviors affect the planet. Students who previously only recognized the term "*climate change*" now understood it as the result of complex interactions between human behavior and natural systems. As one participant remarked, the game "helps you see the real connection between human actions and how the Earth responds." Such awareness marks an important first step toward developing pro-environmental behavior and climate literacy among younger generations.

For future development, *Jagad* can be localized to better align with Indonesia's social and geographical contexts. Incorporating scenarios such as tidal flooding (*banjir rob*) in Semarang, forest fires in Kalimantan, or air pollution in Jakarta would make the game's messages more contextual, emotional, and relatable for players from various regions.

By combining elements of entertainment, learning, and social interaction, *Jagad* not only enhances students' understanding of scientific concepts related to climate change but also cultivates ecological awareness and motivation to take real action for environmental sustainability (Kolb, 1984). *Jagad* has strong potential to serve as an educational and environmental communication medium that can be used in schools, communities, and public institutions to nurture a climate-conscious and resilient young generation.

4. CONCLUSION

4.1 Conclusion

The Jagad board game has proven to be an effective innovation for educating climate change issues while serving as an engaging and inclusive environmental communication tool. Through its game-based learning approach, the game successfully simplifies complex scientific concepts into interactive experiences that are easy for students to understand. Evaluation results show significant improvements in students' understanding: they not only recognize the term "climate change," but also comprehend its connections to human activities and its impact on global temperatures, weather patterns, and ecosystem sustainability.

Additionally, Jagad fosters active discussions, collaboration, and empathy among players, creating a participatory and enjoyable learning environment. Although there are challenges, such as the initial complexity of the rules and limited playtime, these can be addressed through simplified mechanics and better facilitation in future implementations. Overall, Jagad serves not only as a learning tool but also as an effective platform for environmental communication, raising collective awareness and encouraging more sustainable behaviours. With the integration of localized content and broader implementation, Jagad has great potential to be used nationally as a climate education medium, supporting efforts to build a generation that is both aware of and responsive to the challenges of the climate crisis.

4.2 Recommendations

The development and testing of the Jagad game demonstrate its great potential as an interactive and enjoyable climate change education tool. However, to maximize its impact, several steps need to be taken:

- 1. Conduct long-term evaluations.**

Long-term testing is needed to assess how well the knowledge and awareness gained by participants are retained over time. This step is important to determine whether the understanding developed through gameplay leads to real behavioral changes, such as reducing plastic use, conserving energy, or actively participating in environmental initiatives within their communities.

- 2. Expand testing to diverse regions.**

Given Indonesia's cultural diversity, literacy levels, and socioeconomic characteristics, testing needs to be expanded to various regions to evaluate the game's effectiveness in different contexts. For example, gameplay experiences and comprehension may differ between students in urban areas, rural communities, or island regions. Expanding testing would help identify the game's strengths and weaknesses across different communities while allowing facilitators to adapt support strategies accordingly.

- 3. Integrate local content.**

Environmental issues faced by Indonesian communities vary by region. In some areas, flooding and water pollution are major concerns, while in others, deforestation, forest fires, or plastic waste crises are more pressing. By adjusting game

scenarios and action cards to reflect local issues, the messages conveyed will be more relevant and relatable to players' daily experiences.

Through these development steps, Jagad is expected to evolve not only as an innovative climate communication medium but also as a tool that builds collective awareness and drives real, sustainable action. This more contextual and inclusive approach will strengthen Jagad's role as an adaptive educational strategy with broad impact across various segments of Indonesian society.

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