
Mystery Box Plant: A Gamified Meaningful Learning Approach to Enhancing Student's Green Affective Within Merdeka Belajar Curriculum Framework

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Abstract:

The *Merdeka Belajar* curriculum and Green School guidelines emphasize project-based learning as a vehicle for cultivating environmental responsibility. However, in practice, students often exhibit low green affective responses and struggle to care for plants in classroom projects—an issue observed during preliminary fieldwork at SMPN 1 Warureja Tegal. To address this, the study aimed to design a meaningful and engaging gamified module that fosters environmental awareness through experiential learning. Employing a design thinking approach, the Mystery Box Plant game was developed, wherein students receive unidentified plant seeds [and \[A1\]](#) and must nurture them until growth allows identification. The element of curiosity, paired with real-time observation, invites deeper reflection on the care process. Students can only “win” by successfully growing and identifying their plant—thus linking responsibility with reward. Pre-test and post-test instruments were used to assess attitudinal change. Results indicate the module not only increased student engagement and responsibility in plant care but also enhanced their understanding of why environmental stewardship matters. By integrating meaningful learning strategies, the game facilitates the internalization of ecological values and encourages the formation of a sustained, affective mindset toward environmental care—advancing both curricular goals and long-term behavioral change.

Keywords: Merdeka Belajar, Meaningful Learning, Green Affective, Gamification, Environmental Education

INTRODUCTION

Education plays a pivotal role in driving the growth and development of a nation. According to Human Capital Theory, societal productivity is positively correlated with the level of education attained by its citizens (Schultz, 1961). In the context of nation-building, curricula function as strategic instruments to guide educational processes in alignment with national visions and values (Ornstein & Hunkins, 2017). In Indonesia, the education system has undergone continuous transformation, notably marked by the introduction of the *Merdeka Belajar* curriculum, launched by the Ministry of Education, Culture, Research, and Technology in 2022. This reform aims to grant schools and teachers greater autonomy in shaping contextually relevant and meaningful learning experiences, as a response to post-pandemic learning loss (Kemendikbudristek, 2022).

The research problem addressed in this study centers on the significant disconnect between the environmental education goals outlined in the *Merdeka Belajar* curriculum and the actual implementation in Indonesian schools (Raflizar et al., 2025). Despite the curriculum's emphasis on meaningful learning and environmental stewardship, students demonstrate low levels of green affective responses and limited engagement with plant-based ecological projects. Field investigation conducted at SMPN 1 Warureja Tegal revealed that only 10% of students perceived their learning as environmentally meaningful, and more than 70% had never engaged in ecological projects, indicating a substantial implementation gap that undermines the curriculum's environmental education objectives.

The urgency of this research is driven by several critical factors: (1) Indonesia's commitment to sustainable development goals requires urgent environmental education improvements at the secondary school level; (2) the post-pandemic learning recovery period presents a critical window for innovative pedagogical interventions; (3) current environmental education approaches fail to develop the affective domain necessary for long-term behavioral change; and (4) the *Merdeka Belajar* curriculum's flexibility demands evidence-based innovative learning models that can be adapted across diverse school contexts.

Meaningful learning, as conceptualized by Ausubel (1963), emphasizes the integration of new information into pre-existing cognitive structures, thereby fostering relevance and long-term understanding. However, its implementation in Indonesian schools still encounters obstacles. Previous research in environmental education has explored various approaches to enhance student engagement and environmental awareness. Lindemann-Matthies et al. (2024) demonstrated significant improvements in plant species literacy through non-digital games at the university level, emphasizing visual identification tasks and experiential learning. Nuradhisti and Prasetyaningtyas (2025) developed Mystery Box learning media for elementary science subjects, confirming that interactive, curiosity-driven formats enhanced learning outcomes. Nisa et al. (2023) showed that environment-themed board games effectively raise environmental awareness and understanding of sustainability. However, these studies primarily focused on cognitive outcomes rather than affective domain development, and limited research has specifically addressed the integration of gamification with meaningful learning principles in the context of the *Merdeka Belajar* curriculum.

A field investigation conducted at SMPN 1 Warureja Tegal revealed that only 10% of students perceived their learning as environmentally meaningful, and more than 70% had never engaged in ecological projects. This indicates a substantial [gap\[A1\]](#) between the aspirational goals of the *Merdeka Belajar* curriculum and the realities of pedagogical practice on the ground. In response, this study proposes the design of a gamified learning module: Mystery Box Plant, as an innovative educational strategy to improve students' green affective and meaningful learning engagement. By combining students' curiosity with project-based plant care, the module intends to foster a deeper sense of responsibility and ecological awareness. As supported by recent educational design research, gamification can enhance student motivation, critical thinking, and emotional involvement (Deterding et al., 2011; Hamari et al., 2014). Moreover, the integration of environmental education within game-based experiences aligns with global trends in sustainability pedagogy (Tilbury, 2011).

The novelty of this research lies in its comprehensive integration of Design Thinking methodology with gamification principles specifically tailored for green affective development within the *Merdeka Belajar* curriculum framework. This study introduces the Mystery Box Plant concept as an innovative educational strategy that combines curiosity-driven learning with hands-on plant care, incorporating culturally relevant visual design elements based on Kobayashi's Color Image Scale. The research contributes a replicable framework for developing educational tools that address both cognitive and affective learning domains while respecting local cultural contexts and curriculum requirements.

This study aims to (1) examine the contextual barriers and opportunities in implementing meaningful environmental learning, (2) design a gamified instructional model tailored to students' interests and school context, and (3) evaluate its effectiveness in enhancing green affective attitudes among junior secondary students. The benefits of this research extend to multiple stakeholders: (1) for educators, it provides an evidence-based gamified learning model that can be adapted to various school contexts within the *Merdeka Belajar* framework; (2) for curriculum developers, it offers insights into effective integration of affective learning outcomes with environmental education goals; (3) for students, it delivers engaging and meaningful learning experiences that foster long-term environmental responsibility; and (4) for educational policymakers, it demonstrates innovative approaches to addressing implementation gaps in environmental education. The implications of this research contribute to advancing both educational innovation and environmental sustainability goals, supporting

Indonesia's commitment to developing environmentally conscious citizens through transformative educational experiences.

METHODOLOGY

This study employed a qualitative research approach utilizing the Design Thinking methodology to develop an educational gamification tool aimed at enhancing students' environmental affective awareness. The research was conducted at SMPN 1 Warureja, involving 20 seventh-grade students selected through cluster sampling, a method suitable for populations divided into naturally occurring groups (Soewardikoen, 2021).

The Design Thinking process encompassed five stages: *Empathize*, *Define*, *Ideate*, *Prototype*, and *Test*. In the *Empathize* stage, data were collected through classroom observations, semi-structured interviews with students and teachers, and focus group discussions to understand the challenges in environmental education. The *Define* stage involved analyzing the collected data using SWOT and PEST analyses to identify key issues and set design objectives.

During the *Ideate* stage [A1], creative solutions were generated using mind mapping techniques. Color selection for the gamification tool was guided by Kobayashi's Color Image Scale, which links color combinations to emotional responses, ensuring the visual design elicited the desired affective reactions (Kobayashi, 1991). Prototypes were developed and refined based on feedback from iterative testing sessions.

Data collection methods included observation, interviews, and questionnaires. To enhance the credibility and validity of the findings, methodological triangulation was employed, combining multiple data sources and methods to cross-verify results (Denzin, 1978; Patton, 1999). This approach aligns with best practices in qualitative research to ensure comprehensive and reliable outcomes.

In the *Test* phase, the effectiveness of the gamified module was evaluated using a one-group pre-test and post-test design. The instrument was a 10-item Likert-scale questionnaire measuring affective learning outcomes. Question items were developed based on the affective domain taxonomy by Krathwohl et al. (1964), the visual-emotional design principle by Norman (2013), and the educational evaluation frameworks proposed by Wang (2013) and Ware (2012). Data were analyzed using the Normalized Gain (N-Gain) method, which measures proportional improvement across pre- and post-test scores (Hake, 1998).

The study's methodology aligns with previous research emphasizing the effectiveness of game-based educational media in enhancing student engagement and learning outcomes (Salamah & Sarjiyem, 2025). By integrating Design Thinking with rigorous qualitative methods and validated design principles, the research provides a replicable framework for developing educational tools that foster environmental awareness among students.

RESULT AND DISCUSSION

Using SWOT and PEST framework, mapped internal strengths such as the presence of a green house, green open spaces, and a vision aligned with environmental character. Weaknesses included minimal contextual learning materials and low student initiative in care-based plant projects. Externally, the Merdeka Curriculum and the Green School movement offered policy opportunities, while barriers included uneven teachers preparedness and declining student interest. These insights confirmed the urgency of an engaging, visual, and affective-centered educational intervention.

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Figure 1. Greenhouse facility at Junior High School 1 Warureja, Tegal.

From ten concept sketches developed during the Ideate phase, students and Teachers selected a mascot design that was later named Detectives-Reja, a character symbolize curiosity of students to solve the game and embedded with cheerful expressions and a local narrative identity. Visual iterations progressed from black-and white conceptual sketches (see Figure 2) to colored, finalized vector Illustrations (see Figure 3)



Figure 2. Sketch Ideas Visual Identity of Mystery Box Plant Gamification



Figure 3. Colored Visual Identity of Mystery Box Plant Gamification

Color choices for the mascot and game visuals were intentionally dominated by green and blue tones, selected based on Kobayashi's Color Image Scale (1991). These colors were chosen to evoke psychological impressions of growth, trust, nature, and calmness, aligning both with the theme of environmental stewardship and the desired affective outcomes of the game. Green symbolized the organic, nurturing aspect of plant care, while blue conveyed calm exploration and responsibility-emotions essential for internalizing ecological values. Notably, the egg-shaped mascot design was interpreted by students as reference to telur asin (salted-egg), a culturally iconic souvenir from Tegal. This local relevance enriched the narrative and improved students emotional attachment to the game.

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The Mystery Box Plant game was structured a progressive mission-based system (Figure 4). Students, working in small groups, received a randomized game set containing planting tools, seed kits, and 10 challenge cards.

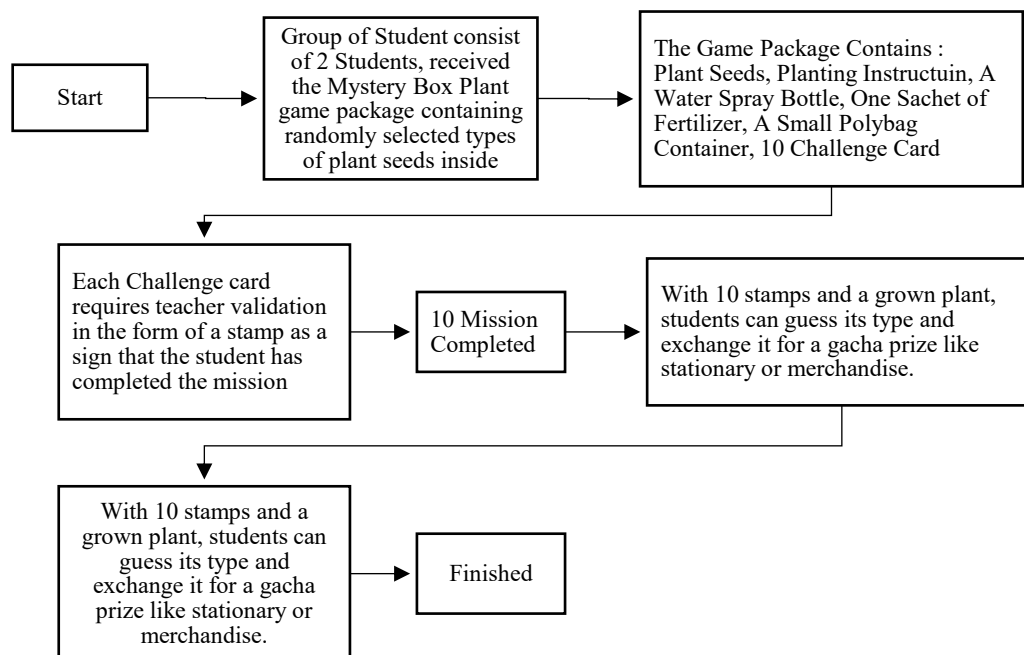


Figure 4. Workflow of the Mystery Box Plant Gamification

Each challenge required validation from teacher marked by a stamp. Once all 10 stamps were collected, students could exchange their progress and growing plant for a gacha-style-reward-such as books stationery, or keychains. At the end of the game, plants were officially handed over to the school's green area, reinforcing environmental stewardship. The system effectively combines gamification with formative assessment and environmental contribution.

The game was implemented over six weeks with 20 students in Seventh Grade. Each student group received an unlabeled seedling and progressed through challenge-based stages. To evaluate impact, pre-and post-test were conducted using 10-item Likert questionnaire based on affective domain principle (Krathwohl et al., 1964), emotional design (Norman, 2013), and educational evaluation models (Wang, 2013; Ware, 2012). The change in scores was quantified using the Normalized Gain (N-Gain) by Hake, 1998.

The formula is as follows:

$$N - \text{Gain} = \frac{(\text{Post Test Score} - \text{Pre Test Score})}{(\text{Maximum Score} - \text{Pre Test Score})} \dots\dots\dots (1)$$

Table 1. Average Students Scores on Green Affective Indicators

Affective Indicator	Pre-Test Mean	Post – Test Mean	N-Gain
Visual Interest	3.20	4.50	0.65
Positive Environmental Emotion	3.15	4.45	0.66
Pro-Environmental Behavioral Intention	3.10	4.40	0.66
Understanding of Plant Importance	3.25	4.40	0.66
Environmental Responsibility	3.25	4.55	0.66
Visual Influence Emotional Response	2.95	4.20	0.63
Clarity of Environmental Visual Message	3.05	4.35	0.66
Interest in Visual Based Learning	3.10	4.45	0.68
Social Environmental Concern	3.00	4.30	0.65
Curiosity Toward Nature and Plants	3.15	4.50	0.66

This approach allows proportional analysis of individual improvements, regardless of the starting score, and categorize effectiveness as:

Table 2. Effectiveness Category Based N-Gain Score

N-Gain Score	Interpretation of N-Gain Score
$>0,70$	High
$0,30 - 0,70$	Moderate
≤ 0.30	Low

The result of this study is consistent with and extend the growing body of research supporting the integration of educational games in environmental and plant-based learning. Lindemann-Matthies et al., (2024) demonstrated that even at the university level, learners exhibit significant improvements in plant species literacy through non-digital games. Their findings underscore the value of visual identification tasks and experiential learning to compensate for gaps in organismic biology education. In a similar fashion, the Mystery Box Plant module used in this study encouraged students to associate visual cues with real-life plant growth, reinforcing taxonomy concepts through physical interaction rather than rote memorization.

The idea of embedding curiosity and narrative exploration through mystery was previously explored by (Nuradhisti & Prasetyaningtyas (2025), who developed a Mystery Box learning media for science subjects in elementary schools. Their results confirmed that interactive, curiosity-driven formats enhanced learning outcomes and promoted logical reasoning. The present study expands on that by applying the mystery box concept in a secondary school context with specific focus on environmental affect, thus demonstrating the scalability and thematic flexibility of the approach.

From a design perspective, Rizkiyah et al., (2024) highlighted the importance of adapting game mechanics to students' learning style to foster motivation. This aligns with the visual-dominant design used in Mystery Box Plant, including the use of expressive mascots, character-based prompts, and visually rich challenge cards—all of which were informed by local cultural elements and validated through teacher-student feedback.

Moreover, the findings support the work of (Nisa et al., 2023), who showed that environment-themed board games like Grow the Plant! can effectively raise students' environmental awareness and understanding of sustainability. Unlike purely conceptual classroom lessons, the Mystery Box Plant experience allowed students to engage in direct, tangible care for their assigned seedlings. This direct interaction not only improved their affective response but also created a sense of responsibility that extended beyond the game's duration.

Together, these studies reinforced the potential of game-based and affect-driven media to bridge the gap between theoretical instruction and meaningful learning outcomes. The Mystery Box Plant module demonstrates that, when grounded in pedagogical theory and supported by cultural relevance and visual engagement, gamified environmental education can serve as a transformative tool for behavioral and affective change in younger learners

CONCLUSION

The Mystery Box Plant gamified module proved effective in enhancing students' green affective attitudes through meaningful, project-based learning. Designed using a Design Thinking approach, the module combines visual storytelling, cultural relevance, and hands-on plant care to foster emotional engagement. Based on N-Gain analysis, all ten affective indicators achieved moderate effectiveness (0.63–0.69), showing notable improvement in areas such as environmental responsibility, [curiosity](#)[\[A1\]](#), and visual interest. The integration of local cultural elements—such as the egg-shaped mascot linked to Tegal's *telur asin*—and the use of Kobayashi's emotional color scale

contributed to the module's relevance and student motivation. This research supports the use of gamified tools to bridge curriculum goals and student engagement, particularly under the *Merdeka Belajar* curriculum framework.

The findings demonstrate that combining curiosity-driven learning with hands-on environmental care can effectively develop both cognitive understanding and affective commitment to environmental stewardship. Future research recommendations include: (1) conducting longitudinal studies to examine the long-term behavioral impacts and sustainability of affective changes beyond the immediate intervention period; (2) testing the scalability of the Mystery Box Plant module across diverse school contexts, geographical regions, and socioeconomic backgrounds to establish broader applicability; (3) exploring digital or hybrid adaptations that combine physical plant care with virtual elements to enhance accessibility and reach; (4) investigating the integration of assessment rubrics that can systematically measure both affective and cognitive outcomes in environmental education; and (5) developing professional development programs for teachers to effectively implement gamified environmental learning approaches within existing curriculum structures.

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