Designing a Locally Contextualised Cooperative Mobile Game for Environmental Education in Iskandar Puteri

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ABSTRACT

Environmental education needs activities that connect everyday environmental problems with opportunities for participation and shared responsibility. Cooperative digital games offer one way to represent collective action, but their educational value depends on the relationship between game rules, environmental content and reflection. This article presents a design and development case study of Bin-Go, an Android cooperative game situated in a stylised representation of Iskandar Puteri, Malaysia. The study examines how local environmental themes can be translated into a reusable gameplay structure and how shared goals can be supported without assigning players permanent roles. The evidence comprises the project report, game design specifications, implementation descriptions and documented interface sequences. Development followed a Game Development Life Cycle informed by iterative refinement, using Unity 6 and Photon Fusion 2. The principal design outcome is a Gather Process Deploy loop in which two to four players collect crisis items, process them at appropriate stations and deliver them to designated destinations for a shared team score. The documented playable implementation contains the Bukit Indah and SIREH Lake environments; the broader five-theme framework represents an expansion plan rather than five completed levels. The design analysis identifies links between environmental tasks, visible consequences and opportunities for informal coordination. It also identifies a need to explain where simplified game actions differ from actual environmental practice. The contribution is a context-specific account of how a cooperative mobile game can organise environmental content and collective participation. The case provides a foundation for facilitated educational use and subsequent learning evaluation. It does not establish gains in environmental knowledge, awareness or real-world behaviour, which require direct assessment in future studies. This revision additionally proposes a structured debriefing sequence, localisation criteria and a staged usability, learning and network evaluation protocol; these additions are not evaluated results.

Keywords: environmental education, cooperative learning, serious games, mobile learning, Iskandar Puteri

INTRODUCTION

Environmental education involves understanding problems and recognising how individual actions relate to collective outcomes. A learner may recognise litter or polluted water without understanding how a sequence of decisions contributes to prevention or remediation. An educational activity therefore needs to make the relationship between an action, its consequence and other people's participation understandable. A game can represent these relationships through rules and feedback, provided that its educational purpose remains visible within play. Sustainability education also connects systems thinking with interpersonal competence, providing a rationale for examining environmental tasks and shared responsibility together (Wiek et al., 2011).

Serious games for environmental management have been examined as settings in which environmental problems can be explored through structured activity. Madani et al. (2017) review the variety of environmental games and highlight the importance of evaluating their effectiveness. This diversity means that the educational contribution

of a particular game should be explained through its actual tasks and intended outcomes. A game about an environmental topic does not automatically demonstrate that players learn from it.

Bin-Go was developed as a cooperative Android game using locations associated with Iskandar Puteri. Players collectively respond to environmental challenges through a shared sequence of collecting, processing and delivering items. Its design treats environmental action as a group activity. The project report documents both a broad thematic proposal and a narrower playable implementation. This article centres the two documented environments and distinguishes their implementation from planned expansion (Lee, 2026).

The article addresses two questions. How does the documented design translate environmental themes into repeatable player actions? How do its rules create opportunities for shared responsibility and coordination? These questions establish a design contribution relevant to educational practice. They do not require assuming that enjoyment or completion of game tasks proves environmental learning.

Design gap and contribution

The design problem addressed here is how to connect locally recognisable settings, repeatable environmental tasks and interdependent participation within one mobile interaction structure. The contribution has three components: a documented mapping between environmental themes and the Gather Process Deploy loop; an account of how shared scoring and flexible task allocation can support collective action; and a proposed instructional extension that connects play to explanation, critique and local application. The first two components interpret the documented artifact. The instructional extension and evaluation protocol below are new proposals developed in response to the limitations of that artifact; neither has been implemented or tested in this study.

The local context is therefore more than a choice of visual assets, but its educational value remains a hypothesis. A recognisable place can anchor a discussion about who produces waste, who manages it and which actions residents can take. Establishing that this connection improves understanding requires learners to identify and explain those relationships directly. The study makes an analytical contribution through explicit design reasoning rather than a claim of demonstrated educational effectiveness.

RELATED LITERATURE

Educational purpose and playable activity

Designing an educational game requires attention to the activities that make players engage with its subject matter. Laine and Lindberg (2020) connect educational design principles with game motivators and identify a range of options for developing engaging learning activities. For Bin-Go, this raises a practical design issue: players need environmental content to matter to their decisions rather than appearing only as background decoration. Ke (2016) similarly identifies the integration of subject-specific learning into game mechanics as a central design concern. Plass et al. (2015) explain that game-based learning involves cognitive, motivational, affective and sociocultural processes, which require attention beyond the presence of rewards.

One approach is to connect progress to the completion of a meaningful action sequence. In this case, collecting an item alone does not complete the task. Players must recognise its next destination and complete an appropriate processing step before contributing to the team score. This arrangement makes the sequence of actions central to success. Whether players understand its environmental rationale remains a separate assessment question. This interpretation follows the integration of learning actions and game actions discussed by Ke (2016); it is a design rationale rather than evidence that this particular sequence produces learning.

Evidence for environmental learning

Mayer (2019) emphasises the need to evaluate educational games with research designs that measure the intended learning outcomes. An implementation case study can document what an artifact makes possible, whereas a learning study must examine what participants actually acquire or retain. This distinction guides the claims made here. The present analysis concerns documented design decisions and their educational

interpretation. Broader reviews likewise distinguish the potential of games from evidence for particular outcomes and call for stronger experimental examination of effective features (Boyle et al., 2016). Wouters et al. (2013) found that learning effects varied with instructional conditions, including supplementary instruction and group play. These findings justify evaluation of the learning arrangement rather than treating a playable artifact as sufficient evidence of effectiveness.

The local setting is treated as a design choice rather than an established cause of learning. A stylised neighbourhood or lake can provide a concrete reference for discussion. It cannot by itself establish that players recognise a location accurately, understand local environmental conditions or transfer game routines to everyday life. Those outcomes need direct evidence from the intended learners. Squire (2006) frames videogames as designed experiences, offering a conceptual basis for considering how tasks and settings work together. This perspective informs the interpretation of the local setting here without demonstrating a location-specific learning effect.

METHODOLOGY

Study approach and evidence

This is a descriptive design and development case study based on Lee's (2026) undergraduate project report. The evidence includes the development methodology, game architecture, rules, production descriptions and interface documentation. The present article reorganises that evidence around environmental task representation and cooperation. It does not report a newly conducted experiment, stakeholder consultation or independent software performance test.

The analysis follows the documented path from environmental topic to player action, from action to feedback and from individual participation to team outcome. These links are interpreted as design affordances: opportunities the rules provide, rather than guaranteed effects on learners. The analysis is an interpretive synthesis of the report rather than a formally coded qualitative study. No inter-rater reliability or thematic saturation is claimed.

Development process

The report describes a Game Development Life Cycle combined with iterative refinement. The process moves from the game concept and requirements through production, testing and revision. Unity 6 provides the development environment, while Photon Fusion 2 supports multiplayer state coordination. The documented target platform is Android, with sessions organised around two to four players using separate devices.

For an educational application, this development structure permits content and interaction problems to be considered together. A confusing destination, for example, may reflect an interface problem, an unclear sorting category or both. The available report describes refinement activities but does not provide a complete version history or a systematic record of every change. The development method is therefore reported at the level supported by the documentation.

Scope control

The early design proposes five environmental themes. Later implementation sections and the conclusion identify Bukit Indah and SIREH Lake as the two active environments. References to five completed crisis levels would therefore overstate the implementation. This article reports a reusable framework with two documented environments and discusses further themes as prospective extensions.

The report also contains varying descriptions of map navigation and thematic coverage. The analysis consequently uses features consistently supported by the production account: cooperative play, shared scoring, collection and processing tasks, the two environments, and a sequence of menus, lobby, level selection, gameplay and results. Fine-grained implementation details should be checked against the release build before replication.

Evidence boundaries and design traceability

To make the interpretation inspectable, each claim is linked to a source category: rules and task descriptions support the action sequence; production descriptions and interface figures support the reported environments and navigation; and theory supports the proposed educational interpretation. Screenshots document visible interface states, but cannot establish usability, network reliability or player understanding. Educational opportunities in Table 1 should consequently be read as propositions for evaluation.

This distinction also separates artifact inspection from participant evaluation. References to testing within a development process do not establish that a documented user study measured learning or cooperation. No participant sample, analysable interaction dataset or educational effect estimate is introduced here. The framework can guide replication, but replication would require verification against the actual build and an explicit record of its version, devices and network configuration.

Design Outcomes

Translating environmental content into actions

The central outcome is the Gather Process Deploy loop. During gathering, players locate and collect items associated with an environmental problem. During processing, they move items to a suitable station and perform the required conversion. During deployment, they deliver the processed item to its designated destination. A completed sequence contributes to the common score.

The documented waste-management example involves collecting waste, processing it and delivering it to an appropriate receiving point. The water setting introduces pollution-related items and processing actions. These are game representations of environmental activity. Mechanical compression, filtering or washing within a brief session should not be interpreted as instruction for handling actual contaminated material. Facilitated use needs to clarify the simplified nature of these actions.

Table 1 summarises the relationship between the design features and the educational opportunities interpreted in this article. The third column expresses intended opportunities, not measured learning outcomes.

Table 1. Design features and intended educational opportunities

Design feature	Documented function	Educational opportunity
Ordered task loop	Gather, process and deploy items	Discuss why environmental actions require an appropriate sequence
Shared team score	Combine completed tasks into one outcome	Discuss collective responsibility and contributions
Flexible task roles	Allow players to change activities	Practise negotiation and support during a shared activity
Two local environments	Residential and aquatic settings	Compare environmental representations across settings
Progress feedback	Display score, timer and results	Reflect on decisions and distinguish speed from accuracy

Source: Lee (2026), design and implementation chapters. Educational opportunities are interpretations, not measured outcomes.

Figure 1 shows how the level selection interface presents the two environmental settings through separate mission cards.

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Figure 1. Level selection interface linking the two environmental settings

Source: Lee (2026), Figure 4.8.

A shared score and flexible participation

All players contribute to a team score. The design therefore makes collective completion more prominent than individual ranking. It creates a visible shared objective: a player can assist by collecting, operating a station or completing delivery. The same objective can accommodate different contributions within a session. Social interdependence theory provides a relevant interpretive lens: cooperative learning involves the relationship between shared goals and the organisation of participants' efforts (Johnson & Johnson, 2009). The shared score is therefore examined as a possible support for cooperation rather than as proof of cooperative learning.

Players are not assigned permanent specialist roles. Instead, the task sequence allows them to negotiate who handles each stage. This flexibility may reduce the barrier to beginning play, because a newcomer can contribute through a limited task before coordinating a longer sequence. It also creates a design challenge. A shared score alone does not guarantee that every participant contributes equally or that one experienced player does not dominate decisions. The distinction is consistent with Johnson and Johnson's (2009) account of structuring cooperative learning, in which group membership alone does not establish productive cooperation.

Carry limits and station availability are described as additional reasons to distribute work. These features create opportunities to exchange items and adjust responsibilities. Their educational interpretation concerns shared responsibility and coordination. Evidence of equitable participation would require observation or interaction records that identify who performed which actions; such records are not provided as an analysable dataset in the report.

Local environments and navigation

Bukit Indah provides a residential setting in which players navigate compact spaces and processing destinations. SIREH Lake provides an aquatic setting with different spatial constraints. Their contrast allows the same core action sequence to be presented in different environmental contexts without requiring players to learn an entirely new control system.

The local names provide a possible starting point for discussion about neighbourhood waste and water environments. However, the stylised scenes should not be treated as evidence of actual pollution levels or verified conditions at the named sites. Their role in this case is contextual representation. Any classroom material making specific claims about those places would need separate, current local sources.

Figures 2 and 3 show the contrasting playable environments. Both retain the visible timer, shared score and touch controls, while the residential obstacles and waterborne objects change the spatial demands of collecting items.



Figure 2. Bukit Indah gameplay with the shared score and countdown interface

Source: Lee (2026), Figure 4.10.



Figure 3. SIREH Lake gameplay with waterborne objects and an aiming guide

Source: Lee (2026), Figure 4.11.

Feedback and reflection

The interface communicates progress through the shared score, time remaining and results screens. These signals help players recognise whether a sequence has contributed to the task. The design also describes environmental facts within the play experience. The educational limitation is that rapid action and factual explanation compete for attention during a timed activity. Instructional-support research indicates that learners may need help selecting and organising relevant information in complex game environments (Wouters & van Oostendorp, 2013). This supports reviewing the timing and clarity of environmental explanations in future versions.

A facilitator can use the results screen as a transition into reflection. Questions can ask why items needed different destinations, how players divided tasks and which parts of the game would be unsafe or unrealistic outside the simulation. These questions are proposed teaching uses, not activities evaluated in the source study. They extend the design into an instructional sequence that would itself require testing. The proposed reflection stage is informed by evidence on supplementary instruction and instructional support in game-based learning (Wouters et al., 2013; Wouters & van Oostendorp, 2013).

DISCUSSION

Contribution to environmental education design

The case illustrates a way to make cooperation structurally relevant to environmental gameplay. The environmental problem supplies the objects and destinations, while the shared score makes success a collective concern. The contribution lies in documenting this arrangement within a mobile game linked to a Malaysian setting. It does not establish that this is the first game to combine these features or that it is superior to alternative instructional approaches.

A useful implication is that educational content should be considered at the level of action rules. A game may depict a polluted setting while rewarding speed alone. Bin-Go's task sequence offers an alternative design emphasis because progress depends on completing an ordered process. Nonetheless, the environmental accuracy of each sequence needs expert review. A mechanically coherent task can still communicate an incomplete or misleading account of the real-world process. This concern is consistent with Ke’s (2016) emphasis on integrating domain learning into gameplay and with the multidimensional design foundations discussed by Plass et al. (2015).

The reusable loop also has a practical advantage for future development: the same interaction pattern can organise additional content. Reuse should be limited by conceptual fit. A new topic should not be forced into collecting, processing and depositing if that sequence obscures its environmental meaning. Expansion therefore requires content review as well as additional maps and assets.

Implications for facilitated use

An initial educational deployment could combine a short introduction, cooperative play and a guided discussion. Learners could first identify an environmental problem relevant to their setting, then compare the game's representation with actual actions available to them. Reflection can address how responsibility was distributed and whether individual choices created difficulties for teammates. Such an arrangement brings the contextual experience of play (Squire, 2006) into discussion with systems thinking and interpersonal competence in sustainability education (Wiek et al., 2011).

Access also matters. Separate Android devices and a functioning multiplayer connection are part of the documented configuration. Before school deployment, educators would need to check connectivity, installation, interface readability and whether all learners can participate comfortably. The case does not supply device coverage or accessibility test results, so broad claims of universal mobile accessibility would be premature.

Structured facilitation and debriefing

A proposed 40-minute classroom sequence comprises a five-minute introduction, five minutes of control familiarisation, fifteen minutes of cooperative play, ten minutes of debriefing and five minutes of individual application. These durations are a suggested teaching arrangement, not a tested intervention. Before play, the educator states one achievable objective, such as explaining why different waste items require different handling, and reminds learners that the game simplifies environmental processes. Within each group, learners agree on an initial task distribution and rotate tasks between rounds so that participation is not restricted to the most experienced player.

Debriefing should first reconstruct an actual event: "Which item caused disagreement, and what did your team do?" It should then probe explanation: "Why did that item require a different destination?" A cooperation question follows: "Who had fewer opportunities to act, and how could the next round be organised differently?" The educator asks for specific examples rather than accepting a high score as evidence of understanding. Learners can compare a fast but poorly explained decision with a slower decision supported by a clear environmental reason.

A final accuracy and transfer stage asks: "Which game action would be unsafe or incomplete in real life?" and "What could your school or neighbourhood actually do about this problem?" In the waste scenario, compression is a game transformation rather than proof that all materials can be recycled together. In the water scenario, washing an object is not evidence that contaminated water or wildlife is safe. Learners should not handle unknown waste, chemicals or affected wildlife to reproduce game actions. The educator uses locally approved guidance and qualified environmental advice to explain appropriate reporting and handling.

For individual application, each learner selects an unfamiliar environmental scenario and records an appropriate action, the reason for it and who should be involved. This short response distinguishes participation from explanation and gives quieter learners an opportunity to demonstrate understanding. The educator records misconceptions for later revision of task instructions. The sequence is an instructional proposal informed by the existing literature on supplementary instruction and instructional support (Wouters et al., 2013; Wouters & van Oostendorp, 2013), not an evaluated feature of Bin-Go.

Adapting the design to other locations

Transfer to another region should preserve the interaction structure only where it represents the environmental concept accurately. Developers first identify an issue relevant to the intended community, then obtain local educational or environmental review of its causes, appropriate responses and limitations. Names and landmarks can be replaced, but waste categories, collection arrangements, language and responsible agencies also need localisation. A change of scenery alone is insufficient to establish contextual relevance.

A practical adaptation record should specify the original feature, its local replacement, the reason for the change and the evidence used to justify it. The revised learning objective is mapped to a player decision and a debriefing question. If a topic involves prevention or long-term policy choices that cannot be represented meaningfully by collecting and depositing objects, a different mechanic should be introduced. Local recognition, conceptual accuracy and accessibility then require assessment with the new audience. The present case offers transferable design questions rather than evidence that the same build will be effective elsewhere.

Limitations and future evaluation

The evidence is a single project report rather than an independently replicated development study. Source descriptions vary between planned and implemented features, and the current analysis has no direct access to the release build. These limits reduce confidence in claims about completeness, performance and deployment readiness. They do not prevent examination of the documented design, but they require clear boundaries around it.

Future evaluation should measure the intended educational outcome directly. For waste sorting, this could involve classification tasks administered before play, immediately afterwards and at follow-up. A comparison activity would help distinguish the contribution of gameplay from exposure to environmental information. Observation could examine how learners explain decisions and whether quieter participants receive meaningful opportunities to act. These proposals respond to calls for stronger empirical evidence and clearer links between game features and learning outcomes (Boyle et al., 2016; Mayer, 2019).

Further work should also assess transfer. Sorting correctly in a simulation is a different outcome from changing disposal practices outside it. A study concerned with everyday behaviour needs an appropriate behavioural measure and a suitable follow-up period. Enjoyment, task completion and knowledge should be reported as separate outcomes rather than combined into a general claim of effectiveness.

Proposed staged evaluation protocol

The following protocol is proposed future work. It is not a report of completed recruitment, expert review or user testing. An initial content review could involve three to five educators or environmental specialists examining the correspondence between objectives, item categories, feedback and real-world actions. Reviewers would identify misleading simplifications and judge whether debriefing corrects them. Disagreements and resulting changes should be recorded rather than reduced to an unsupported statement that the content was validated.

A formative usability pilot could then recruit approximately 12 to 16 intended users in groups of two to four, with appropriate consent, assent and institutional approvals where required. This is a practical planning range for identifying interaction problems, not a statistically powered effectiveness sample. A standardised briefing and familiarisation period should precede two short gameplay rounds with task rotation. An observer records installation or joining failures, requests for help, incorrect routing, task handovers, stalled stations and unequal participation. Brief post-play interviews ask users to explain selected actions and identify confusing feedback. A short usability questionnaire may supplement observation, but satisfaction should be reported separately from learning.

The pilot analysis should report group composition, prior gaming experience, device specifications, build identifier, session length and withdrawals. Findings should include task completion counts, error descriptions and concrete revisions, with denominators and missing data stated. Group-dependent observations must not be treated as independent individual outcomes. A small pilot can guide redesign and establish feasibility; it cannot by itself demonstrate sustained environmental learning or behavioural change.

An educational evaluation would subsequently compare the facilitated game sequence with an activity matched for environmental content, instructional time and discussion. Assessment should include a pre-test, an immediate post-test and a delayed test, for example two to four weeks later. Parallel classification and explanation items can assess knowledge and application to unfamiliar situations. The study should specify its primary outcome in advance, justify sample size, account for group or classroom allocation, and report effect estimates with uncertainty. Any difference would concern the complete instructional arrangement unless the study separately manipulates gameplay and debriefing.

Behavioural transfer requires additional evidence beyond self-reported intention or game scores. A later study could examine an approved, clearly defined disposal task or aggregate school waste-sorting outcomes over an appropriate period, with attention to privacy, opportunities to act and competing influences. Knowledge, enjoyment, observed cooperation and real-world practice should remain distinct outcomes.

Multiplayer performance and deployment assessment

Unity 6 and Photon Fusion 2 identify the implementation technologies; their use alone does not demonstrate network robustness or scalability. The documented configuration concerns two to four players per session. It does not establish how many concurrent rooms the deployed service can support. Before classroom deployment, the actual build should be tested across two-, three- and four-player sessions, representative Android devices and both stable and constrained connections. The test record should identify the server region, network conditions, build version, session duration and device configuration.

Proposed measurements include room-joining success, time to join, disconnections, recovery after connection loss, frame rate and discrepancies in item ownership, shared score and timer state. Where controlled impairment is feasible, latency, jitter and packet loss should be varied and recorded separately; bandwidth alone does not describe connection quality. Concurrent-room testing is a separate assessment and should specify the tested load. Acceptance criteria should be set before testing for the intended classroom use, with observed failures and their consequences reported. No latency, frame-rate or capacity benchmark is claimed in this manuscript.

Particular attention should be given to two players attempting to collect the same item, deployment during a connection interruption, and a player leaving mid-round. The evaluation should determine whether the

implemented state-management rules prevent duplicate scoring, lost items or an unrecoverable session. Any proposed recovery behaviour requires confirmation in the build. Educators also need a contingency activity if a session cannot continue; observation of another group can support discussion, but should not be counted as equivalent hands-on participation in an evaluation.

CONCLUSION

Bin-Go provides a documented design and development case linking environmental task sequences, collective goals and two locally contextualised mobile environments. The contribution is the explicit relationship between the Gather Process Deploy loop, flexible participation and environmental interpretation, together with a proposed facilitation sequence that addresses the gap between simplified game actions and real-world practice. The implementation account supports examination of the design, while the staged evaluation protocol makes its educational and technical assumptions testable. Content review, pilot usability assessment, network testing and comparative learning evaluation remain necessary. Neither learning gains nor behavioural change can be inferred from the current documentation.

Declarations

This manuscript is derived from the Bin-Go undergraduate project documented by Lee (2026). A companion manuscript examines player experience from the same project; the present article is restricted to the design and development contribution. Final authorship, corresponding author details, funding, competing interests, permissions and any required ethics statements must be confirmed by the authors before submission. No new participant data are introduced in this design account.

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