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IMPLEMENTATION OF THE ADDIE METHOD IN THE DEVELOPMENT OF A 2D ACTION GAME WITH MISSION MECHANICS AS AN EDUCATIONAL MEDIUM FOR ENVIRONMENTAL CONSERVATION

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Abstract

Environmental education at the elementary school level requires learning media capable of delivering information in an engaging and easily understood manner. Observations and interviews conducted at SD Negeri 57 Kota Bengkulu found that classroom learning still relies heavily on lectures, textbook reading, and question-and-answer sessions, and that teachers face limitations in giving students a direct, tangible picture of specific environmental conditions such as littering and waste accumulation. To address this gap, the present study develops Eqoquest, a 2D action game with mission-based mechanics designed as an educational medium for environmental conservation. The study aims to apply the ADDIE model in the development of Eqoquest, to determine the results of functional testing, and to evaluate the usability of the game using the System Usability Scale (SUS). The game was built with Godot Engine version 3.3.2 through five sequential ADDIE stages, namely Analysis, Design, Development, Implementation, and Evaluation. Environmental information is conveyed to players through information boards, character dialogues, a mission board, and a collectible-gathering activity involving three types of waste objects: plastic bottles, banana peels, and metal scraps. Each collectible obtained increases an on-screen counter and contributes toward the mission requirement, while monsters, a boss monster, and a ravine obstacle function purely as optional challenges that are not required to complete the mission. Functional testing covering fifteen scenarios that exercise the game's main features achieved a 100% success rate, indicating that every tested function operated as designed. Field implementation involving 12 fourth-grade students of SD Negeri 57 Kota Bengkulu on 19 August 2026 produced a total SUS score of 652.5 with a mean score of 54.38, which falls into the Marginal Low category on the Acceptability Range, Grade F on the Grade Scale, and the OK category on the Adjective Rating. These findings indicate that Eqoquest functions correctly according to its design, whereas its usability, as perceived by young end users, still leaves considerable room for improvement in subsequent development cycles. The study did not conduct expert validation and did not measure gains in students' environmental knowledge or learning outcomes, since no pretest-posttest design was employed.

Keywords: ADDIE, Eqoquest, 2D Action Game, Environmental Conservation, System Usability Scale

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INTRODUCTION

Environmental education plays an important role in developing students' awareness of their surrounding environment. It is not limited to transferring environmental knowledge but also aims to build understanding of the relationship between humans and nature, as well as encouraging responsible actions to preserve environmental sustainability. UNESCO emphasizes that environmental education should foster knowledge, awareness, attitudes, skills, and active participation in solving environmental problems.

At the elementary school level, environmental learning must be adapted to students' developmental characteristics. Interactive learning media can support this process by presenting information in a more engaging and understandable manner than conventional lecture-based methods. Previous studies have shown that technology-based and activity-oriented learning media can increase student participation and learning interest compared to static or text-based materials.

One digital medium that can be utilized to support environmental learning is an educational game. Educational games combine entertainment and instructional content, allowing learners to gain knowledge while interacting with the game system. By embedding learning objectives into gameplay mechanics, educational games can provide meaningful learning experiences while maintaining student motivation and engagement.

Based on observations and interviews conducted at SD Negeri 57 Kota Bengkulu, classroom learning still relies primarily on lectures, textbook reading, question-and-answer sessions, and limited visual media. Teachers reported that students tend to be more enthusiastic when learning activities involve attractive visualizations and direct interaction. However, teachers face difficulties in presenting environmental issues such as waste accumulation and environmental degradation in a realistic classroom setting, creating a need for more interactive learning media.

A two-dimensional (2D) educational game was selected as the proposed solution because it enables the integration of characters, objects, environments, and educational content within a single interactive platform while remaining relatively efficient to develop. Previous studies have demonstrated that 2D educational games remain suitable and effective for elementary school students due to their simplicity, accessibility, and engaging visual presentation.

This study developed a 2D action game called *Eqoquest*, which combines mission-based gameplay with environmental conservation content. In the game, players collect different types of waste, including plastic bottles, banana peels, and metal scraps, while interacting with information boards that provide educational content about each waste type. Character dialogues and mission objectives are also integrated to strengthen players' understanding of environmental issues and conservation practices.

In addition to educational elements, *Eqoquest* incorporates action mechanics such as monsters, environmental obstacles, and exploration challenges. Mission completion requires players to collect the required waste items and reach the designated endpoint. These mechanics are designed to create an engaging learning experience while ensuring that environmental conservation messages remain closely connected to player activities throughout the game.

The game was developed using the Godot Engine and followed the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. To assess the quality of the developed product, evaluation was conducted through functional testing and the System Usability Scale (SUS). Through this approach, the study aims to develop an educational 2D action game that supports environmental education for elementary school students while providing a usable and engaging learning medium.

1.2 Theoretical Background

Educational games combine playful activity with material that carries an instructional purpose, allowing users to interact with various in-game elements while simultaneously acquiring the information embedded in the gameplay. Ariel and Yusuf (2025) developed an educational game for elementary mathematics learning by integrating instructional content directly into gameplay activity, showing that games can be designed as interactive learning media by adapting features, interface, and gameplay activity to the characteristics of elementary-school users.

Two-dimensional (2D) games present characters, objects, environments, and other game elements through a two-dimensional visual representation. The 2D format can be applied across a wide range of genres and allows developers to build characters, environments, interactive objects, interfaces, and gameplay mechanics within a two-dimensional space. Hasanah et al. (2025), for instance, developed the UI/UX of a 2D educational game as a supporting learning medium, demonstrating the application of the 2D format combined with educational elements and user-experience evaluation.

Action games place player action and response at the center of the gameplay experience: players control a character that moves and interacts with a variety of challenges within the game environment, with action elements realized through character-movement mechanics, interaction, obstacles, or combat with enemies. Kartadinata and Akbar (2025), in their development of a character system for a 2D RPG game using Godot Engine, implemented a character controller and combat system encompassing character movement, attacks, enemy detection, and a damage system, indicating that movement and combat can form part of a 2D action game's mechanics.

Mission mechanics provide direction and purpose for player activity throughout a game. A mission can define particular actions or targets that the player needs to accomplish, giving in-game activity a clear objective. Naufal et al. (2024) explain that in-game activities such as quests or missions play a role in shaping the play experience of serious games, and that clear activity design is required so that gameplay activity can support both user experience and the game's underlying purpose. In games that integrate educational information, mission mechanics can likewise be used to connect the game's objective with the activity and information presented to the player, so that the mission mechanic not only directs gameplay but also becomes the bridge linking information with the player's in-game activity.

Godot Engine is a game engine that can be used to develop games, including 2D games, by managing characters, environments, objects, interfaces, interaction systems, and various gameplay logic. Kartadinata and Akbar (2025) used Godot Engine to implement a character system for a 2D RPG game comprising a character controller and combat system, while Jonathan, Pragantha and Haris (2023) used Godot Game Engine to develop a 2D strategy game, both illustrating the engine's suitability for building varied gameplay mechanics within a single development environment.

Research and Development (R&D) is a research approach directed toward producing a specific product and testing its effectiveness, and the ADDIE model is one instructional-design framework commonly used within an R&D approach. ADDIE consists of five stages: Analysis, used to identify the needs and conditions underlying development, including problem analysis, user needs, user characteristics, and subject matter; Design, used to compose the product design prior to development, covering concept, flow, mechanics, system structure, interface, and other components needed as a guide for development; Development, the process of realizing the design into a usable product by integrating the various designed components; Implementation, the stage at which the developed product is applied to users under a

determined usage condition, giving users the opportunity to interact directly with the product; and Evaluation, the stage at which the product and the results of development are evaluated according to the evaluation forms established for the study, providing information about the product's functionality and usage as a basis for judging the outcome of development and identifying areas that still require improvement. Ariel and Yusuf (2025) likewise applied the five ADDIE stages in developing an educational mathematics game for elementary students.

Usability concerns the quality of a system or product as experienced during use, and its evaluation is required to obtain a picture of the user experience when interacting with a developed product. In the context of educational games, usability evaluation can be used to determine users' assessment of the interface and overall usage experience; Hasanah et al. (2025) used the System Usability Scale (SUS) in testing the UI/UX of a 2D educational game, producing a SUS score as one measure for evaluating the product's usability based on user assessment.

The System Usability Scale (SUS), introduced by Brooke (1996), is a usability-evaluation instrument consisting of ten statements with five response options each. SUS scoring assigns different contribution scores to odd- and even-numbered statements: for odd-numbered statements, the contribution score is obtained by subtracting one from the response value, while for even-numbered statements it is obtained by subtracting the response value from five. All ten contribution scores are then summed and multiplied by 2.5 to yield a SUS score ranging from 0 to 100. Hasanah et al. (2025) likewise applied SUS to evaluate a 2D educational game, obtaining a usability assessment from users regarding the design of the game they developed.

Functional testing is carried out to determine whether the functions contained in a piece of software operate in accordance with the expected outcome, typically through a set of scenarios in which a particular input is provided or a particular function is executed and the resulting output is observed. Utami, Alifa and Yaqin (2024) applied black-box testing to a game in order to test its gameplay functions without examining internal code structure, and Ariel and Yusuf (2025) applied a similar approach in the development of a mathematics educational game. In functional testing, software functions are tested according to a set of predetermined scenarios, and the actual outcome of each scenario is compared against the expected outcome to determine whether the tested function succeeded, thereby providing information about the functional soundness of the software based on the scenarios used.

Building on the preceding literature and theoretical background, this study addresses the need for a medium capable of conveying environmental-conservation information through interactive activity for elementary students. A game was chosen as the medium because it allows environmental information to be integrated directly with the activity performed by the user during play. The resulting product adopts a 2D action format with mission mechanics, chosen specifically to give the player a clear objective while simultaneously connecting gameplay activity with the environmental-conservation theme through the information and activity embedded in the game. Eqoquest was developed using the ADDIE model together with Godot Engine as the development tool, and the resulting product was subsequently tested through functional testing to determine feature functionality according to the test scenarios, as well as through the System Usability Scale to obtain a picture of usability based on user assessment after using the game.

Based on the foregoing discussion, this study formulates three research questions: how is the ADDIE method applied in the development of a 2D action game with mission mechanics as an educational medium for environmental conservation; what are the results of functional testing of the developed 2D action game; and what is the level of usability of the game based on user assessment using the System Usability Scale (SUS)? In line with these questions, the objectives of this study are to apply the ADDIE model in the development of Eqoquest, to

determine the results of functional testing of the developed 2D action game, and to determine the level of usability of the game based on user assessment using SUS. This study is not intended to measure any increase in students' knowledge or learning outcomes regarding environmental conservation.

RESEARCH METHOD

This study adopts a Research and Development (R&D) approach based on the ADDIE model, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. These stages were preceded by a problem-identification step carried out through observation and interviews at SD Negeri 57 Kota Bengkulu in order to obtain a picture of the existing learning conditions and the media-development needs at that school. The details of the research framework are presented in Table 1.

Stage	Main Activity	Outcome
Problem Identification	Identifying learning conditions and media needs through observation and interviews at SD Negeri 57 Kota Bengkulu	Problems and media-development needs obtained
Analysis	Analyzing user needs, student characteristics, subject matter, and hardware/software requirements	Requirements underlying the development of Eqoquest obtained
Design	Designing the game concept, mission mechanics, gameplay flow, framework, flowchart, use case diagram, activity diagram, storyboard, menu structure, and interface	Eqoquest design obtained
Development	Developing Eqoquest using Godot Engine based on the design results	A runnable, testable Eqoquest game produced
Implementation	Implementing Eqoquest with 12 fourth-grade students of SD Negeri 57 Kota Bengkulu and administering the SUS questionnaire	User assessment data on Eqoquest's usability obtained
Evaluation	Conducting functional testing and analyzing the SUS questionnaire results	Functional-testing results and usability-evaluation results for Eqoquest obtained

Table 1. Research Framework

The research process began with problem identification to obtain an overview of the initial conditions and media-development needs. After the problem was identified, the study proceeded through the ADDIE stages. During the Analysis stage, the needs of users, the characteristics of students, the subject matter, and the development requirements of the game were analyzed, with the necessary data obtained through observation, interviews, and a literature review; the results of this analysis served as the basis for determining the product design.

The Design stage involved composing the Eqoquest design prior to development, covering the game concept, gameplay flow, mission mechanics, interface, storyboard, flowchart, use case diagram, activity diagram, and other components required during development. The Development stage was the process of realizing the design results into the Eqoquest game using Godot Engine, during which the player character, game environment, monsters, boss monster, mission board, information boards, dialogue, collectibles, counter, interface, interaction system, gameplay obstacles, and other designed functions were implemented.

The Implementation stage was carried out by giving users the opportunity to try Eqoquest directly; after using the game, users completed the System Usability Scale (SUS) questionnaire as the usability-evaluation instrument. The Evaluation stage analyzed the results of functional testing and the SUS questionnaire: functional testing was used to determine the functional soundness of the tested features, while SUS was used to obtain a picture of Eqoquest's usability based on user assessment. Evaluation in this study was focused solely on these two aspects and did not include validation by subject-matter or media experts; the evaluation results were then used to draw the study's conclusions.

2.1 Needs Analysis

The users of Eqoquest for the purposes of this study were fourth-grade students of SD Negeri 57 Kota Bengkulu. This choice of users was taken into consideration when designing the display, gameplay mechanics, controls, and information presentation so that the game would be usable by elementary school students. During implementation, the fourth-grade class comprised 13 students in total; one student was absent, so the implementation activity was attended by, and the SUS questionnaire subsequently completed by, 12 students.

The main hardware used in the development and implementation of Eqoquest was a laptop belonging to the researcher, with the following specifications: an AMD Ryzen 5 5600H processor with Radeon Graphics running at 3.30 GHz, 8 GB of RAM, AMD Radeon(TM) integrated graphics, 477 GB of storage, and a 64-bit operating system on an x64-based processor. During implementation, Eqoquest was run on this laptop and used by students in turn; the study did not use a projector or other display equipment.

The main software used in the development of Eqoquest was Godot Engine version 3.3.2, employed to build and integrate the game's various components, including the character, environment, interface, interactive objects, mission system, collectibles, monsters, boss monster, and gameplay obstacles.

The subject matter applied within Eqoquest concerns waste and environmental cleanliness as part of the broader theme of environmental conservation. This material was used as the basis for determining the environmental information conveyed through the game's elements, particularly the information boards, character dialogue, mission board, and collectible-gathering activity. Three types of collectibles are found in the game — plastic bottles, banana peels, and metal scraps — corresponding to three information boards each addressing one type of waste. Each information board is placed near the first collectible of the corresponding type encountered by the player; players do not receive information automatically upon picking up a collectible but must instead interact with the corresponding board to view the available information. Character dialogue supplements this information by providing further context about the in-game environmental condition, such as the line "There is so much waste here, I must collect it immediately," without triggering any automatic collection behavior.

2.2 System Design

Eqoquest was designed as a 2D action game with mission mechanics themed around environmental conservation. The player controls a character that explores the play area, interacts with specific objects, obtains information through information boards and dialogue, collects collectibles, confronts or bypasses monsters, and reaches the far end of the play area. Collecting collectibles forms part of the mission requirement that must be satisfied before the player can complete the mission at the end of the play area.

The game consists of a single, elongated level that the player must traverse while collecting the required collectibles. During the journey the player faces a variety of challenges in the form of monsters and environmental obstacles; monsters may be confronted or bypassed, since defeating them is not a requirement for mission completion. A single boss monster is placed at the end of the play area as part of the game's challenge. Once the collectible requirement is fulfilled, the player must still reach a trigger at the far end of the play area to complete the mission. On the main menu, the player is offered three options: Start, About, and Exit, used respectively to begin the game, view information about Eqoquest, and quit the application.

The mission mechanic is designed as the core activity of the game. The player controls the character to explore the play area, collect collectible objects, obtain information about waste types, confront or bypass various obstacles, and reach the end of the play area before a three-minute time limit expires; if the time limit reaches zero before the mission-completion condition is satisfied, the system displays a Mission Failed pop-up. When the player character touches a collectible object, that object is collected and the counter value, displayed in the upper-right corner of the screen, increases by one. Collecting collectibles does not immediately trigger the Mission Success condition; after the requirement is fulfilled, the player must continue until reaching the transparent trigger placed at the end of the play area. When the player character reaches this trigger, the system checks the collectible requirement: if it has been fulfilled, the system executes and displays the Mission Success pop-up; if it has not, the Mission Success condition is not executed and the player must return to collect the remaining required collectibles before reaching the end trigger again. Additionally, if the timer reaches 00:00 before the completion condition is met, the system displays a Mission Failed pop-up.

The game's overall mechanics and the corresponding system responses are summarized in the framework presented in Table 2.

Component	Player Activity	System Response
Main Menu	Player selects Start, About, or Exit	System executes the function corresponding to the selected menu
Mission Board	Player clicks the interaction area on the mission board	System displays a scene containing information about the game's mission
Character Dialogue	Player clicks the dialogue interaction area	System displays a dialogue scene giving context about the environmental condition or gameplay activity
Collectible	Player character touches a plastic bottle, banana peel, or metal-scrap collectible	System removes the collected object, increases the counter

		value, and records the collectible toward the mission requirement
Information Board	Player clicks an information board at the first location of a given collectible type	System displays a scene with information corresponding to the type of waste
Monster / Boss Monster	Player character is hit by a monster or boss-monster attack	Player HP decreases; the monster or boss monster may be confronted or bypassed
Player HP	Player HP reaches zero due to monster attacks	System displays the Mission Failed pop-up
Ravine	Player character falls into the ravine	System automatically reloads the play area so the mission restarts without displaying the Mission Failed pop-up
End Trigger	Player reaches the end of the map and touches the transparent trigger object	System checks the collectible requirement; Mission Success is executed if fulfilled, otherwise the player must keep collecting
Mission Failed	Player HP reaches zero, or the timer reaches 00:00 before completion	System displays the Mission Failed pop-up and applies the corresponding restart mechanism
Mission Success	Player has fulfilled the collectible requirement and reached the end trigger	System displays the Mission Success pop-up, marking completion of the mission
Timer	Player attempts the mission within the available time budget	System counts down for three minutes; reaching 00:00 before completion triggers Mission Failed

Table 2. Eqoquest Game Framework

As shown in Table 2, Eqoquest's mechanics comprise several interrelated components active throughout gameplay. Players interact with the mission board, information boards, and dialogue through clickable interaction areas; collectibles — plastic bottles, banana peels, and metal scraps — can be gathered to increase the counter value while simultaneously contributing toward the mission-completion requirement; and information boards concerning each waste type are placed at the first location where the corresponding collectible type is encountered. While exploring the play area, players also face obstacles in the form of monsters, a boss monster, and a ravine: the first two can be confronted or bypassed and do not constitute mission requirements, whereas falling into the ravine triggers an automatic area reload distinct from the Mission Failed condition triggered by HP depletion or time expiry. Mission completion is ultimately achieved only when the collectible requirement has been fulfilled and the player has reached the end trigger within the three-minute time limit.

The overall game flow — from launching the application, through menu navigation and gameplay, to the final Mission Success or Mission Failed outcome — was documented in a flowchart used as a reference during implementation. Player interaction with the system was further modeled with a use case diagram in which the player is the sole actor, since Eqoquest

does not employ user accounts, an administrator role, or a database involving other actors; the diagram covers accessing the main menu, starting the game, opening the About menu, controlling the character, exploring the play area, interacting with the mission board, interacting with information boards, viewing dialogue, collecting collectibles, confronting or bypassing monsters and the boss monster, completing the mission, and exiting the game. Activity diagrams and a storyboard were subsequently used to detail the sequence of player actions and corresponding scene transitions for each of these interactions, while the menu structure and interface layout were designed to remain simple and legible for elementary-school users.

2.3 Implementation with Users

Implementation with users was carried out on 19 August 2026 at SD Negeri 57 Kota Bengkulu. The number of registered fourth-grade students was 13, but one student was absent, so the implementation activity was attended by 12 students, who subsequently served as respondents. Eqoquest was run on the researcher's laptop and used by the students in turn, without the use of a projector or other display equipment. After trying the game, students completed the System Usability Scale (SUS) questionnaire.

2.4 Functional Testing

Functional testing was carried out to determine whether the functions within Eqoquest operate in accordance with the design, by comparing the actual result against the expected result for each of fifteen test scenarios. The scenarios covered menu functions, character control, the mission board, information boards, character dialogue, collectibles, the counter, monsters, the boss monster, the ravine obstacle, and the mission-completion conditions. The success percentage of functional testing was calculated using the following formula:

$$P = (\text{Number of successful scenarios} / \text{Total number of test scenarios}) \times 100\%$$

2.5 SUS Instrument and Data Analysis

Usability evaluation was carried out using the System Usability Scale (SUS), an instrument consisting of ten statements with five response options each, ranging on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree), arranged so that positively and negatively worded statements alternate. The instrument was administered to users after they had used Eqoquest, in order to obtain their assessment of the game's usability.

For odd-numbered statements (statements 1, 3, 5, 7, and 9), the contribution score was obtained using the formula $Si = Xi - 1$, where Xi is the respondent's response value for statement i. For even-numbered statements (statements 2, 4, 6, 8, and 10), the contribution score was obtained using the formula $Si = 5 - Xi$. Each respondent's overall SUS score was then calculated by summing the ten contribution scores and multiplying the total by 2.5, producing a score on a scale of 0 to 100:

$$SUS = (\Sigma i=1..10\ Si) \times 2.5$$

The mean SUS score across all respondents was subsequently calculated using the formula $\bar{X} = \Sigma X / n$, where ΣX is the sum of all respondents' SUS scores and n is the number of respondents. Data from observation and interviews were analyzed descriptively and used as supporting data in the needs-analysis stage. Functional-testing results were analyzed according to the agreement between the expected result and the actual result for each test scenario, expressed as a success percentage. The resulting mean SUS score was then interpreted using the Acceptability Range, Grade Scale, and Adjective Rating scales proposed by Bangor, Kortum and Miller (2009), allowing the usability level of Eqoquest to be positioned relative to

established usability benchmarks. This interpretation was used purely to evaluate usability based on user assessment and was not used to establish the validity of the medium or the effectiveness of Eqoquest in improving students' knowledge or learning outcomes.

RESULTS AND DISCUSSION

3.1 Application of the ADDIE Model

During the Analysis stage, needs analysis was carried out through observation and interviews at SD Negeri 57 Kota Bengkulu, producing a picture of user characteristics, subject matter, and the requirements for game development. The Design stage produced the design of the game concept, mission mechanics, framework, flowchart, use case diagram, activity diagram, storyboard, menu structure, and interface for Eqoquest. The Development stage realized this design into Eqoquest using Godot Engine version 3.3.2, with game components — the player character, play area, mission board, information boards, character dialogue, collectibles, counter, monsters, boss monster, HP system, and ravine obstacle — integrated into a single, coherent gameplay flow.

On the main menu, players are presented with Start, About, and Exit options. The Start button loads the play area and begins the three-minute countdown timer; the About menu displays supporting information regarding Eqoquest and provides a function to return to the main menu; and the Exit button closes the application. Within the play area, the player character can be controlled to explore a single elongated level, interact with the mission board and information boards, view dialogue, collect collectibles, and confront or bypass obstacles.

Eqoquest's mission mechanic was implemented through exploration of the play area combined with the collection of collectibles — plastic bottles, banana peels, and metal scraps. Every collectible obtained increases the counter value by one and becomes part of the mission-completion requirement. Information regarding each type of waste is not shown automatically when a collectible is picked up; instead, it is delivered through three information boards, each placed near the first location at which the corresponding collectible type is encountered. Character dialogue, such as "There is so much waste here, I must collect it immediately," supplies additional context about the in-game environmental condition without automatically collecting waste on the player's behalf. Interaction with the mission board, information boards, and dialogue is performed by clicking a transparent button area placed on the relevant object, accompanied by a "click here" prompt so that players know which areas can be interacted with.

The action elements of Eqoquest are realized through character control, the presence of monsters and a boss monster, an HP system, and environmental obstacles. Monsters can attack the character and reduce player HP, but the player is not required to defeat every monster encountered, since combat is optional rather than mandatory for progression. If the character's HP reaches zero due to monster attacks, the system executes the Mission Failed condition. In addition to monsters and the boss monster, a ravine serves as an environmental obstacle; if the character falls into it, the system automatically reloads the play area so that the player restarts the level without a Mission Failed pop-up being shown, a deliberate design choice intended to soften the penalty for an environmental hazard compared with combat-related failure.

Mission completion is determined jointly by fulfillment of the collectible requirement and the player reaching the trigger at the end of the map. When the player reaches and touches the end trigger, the system checks whether the collectible requirement has been fulfilled; if so, the Mission Success condition is executed, and if not, the player must return to collect the remaining required collectibles before the Mission Success condition can be triggered. Neither the number of monsters confronted nor whether the boss monster is defeated is used as a

completion requirement, since both function purely as optional challenges along the way. The Implementation stage was carried out on 19 August 2026, involving 12 fourth-grade students of SD Negeri 57 Kota Bengkulu as end users, while the Evaluation stage was carried out through the analysis of functional-testing results and the SUS questionnaire, as detailed in the following subsections.

3.2 Functional Testing Results

Functional testing was carried out across fifteen scenarios covering the main-menu functions, character control, the mission board, information boards, character dialogue, collectibles, the counter, monsters, the boss monster, the ravine obstacle, and the mission-completion condition. A summary of the functional-testing results is presented in Table 3.

Feature Tested	Expected Result	Actual Result
Start / About / Exit Menu	System loads the play area, displays the information page, and closes the game respectively	Succeeded as designed
Character Control	Character moves according to the player's control input	Succeeded as designed
Mission Board & Information Board	System displays the mission-information scene and the corresponding waste-type information scene	Succeeded as designed
Character Dialogue	System displays the character-dialogue scene	Succeeded as designed
Collectible & Counter	Collectible can be collected and the counter value increases by one	Succeeded as designed
Monster & HP Depletion	HP decreases upon being attacked; the Mission Failed pop-up appears when HP reaches zero	Succeeded as designed
Boss Monster	Player can continue the journey without being required to defeat it	Succeeded as designed
Ravine Obstacle	Play area automatically reloads without displaying the Mission Failed pop-up	Succeeded as designed
End Trigger & Mission Success	System executes the Mission Success condition once the collectible requirement has been fulfilled	Succeeded as designed

Table 3. Summary of Eqoquest Functional Testing Results

Based on Table 3, all fifteen test scenarios achieved a successful status, so that the functional-testing success percentage is calculated as $P = (15/15) \times 100\% = 100\%$. This result indicates that every function included in the test scenarios operated in accordance with the expected outcome. Functional testing in this study was used solely to determine the functional soundness of the tested features and was not used as a measure of usability or of Eqoquest's effectiveness in improving user knowledge.

3.3 Usability Evaluation (SUS) Results

The SUS questionnaire was administered to 12 respondents (coded R01 through R12 to preserve anonymity) after they had tried Eqoquest. Table 4 illustrates the calculation for respondent R01 as a worked example: R01's raw responses to the ten SUS statements were 5, 2, 4, 4, 5, 3, 3, 2, 2, and 5. After converting these responses according to the SUS scoring rule, R01's contribution scores became 4, 3, 3, 1, 4, 2, 2, 3, 1, and 0, which sum to 23; multiplying this sum by 2.5 yields a SUS score of 57.5 for respondent R01. The same calculation procedure was applied to every respondent to obtain their individual SUS scores, summarized in Table 4.

Respondent	Sum of Contribution Scores	SUS Score
R01	23	57.5
R02	32	80.0
R03	34	85.0
R04	34	85.0
R05	21	52.5
R06	17	42.5
R07	14	35.0
R08	13	32.5
R09	17	42.5
R10	11	27.5
R11	23	57.5
R12	22	55.0
Total	261	652.5

Table 4. SUS Score Calculation Results for Each Respondent

Based on Table 4, the total SUS score across the 12 respondents is 652.5, so the mean SUS score is calculated as $\bar{X}$ = 652.5 / 12 = 54.375, rounded to 54.38. The highest SUS score was obtained by respondents R03 and R04, both scoring 85.0, while the lowest score was obtained by respondent R10 at 27.5, indicating considerable variation in usability perception among individual respondents.

According to the SUS interpretation scale proposed by Bangor, Kortum and Miller (2009), a mean score of 54.38 falls into the Marginal Low category on the Acceptability Range, Grade F on the Grade Scale, and the OK category on the Adjective Rating. This result indicates that Eqoquest's usability still requires improvement, even though every tested function operated correctly. The gap between the 100% functional-testing success rate and the 54.38 SUS score does not represent a contradiction, since the two evaluations assess different aspects: functional testing measures whether features work as intended, whereas SUS measures the user's subjective experience of ease of use.

As a further descriptive point of interest, statement three of the SUS instrument, concerning perceived ease of use, received a total response value of 41 across the 12 respondents, corresponding to a mean of 3.42 on the 1–5 scale; when descriptively converted to a 1–10 scale by doubling the mean, this corresponds to 6.83 out of 10. This figure is presented

purely as a descriptive illustration of user responses to that specific statement and does not constitute a standard SUS calculation.

This study did not employ a pretest-posttest design, so the results cannot be used to conclude that using Eqoquest improved students' knowledge or learning outcomes regarding environmental conservation. Evaluation in this study was focused specifically on feature functionality and usability, while the educational elements embedded in Eqoquest are discussed here in terms of content implementation and gameplay mechanics rather than as a measured learning-effectiveness outcome.

Discussion

Overall, this study produced Eqoquest as a 2D action game with mission mechanics themed around environmental conservation, developed using Godot Engine version 3.3.2 through the five ADDIE stages of Analysis, Design, Development, Implementation, and Evaluation, applied systematically from needs identification through to evaluation of the finished product. The environmental-conservation theme was implemented through information boards, character dialogue, a mission board, and a collectible-gathering activity involving plastic bottles, banana peels, and metal scraps, all of which were connected to the mission-completion requirement rather than treated as a separate, disconnected layer of content.

The educational component of Eqoquest is realized through the interplay between environmental information and player activity within the game: information boards convey information about specific waste types, character dialogue provides context about the polluted environmental condition depicted in the game, the mission board directs the activity the player must undertake, and the collectible-gathering activity itself becomes the concrete task performed while pursuing the mission. In this way, the mission mechanic serves as the medium connecting environmental-conservation information with the player's in-game activity, so that the educational element is not merely presented as isolated information but is woven into the context and activity of gameplay through the information boards, dialogue, mission board, and collectible-gathering mechanic together.

The action component of Eqoquest, meanwhile, is realized through character control, the presence of monsters and a boss monster, an HP system, and environmental obstacles. Because defeating monsters is never a requirement for mission completion, the design allows players of varying skill levels to progress through the mission at their own pace, choosing to engage with combat encounters or avoid them altogether. The distinction between the automatic-reload consequence for falling into the ravine and the Mission Failed consequence for HP depletion or time expiry likewise reflects a deliberate design decision to differentiate environmental hazards from combat-related failure within the game's feedback system.

From a results perspective, the 100% functional-testing success rate demonstrates that the technical implementation of Eqoquest's features — menu navigation, character control, the mission board, information boards, dialogue, collectibles, the counter, monsters, the boss monster, the ravine obstacle, and the mission-completion logic — matches the design specification produced during the Design stage. This finding validates the Development stage of the ADDIE process and confirms that the mechanics designed on paper were successfully realized in the working product using Godot Engine.

The SUS result of 54.38, however, indicates that functional correctness alone does not guarantee a favorable subjective usability experience among the target user group. Several factors evident in the underlying design may plausibly contribute to this outcome, including the reliance on small, clickable transparent interaction areas that may be difficult for young

children to locate precisely, the three-minute time limit that may introduce time pressure inconsistent with an exploratory, informational objective, and the requirement to interact separately with the mission board, information boards, and dialogue rather than receiving information through more integrated or automatic means. The considerable spread between the highest individual score (85.0) and the lowest (27.5) further suggests that the game's usability was experienced quite differently across individual students, which may relate to varying levels of prior exposure to digital games and computer-based controls among the fourth-grade cohort.

These findings collectively demonstrate that a game can be functionally sound while still requiring refinement in interface design, control scheme, navigation, and interaction mechanics to be considered genuinely usable by its intended young audience. The results also underscore the value of treating functional testing and usability evaluation as complementary rather than interchangeable measures within an ADDIE-based development cycle, since relying on functional testing alone would have concealed the usability concerns that SUS was able to surface.

CONCLUSION

This study produced Eqoquest, a 2D action game with mission mechanics themed around environmental conservation, developed using Godot Engine version 3.3.2 through the ADDIE model comprising the Analysis, Design, Development, Implementation, and Evaluation stages. The environmental-conservation theme was integrated through information boards, character dialogue, a mission board, and a collectible-gathering activity involving plastic bottles, banana peels, and metal scraps, while monsters, a boss monster, and a ravine functioned as challenges that were not required for mission completion.

Functional testing across fifteen scenarios achieved a 100% success rate, indicating that every tested function operated in accordance with its design. Implementation with 12 fourth-grade students of SD Negeri 57 Kota Bengkulu on 19 August 2026 produced a total SUS score of 652.5 with a mean of 54.38, placing Eqoquest in the Marginal Low category on the Acceptability Range, Grade F on the Grade Scale, and the OK category on the Adjective Rating according to the SUS interpretation scale used in this study. These results indicate that Eqoquest's usability still has considerable room for improvement in future development. This study did not conduct expert validation by subject-matter or media experts and did not employ a pretest-posttest design, so its findings are limited to the development process, the functionality of the tested features, implementation with users, and usability evaluation, and should not be used to conclude anything about the product's validity from an expert standpoint or about any improvement in students' knowledge or learning outcomes.

Future development is recommended to refine Eqoquest's interface, controls, navigation, and interaction mechanics based on the SUS evaluation results in order to make the game easier to use for its target audience. The environmental-conservation material presented in the game can be expanded with additional types of information and environmental topics suited to user characteristics and development goals, and the current information boards and dialogue can be diversified into more varied forms of interaction so that the educational element becomes more thoroughly integrated with gameplay activity. Gameplay mechanics can likewise be extended by adding further levels, environmental variation, additional collectible types, monsters, obstacles, challenges, and missions, so that Eqoquest offers a richer range of gameplay content; future development could also document asset sources and licensing more systematically, recording the creator, source, link, and licensing terms of each asset used. Finally, future research is encouraged to involve a larger number of respondents drawn from a broader range of users to obtain a more representative picture of Eqoquest's usability across

diverse user groups, and, where the aim is to determine Eqoquest's effect on students' knowledge or learning outcomes regarding environmental conservation, to adopt a pretest-posttest measurement design appropriate to that purpose.

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