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Interactive Story for Teaching Ecosystem Topics Using Twine Application for Elementary School Students

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ABSTRACT

Purpose of the Study. This study aims to design, develop, and evaluate EcoQuest, an interactive digital story for teaching ecosystem topics to high school students. Utilizing the Twine application, EcoQuest integrates interactive storytelling to create an engaging instructional tool for science education.

Methodology. A descriptive-developmental research design, following the ADDIE model, was employed. EcoQuest was developed using Twine for interactivity, Canva for visual design, and AI-generated narration for audio. Supplementary videos were sourced from YouTube. The tool was evaluated by science education and IT experts using the DepEd Learning Resources Management and Development System (LRMDS) tool and pilot-tested with Grade 6 Elementary student for usability and engagement.

Main Findings. Expert evaluations confirmed that EcoQuest met high instructional and technical quality standards, while student feedback indicated that the interactive format enhanced engagement and ease of use. The study validated EcoQuest as a viable educational tool, demonstrating its potential to support ecosystem instruction in high school science education.

Novelty/Originality of this Study. This study introduces EcoQuest as a localized, interactive, and curriculum-aligned instructional material for teaching ecosystems. Unlike traditional static materials, it employs branching narratives and multimedia elements to foster student engagement. By integrating digital storytelling into science education, EcoQuest provides an innovative approach to enhancing learning experiences in environmental science.

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1. INTRODUCTION

Science education plays a pivotal role in fostering scientific literacy and environmental awareness among students. It intertwines scientific inquiry with educational principles to promote comprehensive understanding and learning [1]. The science curriculum aims to enhance students' grasp of biological and physical world aspects, cultivate positive attitudes toward science, and encourage exploration of its impact on daily life and the environment [2]. Despite ongoing efforts to improve science education in the Philippines, challenges persist. The PISA 2018 results indicated that fifteen-year-old Filipino students scored an average of 357 points in science literacy, ranking them second to last among 78 countries. Factors such as awareness of reading strategies, school social experiences, and family influences, including parental characteristics and access to technology, significantly affect academic performance [3]-[5]. In Cebu, a study revealed that 150 eighth-grade Biology students failed to meet learning competencies in topics like the digestive system, biodiversity, and ecosystems, with most scoring below 75%, underscoring the need for improved science instruction [6].

Ecosystems are fundamental to biology education, helping students comprehend the interdependence of organisms and their environments, ecosystem services, and the consequences of ecosystem degradation. Equipping students with knowledge of ecosystems is essential for promoting ecological balance and sustainable practices [7], [8]. Given the low performance in ecosystem-related topics, exploring innovative teaching methods that enhance student engagement and learning outcomes is crucial. Modern educational strategies emphasize the use of technology to amplify students' visual and intellectual engagement, particularly for complex and abstract concepts [9]. The Department of Education (DepEd) Order No. 42, s.2016, highlights the importance of integrating Information and Communication Technologies (ICTs) into instruction, enabling teachers to enhance lesson planning, delivery, and assessment through interactive and multimedia-based approaches [10].

One promising digital learning tool is interactive storytelling, which engages students by allowing them to shape narratives and make decisions influencing story outcomes. This approach enhances critical thinking, active learning, and conceptual retention [11]. Interactive storytelling has proven effective in various subjects, including ecology, mathematics, language learning, and history, fostering independent learning and cultural engagement [12]-[15]. Among digital storytelling tools, Twine stands out as a free, open-source platform enabling users to create nonlinear, interactive stories. Twine facilitates interactive decision-making, branching scenarios, and hyperlinked texts, making it a powerful tool for science educators [16]. Notably, Twine requires no programming knowledge, making it accessible and user-friendly for both teachers and students [17], [18].

Despite the effectiveness of interactive storytelling in fostering engagement and comprehension across various subjects, its application in ecosystem education remains underexplored. Current digital learning interventions in science education primarily focus on simulations, augmented reality, and game-based learning [19], [20], with limited exploration of interactive narratives. Additionally, most existing studies on digital storytelling concentrate on language acquisition, cultural storytelling, and historical narratives rather than scientific content [21], [22]. There is also a gap in contextualizing digital learning tools within localized environmental settings, which could enhance student engagement and conceptual retention. To address these gaps, this study developed EcoQuest, a Twine-based interactive story specifically designed to teach ecosystem concepts within a Philippine environmental context. Unlike traditional linear narratives, EcoQuest integrates real-world ecological challenges and branching decision-making pathways, allowing students to explore multiple outcomes based on their choices. This approach fosters critical thinking, problem-solving, and a deeper understanding of ecological principles [23].

Recent studies have highlighted the growing integration of interactive digital tools in science education. For instance, augmented reality (AR) applications have been shown to significantly boost student enthusiasm and engagement by providing personalized learning experiences [24]. Similarly, immersive learning environments, such as virtual reality (VR), have been effective in simplifying complex contexts and enhancing learning effectiveness [25]. These advancements underscore the potential of interactive storytelling platforms like Twine to create engaging and effective educational experiences.

Moreover, incorporating localized environmental contexts into educational materials has been shown to enhance student engagement and knowledge retention. By integrating Philippine environmental settings, EcoQuest ensures that students can relate ecosystem principles to their immediate surroundings, making the learning process more relevant and impactful [26]. This study focuses on the development and validation of EcoQuest, assessing its usability and appropriateness as an instructional material. However, further research is needed to determine its long-term effectiveness on different learning variables, such as conceptual understanding, students' attitudes toward learning ecosystem topics, motivation, and retention of knowledge over time. Future studies can also explore the integration of EcoQuest into different educational settings and grade levels and compare its effectiveness with other digital learning tools.

Given these, this study aims to design, develop, and validate an interactive digital story—EcoQuest—to enhance students' understanding of ecosystem concepts. The findings will contribute to the growing body of research on digital storytelling in science education and provide educators with a novel instructional tool that aligns with 21st-century learning strategies.

2. RESEARCH METHOD

2.1 Research Design

This study aimed to design, develop, and validate EcoQuest, an interactive digital story for teaching ecosystem topics. The researchers employed a descriptive-developmental research design, which is well-suited for the systematic creation, evaluation, and refinement of instructional materials. The descriptive method was used to analyze and interpret existing data related to students' difficulties in understanding ecosystems. In contrast, the developmental method focused on designing and improving the interactive story to align with instructional standards and learning objectives. According to [27], developmental research involves the systematic study of the design, development, and evaluation processes of instructional interventions to improve effectiveness and

efficiency. Similarly [28] emphasized that instructional development research is critical in refining educational materials and ensuring their alignment with learning theories and pedagogical approaches. This research design was particularly relevant as it allowed iterative refinements of EcoQuest, guided by expert feedback and empirical evaluation.

The study followed a structured process using the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) model, ensuring a comprehensive and iterative approach to instructional material development [29]. The ADDIE model has been widely recognized as a practical instructional design framework for developing educational tools and has been used in multiple instructional technology studies to create engaging and pedagogically sound learning resources [30]. Validation of EcoQuest was conducted using the DepEd Learning Resources Management and Development System (LRMDS) tool, evaluating its content quality, instructional effectiveness, and technical aspects. Additionally, student feedback was gathered to assess usability and engagement. The combination of these validation measures ensured that EcoQuest adhered to instructional standards while effectively facilitating meaningful learning experiences for students.

2.2. Sampling Procedures and Respondents

The study utilized purposive sampling to select participants, ensuring that individuals with relevant expertise and experience were chosen. The evaluation process involved two groups of experts: content experts in science education and information technology (IT) experts specializing in educational technology. A total of eight expert evaluators, consisting of five science educators and three IT experts, participated in assessing the validity and quality of EcoQuest. The science educators were selected based on the following criteria: (1) at least five years of teaching experience in science education, (2) familiarity with DepEd's Most Essential Learning Competencies (MELCs) for Grade 6 Elementary Ecosystem Topics, (3) experience in evaluating instructional materials, and (4) holding at least a master's degree in science education or a related field. Meanwhile, the IT experts were selected based on their (1) experience in software development or educational technology, (2) proficiency in usability testing and interface design, and (3) experience in integrating technology in instructional materials.

For the pilot testing, twenty-five purposively selected Grade 6 Elementary students from a public basic education institution in Sorsogon, Philippines participated in assessing the usability and learning effectiveness of EcoQuest. The selection of Grade 6 Elementary students was based on their familiarity with ecological concepts, ensuring that they could critically evaluate the interactive story's content, engagement level, and ease of use. The use of purposive sampling ensured that participants had the necessary background and experience to provide meaningful feedback on the instructional tool. The sample sizes align with previous validation studies on educational technology tools, ensuring meaningful qualitative and quantitative feedback while maintaining feasibility. Studies suggest that sample sizes of 20-30 participants in pilot testing can provide reliable initial insights into usability and effectiveness [31]. Furthermore, expert validation typically requires 5-10 subject matter experts to ensure content validity [32]. Future research should consider more immense and more diverse samples to enhance generalizability.

In addition, since the study involved elementary students, ethical safeguards were put in place to ensure the safety, privacy, and well-being of the participants. Before any data collection, informed consent was secured from parents or legal guardians, with a detailed parental consent form explaining the study's objectives, data privacy policies, and participants' rights, including the option to withdraw at any stage. Additionally, student assent was obtained to ensure their voluntary participation [33]. Ethical guidelines emphasize the need for children to fully comprehend their involvement in research and to participate without coercion [34]. Likewise, to protect participants' privacy, all student responses were anonymized using participant codes instead of personal identifiers, and data was securely stored on password-protected digital files, accessible only to the research team. No identifying information was included in reports or publications, ensuring compliance with ethical data protection standards such as the Children's Online Privacy Protection Act (COPPA) [35]. To mitigate potential psychological stress, EcoQuest integrated in-game hints and guided reflection sessions, enabling students to discuss their learning experiences with their teachers, fostering resilience and a growth mindset [36].

2.3. Research Instruments

To ensure a rigorous evaluation, the study employed multiple research instruments. The LRMDS Assessment and Evaluation Tool, adapted from DepEd DM No. 441 s.2019, was used to evaluate non-print instructional materials in terms of content accuracy, instructional quality, and technical features. Expert validators assessed EcoQuest using a 40-point scale for content and instructional quality and a 52-point scale for technical quality. Additionally, a student validation tool adapted from Lasala [37] was used to evaluate EcoQuest's format, clarity, engagement, and usability. Student participants provided qualitative feedback on usability and learning effectiveness, guiding potential refinements.

2.4. Data Collection

This study utilized the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) Model to develop and validate the EcoQuest Interactive Story, which will be used as instructional material in teaching ecosystem topics in Biology. The ADDIE model provides a systematic instructional design framework ensuring that the development process is grounded in educational best practices and empirical research [29]. The data collection procedures for each phase are as follows:

The Analysis stage involved identifying learning issues and difficulties in teaching ecosystem topics through a comprehensive review of literature and educational reports. Findings from the PISA 2018 results revealed that the Philippines has a low level of scientific literacy, attributed to several factors, including inadequate instructional materials, limited access to engaging resources, and reliance on traditional teaching methods [38]. Studies also indicate that Filipino students struggle to meet the learning competencies in Biology, particularly in biodiversity and ecosystem topics [39]. To address these gaps, it was essential to develop instructional materials that enhance student engagement and comprehension. Research supports the integration of technology in lesson delivery as a means of improving conceptual understanding and retention [40]. Interactive storytelling, in particular, has been found effective in increasing student motivation and fostering active learning [41]. Twine, a tool for creating interactive stories, was identified as a suitable platform for this study due to its ease of use, adaptability, and ability to provide a non-linear, immersive learning experience [42].

The design phase involved conceptualizing and refining the content, structure, and interactive features of the story based on the identified learning gaps and in alignment with DepEd's Most Essential Learning Competencies (MELCs). The interactive story, titled "EcoQuest," was structured into three chapters, each corresponding to specific learning competencies. The term "Eco" refers to ecology, the study of relationships between organisms and their environments, while "Quest" signifies an adventure with a purposeful learning goal. The storyline follows the characters Mia and Alex as they embark on a camping trip that turns into an exploration of ecosystems, biodiversity, and human environmental impact. The story integrates decision-based branching paths, allowing learners to interact with and influence the narrative, thereby reinforcing critical thinking and problem-solving skills [43].

The development phase involved the actual creation of EcoQuest using Twine, an open-source tool for non-linear storytelling. Visual and interactive elements were incorporated to enhance engagement and accommodate different learning styles [44]. Images were designed using Canva, while multimedia elements such as videos, audio narration, and hyperlinks were embedded within the Twine framework. Studies indicate that multimedia-enriched learning materials contribute significantly to improved student understanding and retention [41]. To ensure accessibility, audio narration was included for visually impaired students, and all multimedia elements were optimized for ease of use. Additionally, supplemental videos from YouTube were integrated to reinforce key ecological concepts. The iterative refinement process ensured that the story was pedagogically sound and visually engaging, aligning with research-backed instructional design principles [42].

The implementation phase involved validation by eight evaluators, consisting of five expert science educators and three IT experts specializing in educational technology. These evaluators assessed EcoQuest using the DepEd Learning Resources Management and Development System (LRMDS) tool to ensure content accuracy, instructional quality, and technical usability. The inclusion of IT experts ensured that usability, interface navigation, and multimedia integration adhered to best practices in educational technology [29]. Following expert validation, pilot testing was conducted with twenty-five purposively selected Grade 6 Elementary students to evaluate usability, engagement, and effectiveness. The selection of students with prior knowledge of ecology ensured that they could critically assess the story's clarity and impact. This phase was crucial in identifying necessary refinements based on validator feedback before large-scale deployment [39].

The evaluation phase involved analyzing the data gathered from expert validators and student participants. This stage was critical in assessing EcoQuest's effectiveness in achieving its instructional objectives. Data analysis focused on four key areas: content quality, instructional quality, technical quality, and student engagement. Descriptive statistics were used to compute mean scores for expert and student evaluations, while qualitative thematic analysis was applied to student feedback to identify recurring patterns and recommendations for improvement [45]. Revisions were made based on feedback, ensuring that the final version of EcoQuest was pedagogically sound, engaging, and accessible. Research supports the iterative refinement of educational materials, emphasizing that multiple cycles of evaluation contribute to improved instructional effectiveness [41]. Future studies may expand sample sizes and assess the long-term impact of EcoQuest on student learning outcomes.

2.5. Data Analysis

The DepEd Learning Resources Management and Development System (LRMDS) was used as the primary assessment tool to analyze the content quality, instructional effectiveness, technical attributes, and accuracy of EcoQuest. The evaluation consisted of four key factors: (A) Content Quality – Minimum passing score: 30/40, (B) Instructional Effectiveness – Minimum passing score: 30/40, (C) Technical Quality – Minimum

passing score: 39/52, and (D) Accuracy – Minimum passing score: 16/16. Each criterion was rated by expert validators and students using a standardized evaluation tool, with results interpreted based on descriptive statistics (mean, standard deviation) and inter-rater reliability tests.

Descriptive statistics were employed to summarize expert and student ratings. The mean score per evaluation criterion was computed to determine the overall quality of the instructional material. Standard deviation values were calculated to assess consistency in validator ratings, following best practices in educational research [45]. Cohen's Kappa statistics were used to measure agreement levels among validators to assess the reliability of expert evaluations. This statistical test ensures that the validation scores are not influenced by chance, providing more substantial support for the credibility of the evaluation process [46]. A Kappa value above 0.75 was considered excellent agreement, aligning with prior studies on instructional material validation [47]. Expert and student feedback was analyzed thematically to identify key strengths and areas for improvement in EcoQuest. Open-ended comments from validators were categorized into themes, such as clarity of instructional content, engagement level, and multimedia effectiveness. This qualitative approach aligns with [48] framework on thematic analysis, ensuring a deeper understanding of user experiences and instructional effectiveness.

3. RESULTS AND DISCUSSION

3.1 Development of the EcoQuest using Twine Application

The integration of technology in education has become a crucial strategy for enhancing student engagement, conceptual understanding, and critical thinking skills. Despite global advancements in digital learning tools, science education in the Philippines continues to face challenges, particularly low student performance and the lack of engaging instructional materials. In response to these issues, this study developed EcoQuest, an interactive digital story designed for Grade 6 elementary students using Twine, a non-linear, decision-based storytelling tool. EcoQuest was designed to align with the Department of Education's Most Essential Learning Competencies (MELCs) for Grade 6 Biology and consists of three interactive chapters, each addressing key ecosystem concepts: interactions among biotic and abiotic components of tropical rainforests, coral reefs, and mangrove swamps; the importance of conservation and protection of tropical ecosystems; and the effects of environmental changes on ecosystems and sustainability.

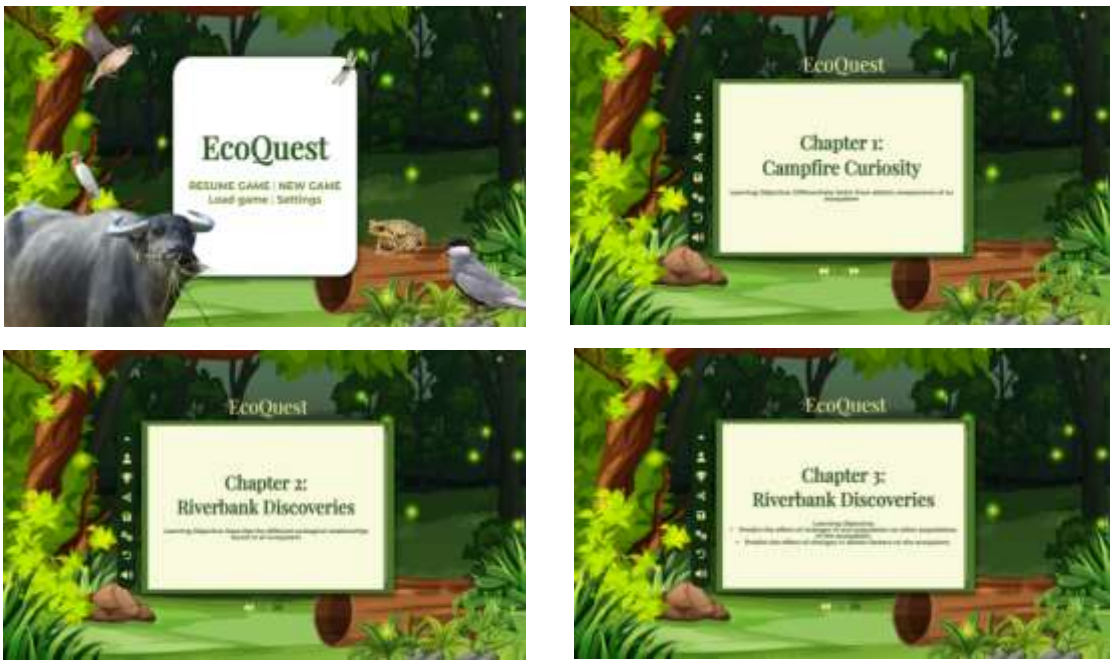
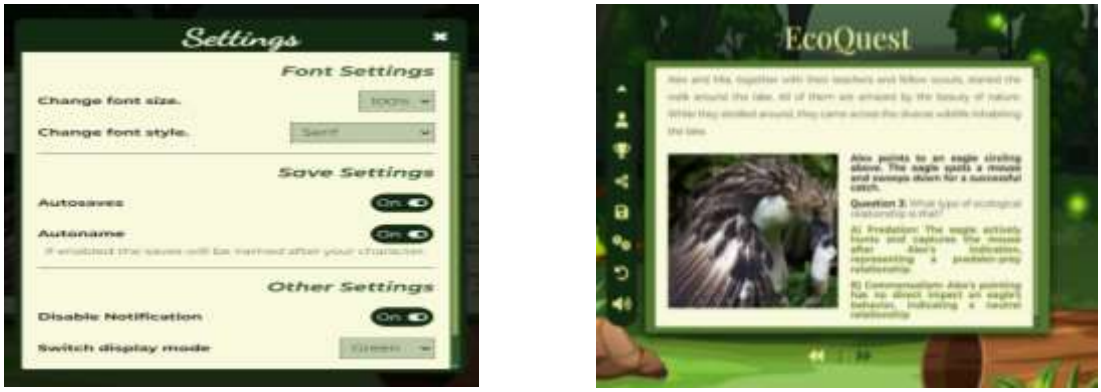


Figure 1. Chapters of the developed EcoQuest based on the MELC of the Deped, Philippines.

The branching narrative format of EcoQuest allows students to navigate different learning pathways based on their choices, fostering active learning, problem-solving, and deeper cognitive engagement [50]. Unlike conventional interactive tools in science education, such as simulations and gamified quizzes, EcoQuest integrates a narrative-driven exploration of ecosystem dynamics, enabling students to engage with environmental concepts in a more immersive and meaningful way. The interactive nature of the story promotes decision-making and critical thinking skills while reinforcing ecosystem concepts through contextualized storytelling. One of the key strengths

of EcoQuest is its personalized learning approach, which allows students to explore ecological concepts at their own pace while making choices that influence the storyline. This adaptability fosters a learner-centered experience, a pedagogical strategy shown to improve knowledge retention and increase motivation [51]. Illustrated in Figure 2, EcoQuest allows students to explore ecological concepts at their own pace while making choices that influence the storyline. By actively engaging with the material, students may not only reinforce conceptual understanding but also develop critical thinking skills in analyzing ecosystem interactions and environmental principles. Unlike conventional interactive tools in science education—such as simulations and gamified quizzes, EcoQuest integrates a narrative-driven exploration of ecosystem dynamics, enabling students to engage with environmental concepts in a more immersive and meaningful way. This story-based approach contextualizes learning, helping students establish deeper connections between theoretical ecological concepts and real-world environmental challenges.

EcoQuest also ensures that its content is both curriculum-aligned and culturally relevant, addressing environmental issues specific to the Philippines. By sitting in ecological problems within a localized context, the tool fosters place-based learning, allowing students to see the direct implications of environmental science in their communities. This relevance not only enhances engagement but also encourages students to apply their learning to real-world sustainability efforts.



a. Setting that allows students to personalize the App

b. Sample question and contextualized Philippine Eagle in one of the Chapters of the Application.

Figure 2. Customizable setting and contextualized features of the developed EcoQuest

Moreover, Figure 3 shows another distinctive feature of the developed EcoQuest: the incorporation of a guided correction system, which further strengthens the learning process by providing immediate feedback when students select incorrect responses. Instead of simply marking answers as incorrect, EcoQuest offers explanatory feedback that reinforces learning, helping students refine their understanding of scientific concepts. This feature aligns with constructivist learning theories, which emphasize active knowledge construction through experience and reflection. [52].

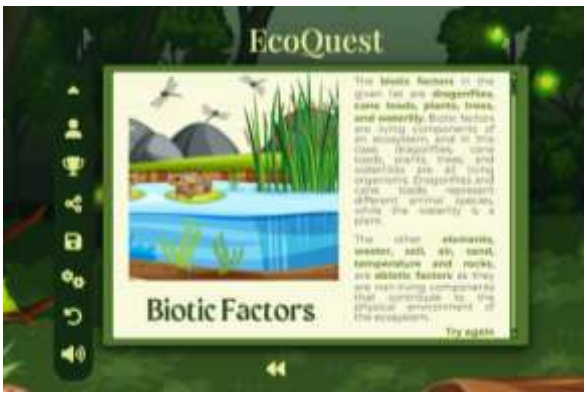


Figure 3. Guided correction in the developed interactive story.

Likewise, the integration of multimedia elements, including images, audio narration, background music, and embedded instructional videos, enhances the overall learning experience. Research has consistently shown that multimedia-supported learning environments improve student engagement and comprehension. The incorporation of supplementary videos sourced from YouTube extends learning beyond text, catering to diverse learning styles and reinforcing key concepts [54]. Findings from this study suggest that interactive storytelling

enhances student engagement by shifting the learning experience from passive reception to active exploration. The branching narrative format of EcoQuest, coupled with the integration of contextualized content and multimedia elements, provides students with an interactive and participatory approach to ecosystem education. This aligns with Mayer's Cognitive Theory of Multimedia Learning, which highlights the effectiveness of integrating text, visuals, and interactivity to improve conceptual retention and student engagement.

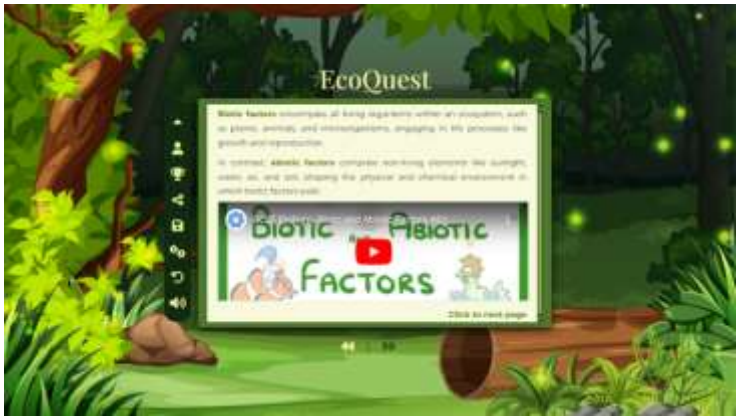


Figure 4. A sample of a supplementary video in the developed interactive story.

The findings of this study are consistent with research on interactive storytelling and digital learning tools in science education. Previous studies have shown that interactive narratives improve student engagement, problem-solving, and decision-making skills by immersing learners in real-world scenarios [55]. Prior research on game-based and interactive learning platforms has also demonstrated their effectiveness in enhancing conceptual understanding, particularly in science subjects. However, most existing studies focus on AR/VR and game-based learning rather than text-based interactive branching narratives, which are less resource-intensive and more accessible for basic education settings in developing regions. The potential of EcoQuest in fostering engagement and conceptual understanding supports existing research emphasizing the role of interactive and personalized learning environments in science education.

This study also reinforces the growing body of literature that highlights the benefits of integrating digital storytelling into science education. The use of branching narratives provides students with autonomy in their learning experience, allowing them to develop scientific literacy through an inquiry-based approach [56]. Unlike traditional linear instructional materials, EcoQuest fosters deeper cognitive engagement by allowing students to construct knowledge actively rather than passively absorbing information [57]. The emphasis on contextualized learning in EcoQuest further strengthens its educational impact by ensuring that students relate abstract ecological principles to real-world environmental challenges. Research suggests that place-based learning and culturally relevant instructional materials significantly improve conceptual retention, reinforcing the potential of EcoQuest as an educational tool. The flexibility of the tool supports differentiated instruction, allowing educators to tailor learning experiences based on student needs and preferences.

3.2. Experts Evaluation of the developed EcoQuest using Twine Application

This study utilized the DepEd Learning Resources Management and Development System (LRMDS) for non-print materials to determine the expert's validity rating of the developed interactive story and obtain comments and suggestions. The EcoQuest was assessed based on four key evaluation criteria: (a) Content Quality, (b) Instructional Quality, (c) Technical Quality, and (d) Accuracy. The weighted mean for each criterion was computed to interpret the results of the ratings. Additionally, the comments and recommendations from expert science educators were incorporated to refine the interactive story before pilot testing.

Table 1. Experts' Summary of Points of EcoQuest Evaluation Criteria

Criteria	Point to Pass (DepEd, 2009)	Mean Scores of Experts Validation	Descriptive Rating
Content Quality	at least 30 of 40	39	VS
Instructional Quality	at least 30 of 40	38.5	VS
Technical Quality	at least 39 of 52	48.5	VS
Accuracy	at least 16 of 16	16	VS

The EcoQuest received an overall very satisfactory rating across all four criteria as per DepEd's LRMDS standards, indicating that it meets the necessary instructional and technical standards. Instructional materials play

a crucial role in enhancing students' learning experiences and academic performance [58]. The results suggest that EcoQuest is an effective and engaging instructional tool for teaching ecosystem concepts in the Grade 6 Science curriculum.

The high content quality score (Mean = 39) indicates that the material is factually accurate, relevant, and aligned with the DepEd Most Essential Learning Competencies (MELCs) for Grade 6 Elementary Biology. The integration of real-world applications and inquiry-based learning principles strengthens its potential to enhance students' conceptual mastery [59]. Furthermore, interactive instructional tools stimulate critical thinking and reinforce learning through contextual engagement [60]. This finding aligns with the Theory of Contextual Learning, which posits that students learn more effectively when content is linked to real-life situations. EcoQuest achieves this by incorporating real-world ecosystem interactions, multimedia elements, and interactive decision-making features. Studies suggest that contextualized learning significantly improves student engagement and retention of scientific concepts [61].

In terms of the instructional quality score (Mean = 38.5), EcoQuest effectively supports learning by providing well-defined objectives, structured engagement, and student-centered interactivity. Research confirms that student engagement with digital instructional tools significantly enhances learning outcomes [62]. Experts highlighted that the interactive nature of EcoQuest fosters active learning, a critical component in modern science education. According to Constructivist Learning Theory, students learn best when they actively construct knowledge through hands-on engagement [63]. Additionally, interactive storytelling has been widely recognized as an effective pedagogical tool for enhancing comprehension and independent learning [64]. Studies indicate that when students are given narrative-driven learning experiences, they exhibit higher motivation, critical thinking skills, and long-term retention of information [65].

The technical quality score (Mean = 48.5) suggests that EcoQuest incorporates effective digital design, clear visual elements, and well-integrated multimedia features. The inclusion of images, animations, AI-generated narrations, and videos enhances accessibility for different learning styles [66]. Experts noted that the synchronization of text, visuals, and audio elements significantly enhances comprehension. Research on multimodal learning suggests that learners retain information more effectively when exposed to multiple sensory inputs simultaneously [50]. This supports the integration of EcoQuest into the 21st-century digital learning environment, which increasingly relies on interactive and media-rich content [52]. Additionally, feedback from expert validators highlighted that the user interface of EcoQuest is intuitive and easy to navigate, making it accessible for both students and teachers.

The accuracy criterion received a perfect score (Mean = 16), indicating that EcoQuest is free from conceptual, grammatical, or technical errors. This reinforces its reliability as an instructional tool for teaching science concepts with precision and clarity [55]. Given the result of the experts' validation, it is essential to assess the consistency of expert evaluations. Table 2 below presents the summary of the inter-rater reliability test, detailing the percentage of agreement among experts on the developed EcoQuest.

Table 2: Summary of the Results of Experts' Percentage of Agreement on the Developed EcoQuest

Criteria	Experts' Rating								% of
	E1	E2	E3	E4	E5	E6	E7	E8	Agreement
Content Quality	39	40	37	38	39	40	39	40	97.5%
Instructional Quality	40	38	34	40	39	40	37	40	96.25%
Technical Quality	50	47	46	50	52	52	39	52	93.26%
Accuracy	16	16	16	16	16	16	16	16	100%
Total									96.75%

The high agreement rate of 96.75% suggests that experts maintained a strong consensus regarding the validity and quality of EcoQuest. The high levels of agreement across all evaluation categories reinforce the reliability of the expert judgment and the consistency of the tool's quality. According to [63], achieving high inter-rater reliability in educational evaluations ensures that instructional materials consistently meet pedagogical standards and minimize subjectivity in expert assessments. Furthermore, an agreement rate above 90% indicates strong data reliability, which is essential in ensuring that the material is practical, well-structured, and pedagogically sound [62]. While the high inter-rater reliability suggests a strong foundation and consistency in expert evaluations, it also highlights areas for improvement. Some experts recommended enhancing the interactivity of EcoQuest by integrating more student-driven decision-making elements and expanding the range of multimedia content to cater to diverse learning styles. These refinements would further enhance the engagement and accessibility of the material, aligning with best practices in digital learning innovation [52].

3.3 Students' Evaluation of EcoQuest

Students played a crucial role in the validation process of EcoQuest, providing essential feedback on its format and content. A group of twenty-five (25) Grade 6 Elementary students from a public basic education

institution in Sorsogon City, Philippines, were purposively selected to assess the interactive story. This inclusion ensures a more comprehensive evaluation by incorporating the perspectives and insights of the primary end users of the instructional material, a critical component in evaluating educational effectiveness.

To conduct this evaluation, the study employed the Student Validation Tool adapted from [37]. While the Learning Resources Management and Development System (LRMDS) is typically designed for expert assessment, it has limited accessibility for broader audiences. Therefore, a student-focused validation tool was essential in capturing learner perceptions regarding the material's usability, engagement, and instructional effectiveness. The results of the students' validation are summarized in Table 3.

Table 3. Students' Summary of Points of EcoQuest Evaluation Criteria

Criteria	Mean Scores of Students' Evaluation	Descriptive Rating
Format	4.66	Excellent
Content	4.66	Excellent

The results indicate that the students rated EcoQuest highly in both format and content, suggesting that it successfully met learner expectations for an effective instructional tool. The format was described as well-organized and user-friendly, with clear illustrations, intuitive navigation, and engaging multimedia elements. These findings align with research indicating that interactive learning tools enhance student engagement and motivation, particularly when they are visually and technically accessible [67].

Students' evaluations of the format emphasized that EcoQuest's layout was clear, concise, and visually appealing, making it easier to navigate and interact with. The interactive features, such as decision-based storytelling and embedded multimedia, contributed to a seamless user experience that aligns with the principles of effective digital learning environments [68]. Furthermore, the integration of visual and auditory elements enhances comprehension and retention, as supported by multimodal learning theories [44]. Several students commented on how the design of EcoQuest made learning enjoyable and interactive. For instance, one of the students commented, "I liked how I could choose what to do in the story. When I picked the wrong choice, it explained why it was wrong instead of just telling me to try again. It made me think more about how the animals and plants depend on each other in the ecosystem." Another student reflected on how the branching narrative structure affected their learning process: "In our usual science lessons, we just memorize definitions, but here, I had to decide what to do next, and that helped me understand how small changes in the environment can affect everything. It made me feel like I was really exploring the ecosystem." This observation aligns with findings that user-friendly and immersive digital learning environments promote student-centered learning experiences [69]. Likewise, this feedback suggests that decision-making elements in EcoQuest encouraged students to engage with the content rather than passively absorbing information actively. The ability to make choices and receive guided feedback appears to have enhanced their conceptual retention, as they were required to apply their knowledge in real-time scenarios rather than simply recalling facts. These insights align with constructivist learning theories, which emphasize that students learn best when they actively participate in the construction of knowledge rather than just receiving information.

Additionally, interactive storytelling has been recognized as a practical pedagogical approach for improving cognitive engagement and conceptual understanding in science education [70]. In terms of content quality, students found that EcoQuest effectively communicated ecosystem concepts, aligning well with the DepEd Most Essential Learning Competencies (MELCs) for Grade 6 Elementary Biology. The inclusion of real-life applications and problem-solving activities was particularly valued, reinforcing research suggesting that contextualized learning enhances student comprehension and motivation [71]. These were evident in the student's feedback, from which one student shared, "I liked that the story felt real because it showed actual problems happening in the environment. It wasn't just facts—we had to solve problems, like deciding how to protect a mangrove forest. It made me understand why these ecosystems are important and what could happen if they're not taken care of." Another student highlighted how contextualized learning helped him grasp abstract concepts more effectively: "The activities in the story made me think about what I would do in real life if I saw these problems in nature. Instead of just reading about ecosystems, I got to make choices, and that made me remember the lessons better." This feedback reinforces the idea that EcoQuest's integration of real-life applications and problem-solving activities contributes to deeper conceptual understanding. By connecting learning to authentic environmental challenges, students were able to relate scientific concepts to practical situations, supporting research that highlights the benefits of contextualized learning in science education. The structured decision-making format also encouraged higher-order thinking skills, as students had to evaluate consequences, analyze interdependencies, and apply scientific principles in a dynamic, narrative-driven environment.

Furthermore, students appreciated the adaptability of the learning material, noting that the interactive decision-making elements enabled a more personalized learning experience. These were manifested in the comments given by the students in their journal entries. One of the students commented that: "I liked that I could go back and try different choices. If I didn't understand something the first time, I could reread it and see how

different decisions changed the story. It helped me figure things out on my own instead of just memorizing answers." Another student commented on how EcoQuest accommodated different learning speeds and styles: "Sometimes, in class, we move too fast, and I don't always understand everything right away. In this story, I could take my time and think about my choices. The explanations also helped when I got something wrong, so I wasn't just guessing—I was actually learning." This student feedback supports the idea that adaptive digital learning tools like EcoQuest cater to diverse learning needs, making science education more inclusive and effective [72]. The ability to revisit learning pathways, explore multiple perspectives, and receive immediate feedback aligns with constructivist learning theories, which emphasize that students learn best when they actively engage with content and reflect on their understanding. The high percentage of agreement (90%) among student validators further validates these perceptions, reinforcing that EcoQuest is not only engaging but also pedagogically sound.

In addition, these are consistent with studies that indicate that adaptive digital learning materials help cater to diverse learning styles and paces, making them more effective than traditional lecture-based approaches [73]. The consistency of student responses was further validated through an inter-rater reliability test, summarized in Table 4. The high percentage of agreement (90%) among student validators underscores the reliability and consistency of their evaluations. These findings are supported by constructivist learning theories, which suggest that student engagement and perception directly influence learning outcomes. The overwhelmingly positive ratings indicate that EcoQuest is a well-designed, effective, and engaging learning tool suitable for integration into the science curriculum.

Table 4. Summary of Students' Percentage of Agreement on the Developed EcoQuest

Criteria	Students' Rating					% of Agreement
	Poor	Fair	Good	Very Good	Excellent	
Format				2	23	92%
Content				3	22	88%
Total						90%

While the development and usability validation of EcoQuest present promising results, several limitations must be acknowledged. This study focused primarily on the development and validation of EcoQuest rather than assessing its long-term impact on learning outcomes. While the initial feedback from students and experts suggests high usability and engagement, further studies are necessary to determine effectiveness in improving conceptual understanding, motivation, and retention over time. The study also did not conduct direct comparisons with other instructional methods, such as traditional lectures, gamified quizzes, or AR/VR-based simulations, which could provide further insights into its relative effectiveness. Additionally, the pilot testing involved a limited sample size, making it necessary to conduct broader studies across multiple schools and regions to enhance the generalizability of the findings.

Future research should focus on evaluating the long-term effects of EcoQuest on student learning outcomes through longitudinal studies that measure knowledge retention, conceptual understanding, and changes in student attitudes toward ecosystem topics. Comparative studies should also be conducted to assess how EcoQuest performs relative to other interactive learning tools and conventional instructional methods. Expanding the sample size to include students from diverse educational backgrounds will provide a more comprehensive understanding of the tool's effectiveness across different learning environments. Additionally, integrating EcoQuest into a blended learning model—combining interactive storytelling with teacher-facilitated discussions, hands-on experiments, and collaborative projects—could further enhance its impact on science education. By refining and expanding its application, EcoQuest has the potential to serve as a scalable, innovative, and effective instructional tool for fostering ecological literacy and scientific inquiry among elementary students.

4. CONCLUSION

EcoQuest, developed using the Twine application, has proven to be an effective interactive digital learning medium in enhancing students' understanding of ecosystem concepts and environmental awareness through a contextual and constructivist-based learning approach. By meeting the teaching material standards of the Philippine Department of Education and utilizing branching storytelling, EcoQuest is able to encourage independent learning, critical thinking, and active student engagement. The study recommends expanding the application of EcoQuest to other science fields, piloting in various school contexts, especially in underserved areas, and developing features such as assessments, simulations, and more complex branching scenarios. In addition, teacher training in the use of this medium is highly recommended to optimize the integration of EcoQuest in digital-based science learning.

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