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Research Paper

Batik Quest: An Educational Role-Playing Game for Learning Indonesian Batik and Supporting Sustainable Cultural Heritage Preservation

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Abstract

Young people commonly wear batik, but this does not always mean they recognize its traditional motifs or understand the meanings. This concern led to Batik Quest, an offline Android RPG that introduces nine traditional motifs as players follow quests, solve puzzles, explore the setting, and talk with characters. Development followed the Game Development Life Cycle (GDLC). Evaluation included black-box testing, User Acceptance Testing (UAT) with 35 participants, and a preliminary pre-test/post-test exercise with a different group of five. Overall UAT results were 86.60%, indicating that participants responded positively to the gameplay, usability, and educational content. In the preliminary knowledge assessment, the mean score increased from 3.00 to 7.00 out of nine immediately after gameplay. With only five participants in that assessment, the increase offers an early sign of educational potential, not proof that the game is effective. These results suggest that a mobile game may be a useful, accessible medium for learning about batik. In sustainable-development terms, the study relates most directly to education and cultural heritage preservation. Economic and consumption-related effects were not examined here.

Keywords: Batik; Educational Game; Cultural Heritage; Godot Engine; Sustainable Development.

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1. Introduction

Batik is an important part of Indonesia's cultural identity. Batik appears in daily and formal settings, from school and office clothing to traditional ceremonies, so it remains highly visible in Indonesian life. In 2009, UNESCO inscribed Indonesian batik on the Representative List of the Intangible Cultural Heritage of Humanity in recognition of its historical, artistic, and cultural value (Meranggi, Yudistira, and Sari 2022). Each batik motif carries a philosophical message, local wisdom, and social values passed down from generation to generation (Syafitri 2025).

Batik preservation is not limited to maintaining the production process; the knowledge attached to each motif must also be passed on. Although batik is widely worn, its everyday use does not necessarily indicate an understanding of motif names and meanings. Previous studies have reported limited recognition of traditional motifs among younger Indonesians (Mauliska and Maneechukate 2024; Yulianingrum et al. 2022). When batik is used without knowing what its motifs represent, part of that knowledge may no longer reach the next generation.

The future of batik is also connected with the people who produce it and with the sustainability of their businesses. Much of Indonesia's batik production takes place in small workshops, family-run businesses, and micro, small, or medium enterprises. For these producers, one source of competition is low-cost printed textiles carrying imitations of traditional motifs (Sugiarto et al. 2025). Knowing more about batik may also help consumers distinguish authentic batik from printed copies. This study does not test whether knowing more about motifs changes what consumers buy or produces benefits for artisans; those questions require separate measurement.

People encounter batik education in classrooms, museums, cultural workshops, and community activities (Wang 2019). Researchers have therefore explored digital options for cultural education, including augmented reality, virtual reality, and digital heritage platforms (Liu, Miao, and Ying 2022; Theodoropoulos and Antoniou 2022). However, many of these applications mainly show information or images, so users have little opportunity for continued interaction with the cultural material.

In an educational game, learning material can appear while players make decisions, complete activities, and respond to challenges. Instead of receiving information passively, learners can encounter knowledge while solving problems and exploring virtual environments. Previous research has consistently explained that game-based learning can increase motivation, engagement, and knowledge acquisition across diverse educational backgrounds (Li, Chen, and Deng 2024; Zhong 2022). Serious games have also been applied to cultural heritage education to encourage public awareness and introduce traditional knowledge (Abdullah et al. 2024; Lin, Zhou, and Guan 2025).

RPGs may suit cultural learning because they can embed information in a story that players explore through characters and challenges. Players can encounter cultural information as part of a story and apply it while completing quests. Previous studies have also shown that RPG-based learning can improve motivation, encourage active participation, and support better knowledge retention (Cullinan and Genova 2023; Sholichah, Gunarhadi, and Musadad 2022; Zhong 2022). These characteristics offer a suitable structure for introducing the visual features and cultural meanings of traditional batik motifs.

Providing the game on a mobile device also makes this form of cultural learning more accessible. Smartphones have become one of the main platforms for information and entertainment among young Indonesians, and mobile games are among the most popular digital activities (Ericaska, Nelloh, and Pratama 2021; Sudirman et al. 2022). An offline application can still be used when the internet connection is weak or unavailable, giving users more flexibility to learn on their own.

Work on batik education, digital heritage, and serious games is available, although the three topics are usually discussed in different studies. Existing batik-related digital media tend to present information or show motifs, whereas cultural heritage games often deal with subjects other than Indonesian batik. Few studies report how users accept the software while also giving an initial view of what they learned from it. This study addresses that gap by integrating nine batik motifs into the quests and narrative of an offline mobile RPG and by evaluating both user acceptance and a preliminary indication of immediate knowledge change. Its contribution lies in this integrated design and evaluation, rather than in claiming that Batik Quest is the first digital cultural heritage game.

Accordingly, this study aims to develop Batik Quest using the GDLC framework and Godot Engine, evaluate its functionality and user acceptance, and explore its educational potential through a small preliminary knowledge assessment. It also considers how mobile game-based learning may complement existing batik education. The study's direct sustainable-development relevance is primarily associated with SDG 4 through accessible cultural learning and with the continued transmission of intangible cultural heritage. Connections with creative-economy livelihoods and sustainable consumption are treated as directions for future research because these outcomes were not measured.

2. Methods

This study used a design-and-evaluation approach to develop and assess a mobile educational game. Three aspects were examined during evaluation: whether the application worked properly, how users responded to it, and how the immediate knowledge scores changed. This research did not include a controlled experiment on learning or socioeconomic impact, as these were outside the scope of the study.

2.1. Game Development

Batik Quest was developed in Godot 4.0 by following the Game Development Life Cycle (GDLC) (Ramadan and Widayani 2013), which consists of initiation, pre-production, production, testing, beta testing, and release. A playcentric approach from Fullerton was added to the GDLC process so that prototypes could be tried and adjusted several times (Blick 2024).

Batik Quest runs offline on Android and is played by one user at a time. As they explore the map, complete quests, solve puzzles, and play mini-games, players come across nine Indonesian motifs. Educational content was embedded in the progression of the game's progression so players encountered motif names, visual characteristics, and associated cultural meanings while completing the story.

2.2. Participant and Research Instrument

Evaluation consisted of black-box testing, UAT, and a short knowledge test completed by a separate group.

The team first ran black-box tests on the game's functions, navigation, gameplay mechanics, and stability before giving it to users. For the UAT, 35 participants were recruited purposively from the intended age group. Eligible participants were 15–25 years old, active smartphone users, willing to install the Android application, and part of the intended young-user group. Recruitment was conducted through Discord, Facebook, and WhatsApp communities. The purposive procedure aimed to reach relevant prospective users rather than produce a statistically representative sample. Participants completed a five-point Likert questionnaire (1 = strongly disagree; 5 = strongly agree) (GUILLEN and NISPEROS 2024). Across the nine items, participants were asked about gameplay, usability, and their perceptions of the educational content. Because the adapted instrument did not undergo separate psychometric validation in this study, the responses are interpreted descriptively as user perceptions, not as a validated measure of educational effectiveness.

Five other participants answered nine knowledge questions just before playing the game and once again immediately afterward. The questions asked participants to identify the motifs and connect them with their meanings. The same items were administered in the pre-test and post-test. This activity was included as a small formative assessment of the game's educational potential; it was not intended to provide generalizable or causal evidence of learning effectiveness.

2.3. Data Collection and Analysis

Data collection proceeded in three stages. First, internal black-box testing identified and corrected functional problems. Second, the 35 UAT participants played the application and completed the acceptance questionnaire. Third, the separate five-person group completed the knowledge assessment before gameplay and again immediately afterward. No delayed post-test or control group was included.

UAT responses were analyzed descriptively. Weighted scores from the five-point Likert scale were converted to percentages using Equations (1) and (2). Following Vanesha et al. (Vanesha, Rizky, and Purwanto 2024), percentage scores between 81% and 100% were interpreted as indicating an excellent

level of user acceptance. This category describes the participants' reported acceptance and should not be interpreted as evidence of learning effectiveness.

$$Q_n = \sum (F \times Scale)$$

$$P = \left(\frac{\left(\frac{Total\ Q_n}{n} \right)}{5} \right) \times 100\%$$

where F is the response frequency for each Likert category, Scale is the corresponding value from 1 to 5, n is the number of respondents, and P is the resulting percentage.

The preliminary knowledge results were analyzed descriptively by comparing individual and mean scores before and immediately after gameplay. Because the assessment involved only five participants, used the same test items, and included neither a comparison group nor a delayed assessment, no inferential analysis was performed. The observed differences are reported as preliminary descriptive evidence only.

3. Results and Discussion

3.1. Development of Batik Quest

Batik Quest is an Android educational RPG that introduces traditional batik motifs through interactive gameplay. Rather than using a separate lesson screen, the game brings batik material into its quests, puzzles, exploration, and character dialogue.

Players move through three main settings: the Batik Museum, Batik Village, and Ancient Dungeon. Activities change from one environment to another and become more difficult as the story progresses. The museum provides introductory information and exploration; the village uses interaction with non-player characters and motif-related quests; and the dungeon combines cultural questions with puzzles and combat challenges.

One batik motif connects to each mission in the main quest sequence. Motif recognition and meaning are connected to story events and task completion rather than presented only as separate reading material. As a result, the same educational ideas appear again in different parts of the story instead of being shown only once.

The connection between a mission, its motif, and the player's task is listed in Table 1.

Table 1. Core quest, motif, and activity mapping

ID	Quest Name	Reward Motif	Required game activity
M1	A Different World	Batik Kawung	Complete introductory phase in the Museum; analyze 4-axis in circle alignment.
M2	The Batik Village	Batik Ceplok	Gather five hidden wax-resist blocks scattered throughout the artisan neighborhood.
M3	Lost Ring Retrieval	Batik Sidomukti	Navigate the forest maze and return the elder artisan's wedding ring.
M4	Kindness to Creatures	Batik Truntum	Solve the courtyard feeding puzzle to uncover the symbolism behind the stellar motif.
M5	Courageous Adventurer	Batik Gringsing	Defeat the first-tier gatekeeper leader in the dungeon using pattern matching.
M6	Fellowship of Rangers	Batik Sawat	Transport medical relief to forest rangers by traversing deep platform gaps.
M7	Floral Textile Mystery	Batik Pring Sedapur	Crack a synchronized switch combination puzzle inside the botanical sanctuary.
M8	Forgotten Village Lore	Batik Sekar Jagad	Reconstruct broken fragments of an ancient cultural stone tablet across ruins.
M9	The Final Assessment	Celestial Gate Access	Successfully answer 9 philosophical and design questions presented by the Gatekeeper.

Before reaching the final assessment, players meet eight motifs across the missions: Kawung, Ceplok, Sidomukti, Truntum, Gringsing, Sawat, Pring Sedapur, and Sekar Jagad. The Collection menu stores motifs obtained during the quests so that players can revisit their names and meanings.

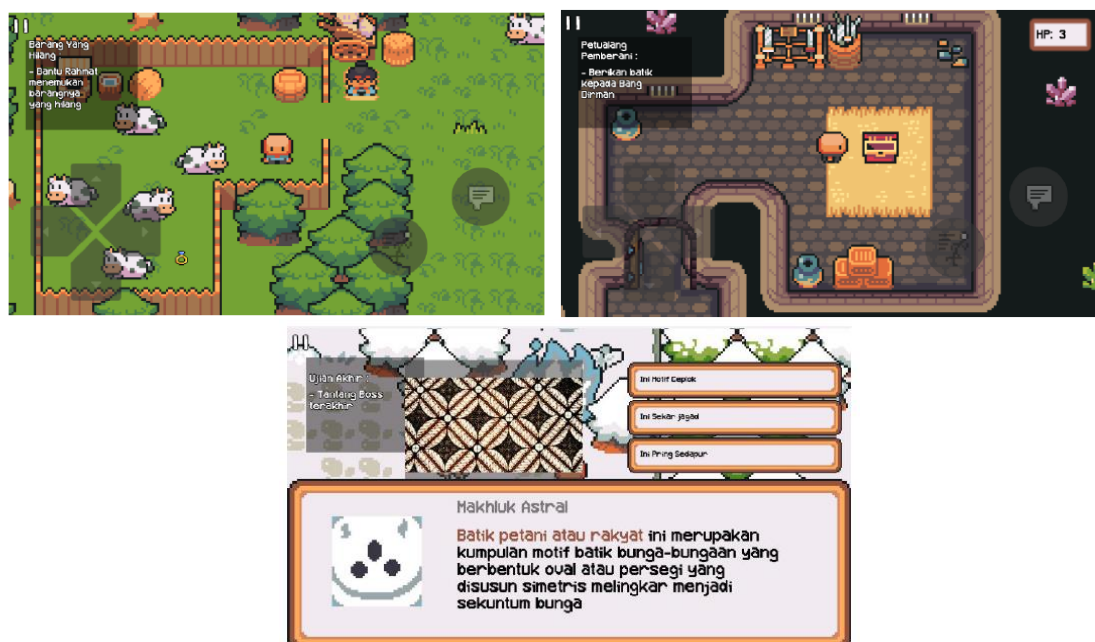


Figure 1. Batik Quest screenshot

Once installed, the game can be played without keeping the device connected to the internet. This feature may extend access in settings with unreliable connectivity, although the present study did not compare the application's use across different infrastructure or educational contexts.

3.2. Functional Testing

Before distributing the beta version, the team used black-box testing to check the main functions of the game. Testing exposed two practical issues. Enemy contact could register damage more than once, while an active item remained available for repeated collection.

The team fixed the enemy collision rule and changed the inventory logic so a reward could be recorded only once. No critical functional error appeared in the user evaluation that followed these corrections. In other words, testing supported the usability of the beta version but said nothing about whether users learned from it.

3.3. User Acceptance Testing (UAT)

After functional testing, 35 participants tried the game and then filled in the UAT questionnaire. They rated the gameplay experience, interface usability, and the way educational material was presented. The resulting overall score was 86.60%. Based on the category used by Vanesha, Rizky, and Purwanto (Vanesha et al. 2024), this is classified as "excellent" acceptance. The score reflects a positive view of the application among these participants, but it alone cannot establish educational effectiveness.

Table 2 brings together the scores for gameplay experience, usability, and perceived educational content. Educational content received the highest rating (89.15%), followed by usability (87.43%) and gameplay experience (83.81%). At the item level, Q9 received 92.00%; this item asked whether playing helped users learn batik names and the values connected with them. Since Q8 and Q9 record what participants felt, their scores suggest that the material fitted the game well; they do not confirm that learning actually occurred.

Table 2. User Acceptance Testing results by evaluation dimension

Evaluation Dimension	Questionnaire Items	Mean Score (%)	Interpretation
Gameplay Experience	Q2, Q3, Q7	83.81	Excellent
Usability	Q1, Q4, Q5, Q6	87.43	Excellent
Perceived Educational Content	Q8, Q9	89.15	Excellent
Overall User Acceptance	Q1–Q9	86.60	Excellent

Table 3. Item-level User Acceptance Testing results

ID	UAT item	Score (%)
Q1	The app runs without crashes or freezes.	89.71
Q2	The pixel-art visuals and thematic audio work well together.	88.00
Q3	The storyline and quest chains give players a clear sense of direction.	89.14
Q4	Text sizes and font choices stay readable across screens.	86.86
Q5	Menu controls and touch panels are easy to find and use.	86.29
Q6	The tutorial explains the core mechanics without confusion.	86.86
Q7	The D-Pad feels responsive during tight navigation.	74.29
Q8	The batik motif illustrations match their real historical counterparts.	86.29
Q9	Gameplay helps players learn batik names and the values associated with them.	92.00

The educational-content responses align with earlier work reporting that learning material can feel more engaging when placed within an interactive game (Li et al. 2024; Zhong 2022). A similar use of digital games to introduce traditional knowledge appears in cultural heritage studies (Abdullah et al., 2024; Lin et al., 2025). The comparison only concerns acceptance and perceived learning because the studies provide no educational effect sizes that can be compared directly.

Usability was another aspect that participants viewed positively. Most participants reported no difficulty in understanding the interface, text, menus, navigation, or tutorial. In an educational game, a problem with the controls can easily distract users from the material they are expected to learn. The item-level results nevertheless reveal a weaker experience with one of the controls.

The lowest item score was 74.29% for Q7, the question on the virtual directional pad, placing it below the ‘excellent’ range. According to participant feedback, the touch area felt rather small and made precise movement harder in faster sequences. This issue is relevant to both usability and accessibility, as navigation can be affected by screen size and differences in fine-motor control. The touch area was enlarged, and input handling was adjusted before the final release. Because there was no second formal UAT round, we cannot say that the revised control completely solved the problem.

Taken together, the responses were favorable, particularly for the educational content and the game’s general ease of use. The D-pad result reminds us that a good overall UAT score may still hide a problem with one specific control.

3.4. Preliminary Knowledge Assessment

The immediate knowledge check involved five participants who were separate from the UAT group. Each person answered the same nine motif questions twice: once before playing and once immediately afterward. Table 4 reports the individual descriptive results.

Table 4. Individual pre-test and immediate post-test scores

Participant ID	Pre-test score (0–9)	Immediate post-test score (0–9)	Descriptive difference
Participant 1	3	7	+4 points
Participant 2	2	6	+4 points
Participant 3	4	8	+4 points
Participant 4	3	7	+4 points
Participant 5	3	7	+4 points
Mean	3.00 / 9.00	7.00 / 9.00	+4.00 points

Every participant answered more questions correctly after playing than in the test taken beforehand. The mean moved from 3.00 to 7.00 out of nine, and every participant showed the same four-point difference.

Although this pattern is promising, it still needs confirmation through a larger assessment with stronger controls. The result cannot establish effectiveness because it comes from five people who repeated the questions, without either a comparison group or delayed testing. The result may also reflect immediate exposure or familiarity with the test items. Before making conclusions about learning or retention, the assessment needs to be repeated with more participants, a validated instrument, suitable paired analysis, and a delayed test. For that reason, we treat the result as a formative observation, not a generalizable knowledge-gain estimate.

3.5. Discussion and Implications for Sustainable Development

In general, the participants viewed Batik Quest positively as a digital way to introduce Indonesian batik motifs. An overall UAT score of 86.60% captures their favorable views of the gameplay, usability, and educational content. The preliminary assessment also recorded higher scores immediately after gameplay, but the small sample and evaluation design prevent causal or generalizable claims. At this point, test users accepted the design and found it usable. Judging its educational effect will require a larger study.

Batik Quest places cultural information within its story and the activities required of the player. Access to cultural content can also be widened through museum education, virtual and augmented reality, or digital heritage platforms (Liu et al. 2022; Theodoropoulos and Antoniou 2022). The RPG adds another type of experience because motif information appears while the player explores, solves problems, and completes quests. The design shares features with recent serious-game research on cultural heritage education (Abdullah et al. 2024; Lin et al. 2025). Its offline Android format also responds to an access issue that immersive digital heritage systems do not always emphasize.

Among the SDGs, the clearest connection of this work most clearly connects to SDG 4 on Quality Education. The game offers an additional cultural learning medium that can be used outside classrooms, museums, and workshops and can operate without continuous internet access. However, the current evaluation examined acceptance and a very small immediate knowledge assessment; it did not measure educational inclusion across locations, long-term learning, or formal classroom outcomes.

The game may also help keep knowledge about intangible cultural heritage in circulation among younger users. Integrating local cultural content into familiar digital formats may encourage young users to engage with motif names and meanings. Digital games should be considered complementary tools rather than replacements for artisans, museums, teachers, or community-based cultural learning, all of which provide forms of knowledge and experience that the application cannot reproduce.

Any connection to SDG 8 or SDG 12 remains only a possibility at this stage. Greater cultural literacy might influence appreciation of authentic batik, sustainable consumption, or support for artisan livelihoods, but the present study did not measure purchasing behavior, willingness to pay, product authentication, demand, or artisan income. They remain questions for later interdisciplinary work and are not outcomes demonstrated by the present Batik Quest evaluation.

Several RPJPN 2025–2045 priorities are relevant to the project, especially digital transformation, human development, and cultural preservation. This alignment indicates a possible area for collaboration among educational institutions, cultural organizations, artisans, and software developers. Evaluating implementation at a wider scale would require evidence on learning, access, cultural engagement, and community outcomes beyond the scope of the present study.

Conclusion

This study developed Batik Quest, an offline Android educational RPG that introduces nine traditional Indonesian batik motifs through quests, exploration, puzzles, and character interaction. The application was developed within the Game Development Life Cycle (GDLC) framework and evaluated through black-box testing, UAT involving 35 participants, and a separate preliminary pre-test/post-test assessment involving five participants.

The application achieved an overall UAT score of 86.60%, indicating positive user acceptance. Perceived educational content received the highest dimension score, while D-pad responsiveness received the lowest item score and identified a specific usability and accessibility concern. In the five-

person preliminary assessment, immediate mean scores increased from 3.00 to 7.00 out of nine. Because of the assessment design and sample size, this observation indicates only educational potential and does not demonstrate effectiveness or retention.

Batik Quest shows how mobile game design can complement cultural heritage education. Its most direct relevance to sustainable development concerns accessible learning and the transmission of cultural knowledge. Economic benefits, sustainable consumption, and effects on artisan livelihoods were not measured and should not be inferred from the present findings. Further evaluation is necessary before the game can be recommended as an evidence-based educational intervention.

Limitations

This study has several limitations: First, Batik Quest was developed only for the Android platform, so users of other mobile operating systems could not use the application. Second, the game only includes nine traditional Indonesian batik motifs, so it does not represent the full regional diversity of Indonesian batik. The UAT responses should not be taken as representative of the wider population because participants were drawn from selected online communities. We did not conduct a separate psychometric test of the adapted nine-item questionnaire, whose educational items recorded opinions rather than learning performance. We did not examine other participant characteristics beyond the stated eligibility criteria.

The preliminary knowledge assessment involved just five people, who answered an identical set of questions immediately before and after gameplay. In the absence of a control group and delayed test, these findings neither support generalization nor demonstrate causality or retention. A second formal UAT round was not conducted for the revised D-pad either. Future research should use a larger, more diverse sample, validate the assessment instruments, use an appropriate comparison design, and examine delayed learning outcomes. Separate studies are required to investigate cultural engagement, purchasing behavior, willingness to pay, sustainable consumption, and possible benefits for batik-producing communities.

Declaration of Generative AI Use

During the preparation of this manuscript, the author(s) used Perplexity to improve the clarity and structure of the paper. After using this tool, the author(s) thoroughly reviewed, edited, and verified the entire content to ensure it accurately represents their own ideas and interpretations. The author(s) take full responsibility for the integrity and originality of the published work.

Author Contributions

The first author contributed to the academic interpretation, conceptualization, supervision, methodology design, and overall manuscript structure. The second author contributed to the literature review, the game development, dataset collection, initial paper drafting, and application testing. The third author contributed to the technical validation of the game framework, particularly the use of the gamification method. The fourth author contributed to result validation and drafting of the results section. All authors reviewed, revised, and approved of the final version of the article.

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Data Availability Statement

The datasets used and analyzed in this study are not publicly available due to institutional data protection. However, anonymized or aggregated data supporting the findings of this study may be made available from the corresponding author upon request.

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Conflicts of Interest

The authors declare that they have no known competing financial interests, personal relationships, or institutional conflicts that could have influenced the research, analysis, interpretation, or publication of this article.

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