Revitalizing Cultural Heritage Education Through a Flow Theory-Based Serious Game Model for Enhancing User Engagement

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***Abstract*—Cultural heritage education plays a vital role in preserving national identity and transmitting traditional knowledge across generations. However, younger learners often perceive learning about cultural heritage as passive and less engaging than contemporary digital experiences. Although serious games have emerged as promising tools for heritage education, many existing applications lack theoretically grounded engagement mechanisms, limiting their effectiveness in sustaining learner participation. This study develops and empirically evaluates a Cultural Heritage Serious Game Model for Enhancing User Engagement Based on Flow Theory in the context of Songket learning. The research employed a four-phase methodology comprising analysis, model design, prototype development, and empirical evaluation. The proposed model integrates key Flow Theory-informed game design elements to support focused attention, intrinsic motivation, problem-solving, and learning transfer. Evaluation findings demonstrated positive engagement outcomes, with mean scores of 3.63 for focused attention, 3.98 for intrinsic motivation, 4.08 for problem-solving, and 4.02 for perceived learning transfer. The findings provide preliminary evidence of positive cognitive engagement in cultural heritage education. This study contributes a theoretically grounded design framework for serious game development and offers practical guidance for leveraging digital technologies to revitalize cultural heritage education.**

***Keywords*—Cultural heritage education; serious games; flow theory; user engagement; songket learning; educational technology**

I. Introduction

Cultural heritage represents a society's collective identity, history, and traditions, serving as an important medium for transmitting cultural values and knowledge across generations. However, globalization, urbanization, and rapid technological advancements have significantly transformed how younger generations perceive and engage with cultural heritage. Traditional instructional approaches, such as textbooks, classroom lectures, and museum exhibitions, often fail to sustain learners' attention and interest, particularly among digital-native students who are accustomed to highly interactive digital environments. Consequently, preserving intangible cultural heritage, including traditional crafts, music, textiles, and performing arts, has become an increasingly important challenge in education. Recent studies suggest that integrating digital technologies into cultural heritage education can significantly improve learners' participation and cultural appreciation while supporting long-term heritage preservation [1], [2].

Among various educational technologies, serious games have emerged as an effective instructional approach that integrates educational objectives with engaging gameplay. Serious games promote active learning through storytelling, challenges, immediate feedback, and interactive exploration, enabling learners to construct knowledge in enjoyable and meaningful ways. Numerous studies have demonstrated that serious games improve learning motivation, cultural awareness, and knowledge retention compared with conventional instructional methods [2], [3]. Nevertheless, despite their growing popularity in cultural heritage education, many existing serious games primarily present cultural information while overlooking the psychological mechanisms that sustain long-term engagement. Consequently, users often experience reduced immersion and declining motivation after initial interactions, limiting the educational effectiveness of these applications [4].

Consequently, user engagement has become a central issue in serious game research because it directly influences learning effectiveness, knowledge retention, and continued intention to use. Engagement encompasses learners' cognitive, emotional, and behavioral involvement throughout the learning process and is among the strongest predictors of successful digital learning environments. Flow Theory, introduced by Csikszentmihalyi, explains that individuals experience optimal engagement when challenges are appropriately matched to their skills, learning goals are clearly defined, immediate feedback is available, and they experience a sense of control during task performance [5].

Recent studies have further confirmed that Flow Theory provides a robust theoretical foundation for designing engaging learning environments across educational technologies, including virtual reality, metaverse learning, gamification, and serious games [6]. Despite its established relevance, relatively few studies have systematically incorporated Flow Theory into the design of serious games for cultural heritage education. Although Flow Theory has been applied to explain engagement in digital learning and games, it has less frequently been operationalized as a design principle throughout the development of cultural heritage serious games. Existing studies provide individual design recommendations or evaluate

user experience, but fewer studies provide an integrated model that explicitly connects Flow Theory-informed game elements, multimedia components, and cognitive engagement outcomes within a cultural heritage learning context. The novelty of the proposed model lies in its explicit operationalization of Flow Theory as a design principle rather than solely as an evaluation construct. The model maps Flow Theory-informed game elements and multimedia components to specific cognitive engagement dimensions within a cultural heritage learning context. This design-oriented mapping provides a structured basis for translating theoretical principles into gameplay features and learning activities for Songket education.

Therefore, this study develops and empirically evaluates a cultural heritage serious game model grounded in Flow Theory to enhance user engagement in learning Songket, one of Malaysia's most valuable forms of intangible cultural heritage. Using a Design and Development Research (DDR) methodology, the study develops a Flow Theory-based serious game model, implements the model in a Songket learning prototype, and empirically evaluates perceived user engagement across four dimensions, namely focused attention, intrinsic motivation, problem-solving, and learning transfer. Unlike previous studies that primarily focus on game usability or learning outcomes, this research contributes a theoretically grounded and empirically validated design framework that demonstrates how Flow Theory can be operationalized to enhance engagement in cultural heritage serious games. The proposed model provides practical guidance for researchers, educators, and game developers seeking to revitalize cultural heritage education through interactive digital technologies.

II. Related Work

A. Digital Transformation in Cultural Heritage Education

The rapid advancement of digital technologies has fundamentally transformed the preservation and dissemination of cultural heritage. Traditionally, cultural heritage education relied heavily on museums, exhibitions, storytelling, and classroom-based instruction to transmit historical knowledge and cultural values. While these approaches remain important, they often provide passive learning experiences that are less appealing to digitally native learners [1]. Consequently, researchers have increasingly explored digital technologies to create more interactive, learner-centered environments that improve cultural awareness and engagement.

Emerging technologies such as virtual reality (VR), augmented reality (AR), mixed reality (MR), digital storytelling, and interactive multimedia have demonstrated considerable potential for enhancing learners' understanding of cultural heritage by enabling immersive exploration of historical artifacts and cultural practices [3], [7]. These technologies facilitate experiential learning through visualization, interaction, and simulation, enabling learners to engage with cultural environments that would otherwise be inaccessible. Recent studies have also shown that digital cultural heritage platforms positively influence learners' cultural identity, historical understanding, and motivation to preserve heritage when they incorporate meaningful interaction rather than simply presenting digital content [4]. Recent research further indicates that interaction design has become an important consideration in cultural heritage serious games, with participatory, cognitive, perceptual, and social interaction identified as distinct interaction dimensions that can shape user experience in immersive heritage environments [16].

Despite these advancements, several studies have reported that many digital heritage applications remain technology-driven rather than pedagogy-driven. Existing systems frequently prioritize visualization and information delivery while paying little attention to instructional theories that explain how learners become cognitively and emotionally engaged in digital learning [2]. As a result, researchers increasingly advocate integrating educational theories into the design of digital heritage systems to improve learning effectiveness and long-term engagement. Recent systematic research on gamified XR applications similarly highlights the importance of aligning technological affordances, interaction design, game mechanics, and educational objectives rather than treating immersive technology as an end in itself [17].

B. Serious Games for Cultural Heritage Learning

Serious games have become one of the most promising educational technologies for cultural heritage learning because they integrate educational objectives with engaging gameplay experiences. Unlike entertainment games, serious games are intentionally designed to facilitate learning while maintaining players' enjoyment through interactive challenges, storytelling, rewards, and immediate feedback [8]. Their ability to combine experiential learning with problem-solving activities makes them particularly suitable for preserving intangible cultural heritage, where learners must understand not only factual information but also cultural values, traditions, and practices.

Previous studies have demonstrated that serious games significantly improve learner motivation, cultural awareness, knowledge acquisition, and learning satisfaction compared with conventional instructional approaches [9]. For example, virtual heritage games enable learners to explore historical environments interactively, while simulation-based games encourage active participation in traditional cultural practices. Similarly, game-based learning has been successfully used to teach traditional architecture, archaeology, historical events, and indigenous knowledge systems [10]. Recent empirical research has further demonstrated that cultural heritage serious games can support knowledge transfer through different immersive technologies, with evidence suggesting that the relationship between interaction, immersion, and knowledge outcomes depends on the nature of the learning task and technology used [18].

Nevertheless, recent reviews indicate that many serious games for cultural heritage emphasize entertainment and visualization without systematically incorporating pedagogical or psychological theories into their design [11]. Consequently, although these games may initially attract users, they often struggle to sustain engagement throughout the learning process. Additionally, evaluation studies frequently focus on usability and learning outcomes while providing limited explanation of how specific game design elements influence engagement mechanisms [12]. These limitations emphasize the need for theoretically grounded serious game models that explicitly connect educational theory with game design

principles. Recent studies have begun to address this issue by examining the specific factors and mechanisms underlying engagement in intangible cultural heritage serious games, including cultural authenticity, information richness, interactivity, aesthetics, and perceived enjoyment [19], [20].

C. Flow Theory and User Engagement in Serious Games

User engagement has become a central construct in educational technology because it strongly influences learning persistence, motivation, satisfaction, and knowledge retention. Engagement is generally understood as a multidimensional concept comprising cognitive, emotional, and behavioral involvement during learning activities [13]. In serious games, maintaining engagement is particularly important because learning occurs simultaneously with gameplay; therefore, disengagement often reduces educational effectiveness.

Flow Theory, proposed by Csikszentmihalyi [5], explains how individuals experience optimal engagement when they become fully immersed in an activity. Flow occurs when learners perceive a balance between task difficulty and their own abilities, receive immediate feedback, pursue clear goals, and maintain a strong sense of control. Under these conditions, learners experience intrinsic motivation, deep concentration, enjoyment, and a reduced awareness of external distractions. Numerous studies have identified Flow Theory as one of the most influential theoretical frameworks for explaining engagement in digital learning environments, including serious games, gamified learning systems, virtual reality, and metaverse-based education [6], [14]. Recent research continues to support the relevance of Flow Theory in digital game-based learning, particularly in explaining relationships involving motivation and problem-solving outcomes [21].

Recent research has further demonstrated that flow experiences positively influence learner motivation, learning achievement, self-efficacy, and continued intention to use educational technologies [15]. In serious games, Flow Theory has been associated with focused attention, higher intrinsic motivation, enhanced problem-solving ability, and perceived knowledge transfer. However, despite these promising findings, relatively few studies have operationalized Flow Theory into a comprehensive game design model specifically for cultural heritage education. Most existing studies measure flow only as an evaluation outcome rather than using it as a guiding framework throughout the game design process [11]. This limitation presents an important opportunity to develop theory-driven serious game models that systematically enhance learner engagement. Importantly, recent research on intangible cultural heritage serious games has shifted attention toward identifying the underlying mechanisms of engagement, showing that authenticity, knowledge acquisition, interactivity, emotional connection, perceived playfulness, and design aesthetics can contribute to users' perceived usefulness, enjoyment, cultural identity, and engagement [20]. This emerging evidence reinforces the need for design models that move beyond measuring engagement as an outcome and explicitly specify how theoretically informed game elements are intended to support different dimensions of engagement.

III. METHOD

This study adopted a Design and Development Research (DDR) methodology to systematically develop, implement, and evaluate a Flow Theory-based Cultural Heritage Serious Game Model to enhance user engagement. The research process consisted of four main phases: 1) Analysis, 2) Design, 3) Development, and 4) Evaluation. Each phase contributed to the progressive refinement of the proposed serious game model, beginning with the identification of design requirements and theoretical foundations, followed by model construction, prototype implementation, and evaluation of user engagement outcomes.

A. Analysis Phase

The analysis phase established the theoretical, contextual, and design foundations for developing the Flow Theory-based Cultural Heritage Serious Game Model. This phase involved three main activities: literature analysis, serious game analysis, and the collection of contextual data. The literature analysis reviewed existing studies on serious games, cultural heritage education, Flow Theory, and user engagement to identify relevant theoretical constructs, game elements, and evaluation dimensions. A comparative analysis of existing cultural heritage serious games was then conducted to examine current design approaches, learning strategies, and engagement mechanisms, and to identify limitations in existing applications. In addition, interviews and observations with Songket and cultural heritage experts were conducted to gather domain-specific knowledge of Songket history, weaving processes, motifs, and cultural values. The findings from this phase informed the identification of user requirements, cultural content specifications, and essential model components that guided the subsequent design and development phases.

B. Design Phase

The design phase focused on transforming the findings from the analysis phase into a structured conceptual framework and detailed game design specifications. This phase involved two main activities: model construction and game design planning. The first activity involved developing a cultural heritage serious game model to enhance user engagement, grounded in Flow Theory. The components identified in the analysis phase were systematically mapped according to their relationships among Flow Theory principles, serious game elements, and expected user engagement outcomes. The proposed model establishes how specific game design features can facilitate psychological engagement states and support meaningful cultural heritage learning experiences.

The second activity involved developing a comprehensive Game Design Document (GDD) to translate the proposed model into practical design requirements. The GDD specified the game objectives, learning objectives, gameplay mechanics, narrative structure, interaction design, level progression, multimedia requirements, character design, and user interface elements. Low-fidelity interface designs, storyboards, and learning scenarios were developed to ensure that the proposed game features aligned with both educational objectives and Flow Theory principles.

C. Development Phase

The development phase involved transforming the approved design specifications into a functional, high-fidelity serious game prototype for Songket learning. This phase consisted of three activities: asset production, prototype implementation, and functional testing. During asset production, multimedia resources, including two-dimensional and three-dimensional graphics, animations, audio elements, interface components, and cultural heritage visual materials, were created and refined. These assets were designed to accurately represent Songket-related knowledge, including weaving processes, traditional motifs and patterns, tools, and cultural narratives.

The prototype was subsequently developed in Unity, integrating the designed game mechanics, interactive elements, learning activities, and multimedia components. The implementation process ensured that each component of the proposed model was embedded in the game environment, particularly user-engagement elements such as interactive challenges, feedback mechanisms, progressive difficulty, and meaningful learning activities. The gameplay was structured around Songket-related learning activities that required participants to interact with cultural heritage content rather than merely receive informational content. Each learning activity was translated into game-based tasks involving clear objectives, challenges, feedback, and progression. Clear objectives guided players towards specific Songket learning goals, while challenges required them to identify, interpret, arrange, or make decisions related to Songket knowledge. Immediate feedback was provided following player actions to indicate task performance and guide subsequent decisions, while rewards and progression mechanisms were used to reinforce task completion and encourage continued participation. The difficulty of the activities was progressively structured to provide increasing levels of challenge as players advanced through the game. Multimedia elements, including graphics, sound/music, and cultural content, were integrated into the gameplay to contextualise information about Songket motifs, weaving processes, tools, and cultural values.

Learning activities related to Songket motifs required players to interact with and identify visual representations of traditional motifs, while activities related to the weaving process required players to engage with task sequences associated with the production process. Other learning activities presented Songket-related cultural information within interactive missions, requiring players to use the information presented during gameplay to complete subsequent tasks. These activities followed a progression in which successful task completion enabled players to proceed to subsequent challenges, while feedback provided information about their performance. This implementation translated the proposed Flow Theory-based design principles into concrete gameplay experiences and ensured that cultural heritage knowledge was embedded within the interaction and progression of the serious game rather than presented solely as supplementary information.

Following implementation, functional testing was conducted to ensure the reliability and usability of the developed prototype. Unit testing and integration testing were performed to examine game functionality, navigation flow, interaction mechanisms, multimedia performance, and potential technical errors. The output of this phase was a fully functional cultural heritage serious-game prototype, ready for empirical evaluation.

D. Evaluation Phase

The evaluation phase aimed to empirically evaluate users' perceived cognitive engagement by examining users' engagement experiences after interacting with the developed Songket learning prototype. The user evaluation involved 25 participants aged between 18 and 25 years, representing the target user group for the Songket learning prototype. Participants were recruited using convenience sampling based on their availability and suitability for the intended learner profile. The evaluation was designed as an initial user-based validation of the developed prototype within the evaluation phase of the DDR methodology rather than as a population-level effectiveness study.

A user-based evaluation approach was conducted with participants representing the intended learner group. Each participant engaged with the game for approximately 30–45 minutes before completing the evaluation questionnaire. The evaluation focused on measuring user engagement across four dimensions adapted from the User Engagement Scale (UES) framework: focused attention, intrinsic motivation, problem solving, and learning transfer.

A structured questionnaire was developed to assess the effectiveness of the proposed model in facilitating engaging cultural heritage learning experiences. The instrument consisted of three sections. Section A collected demographic information to describe participants' background characteristics. Section B measured user engagement across four subdimensions: focused attention, intrinsic motivation, problem-solving, and learning transfer. Focused attention examined the extent to which users were immersed and concentrated during gameplay; intrinsic motivation evaluated users' enjoyment, interest, and willingness to continue engaging with the learning activity; problem-solving assessed users' cognitive involvement in completing game-based challenges and applying acquired knowledge; while learning transfer measured users' ability to relate and apply the knowledge gained from the game to Songket-related concepts and cultural understanding. Section C evaluated users' overall perceptions of the developed serious game, including overall satisfaction and recommendations. Items in Sections B and C were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The collected quantitative data were analyzed using descriptive statistical analysis to determine the level of user engagement achieved by the developed serious game model. Mean scores were calculated for each engagement dimension to evaluate the extent to which the proposed model supported meaningful learning experiences. The evaluation outcomes were subsequently used to empirically evaluate the Flow Theory-based serious game model and to demonstrate its contribution to enhancing cultural heritage education through an interactive, engagement-driven digital learning approach.

IV. Result and Discussion

This section presents the study's outcomes: a proposed cultural heritage serious game model for enhancing user engagement, grounded in Flow Theory, and an empirical evaluation of perceived cognitive engagement in Songket learning. The results are presented in two stages. First, the proposed model is described as integrating Flow Theory principles and multimedia elements within the serious game environment. Second, the empirical evaluation examines participants' perceived cognitive engagement after interacting with the Songket prototype across four dimensions: focused attention, intrinsic motivation, problem-solving, and learning transfer.

A. Cultural Heritage Serious Game Model for Enhancing User Engagement Based on Flow Theory

The study resulted in the development of a cultural heritage serious game model to enhance user engagement, based on Flow Theory, as illustrated in Fig. 1. The model conceptualizes a serious game as an integrated learning environment in which Flow Theory-based game elements and multimedia components work together to facilitate cognitive engagement. The model consists of two primary inputs within the serious game environment: 1) Flow Theory-based game elements and 2) media elements. The Flow Theory-based game elements comprise feedback, clear goals, challenges, rewards, and focused attention. These elements are designed to structure the learning experience and encourage sustained interaction by providing learners with explicit objectives, appropriately challenging tasks, timely responses to their actions, motivational reinforcement, and opportunities to maintain concentration during gameplay. The media component complements these game mechanics by integrating graphics, sound/music, and cultural heritage content, thereby providing multimodal representations of Songket knowledge and creating a more interactive and meaningful learning environment.

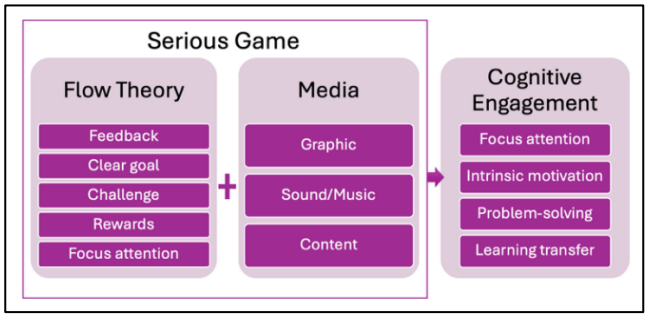

Fig. 1. Cultural heritage serious game model for enhancing user engagement based on flow theory.

The proposed relationships between the game design elements and cognitive engagement dimensions are theoretically grounded in the mechanisms of Flow Theory. Clear goals provide task orientation by directing learners toward specific objectives, thereby supporting focused attention on relevant learning activities. Challenges create opportunities for cognitive processing by requiring learners to analyse information, make decisions, and develop strategies, which supports problem-solving engagement. Feedback provides immediate performance awareness by informing learners about the consequences of their actions and progress toward goals, thereby helping them maintain attention and adjust their strategies during gameplay. Rewards, when integrated with meaningful progression and achievement, reinforce learners' sense of accomplishment and can support intrinsic motivation by sustaining interest and continued participation. In addition, the integration of cultural heritage content with interactive gameplay provides contextualization by allowing learners to encounter, manipulate, and apply Songket-related knowledge within meaningful game situations. Collectively, these relationships establish a theoretically informed pathway in which Flow Theory-based design mechanisms and multimedia-supported cultural content are intended to facilitate distinct but complementary dimensions of cognitive engagement.

The model proposes that the interaction between these game and media elements supports cognitive engagement, which is represented by four dimensions: focused attention, intrinsic motivation, problem-solving, and learning transfer. In the context of Songket learning, the game elements provide structural and motivational mechanisms to engage learners, while multimedia elements support the presentation and contextualization of cultural heritage knowledge. For example, clear goals and challenges can direct learners' attention toward specific Songket-related learning tasks, while feedback and rewards can reinforce participation and encourage continued engagement. Similarly, graphics, sound/music, and culturally relevant content can enhance the representation of Songket weaving traditions and facilitate learners' understanding of associated cultural knowledge. Through this integration, the model positions cognitive engagement as the intended outcome of the serious game experience, in which learners are expected to remain attentive to the learning activity, develop intrinsic motivation, actively engage in problem-solving, and transfer acquired knowledge into their understanding of Songket and cultural heritage.

B. Evaluation of Cognitive Engagement

User engagement within the Flow Theory-based serious game was evaluated in terms of perceived cognitive engagement. The evaluation involved 25 participants aged 18-25, representing the target user group for the Songket learning prototype. Cognitive engagement was operationalized across four dimensions: focused attention, intrinsic motivation, problem-solving, and learning transfer. Participants interacted with the Songket serious game prototype before completing the evaluation questionnaire.

1) Focused attention: The findings indicate a positive level of focused attention among participants, with an overall mean score of 3.63 (SD = 1.06) as shown in Table I. The results suggest that participants generally experienced concentration and involvement while interacting with the Songket serious game. In particular, the item-level results indicate that participants reported relatively strong attention toward game-related tasks, with the highest mean observed for the statement "My attention was fully focused on the game tasks" (M = 4.16, SD = 0.90). This finding suggests that structured gameplay activities and task-oriented interactions

effectively directed participants' attention toward the learning activities embedded in the game. Participants also reported relatively high levels of absorption in the game (M = 3.68) and immersion in the game environment and storyline (M = 3.80), indicating that the combination of gameplay and multimedia elements helped maintain users' attention.

However, the comparatively lower mean scores for "I lost track of time while interacting with the game" (M = 3.32, SD = 1.18) and "I was so involved that I forgot about my surroundings" (M = 3.20, SD = 1.23) suggest that the level of deep immersion was less consistent among participants. The relatively higher standard deviation also indicates greater variation in participants' experiences of focused attention. This finding is important in relation to the proposed Flow Theory-based model because focused attention reflects not only the game's ability to attract attention but also the extent to which users experience sustained cognitive absorption. The results suggest that the current implementation was effective in directing attention toward specific learning tasks. However, opportunities remain to strengthen deeper immersion through more sophisticated narrative structures, adaptive challenges, richer interactive feedback, and more continuous gameplay progression. Future iterations of the model could further investigate how these design mechanisms influence sustained attention and deeper flow experiences during cultural heritage learning.

TABLE I. FOCUSED ATTENTION ELEMENT

Item	Statement	M	SD
FA1	Completely absorbed in the game	3.68	0.80
FA2	Lost track of time	3.32	1.18
FA3	Forgot about surroundings	3.20	1.23
FA4	Attention fully focused on game tasks	4.16	0.90
FA5	Immersed in game environment and storyline	3.80	0.91
	Overall Mean/SD	**3.63**	**1.06**

2) Intrinsic motivation: The results demonstrate a high level of intrinsic motivation**,** with an overall mean score of 3.98 (SD = 0.84), as shown in Table II**.** This finding indicates that participants generally experienced enjoyment, curiosity, and personal interest while interacting with the Songket learning game. The item-level findings further support this interpretation, with participants reporting that their motivation was primarily associated with interest and enjoyment rather than external rewards (M = 4.04, SD = 0.89)**.** Participants also demonstrated a strong willingness to explore and master challenges (M = 3.96) and reported continued engagement driven by curiosity (M = 4.00). These results suggest that the game experience provided internally rewarding interactions that encouraged participants to remain engaged with the learning activities.

The findings are particularly relevant to the Flow Theory foundation of the proposed model. Flow-oriented experiences are commonly associated with intrinsic enjoyment and the willingness to engage in an activity for its inherent satisfaction rather than solely for external outcomes. Within the proposed model, the integration of clear goals, challenges, feedback, rewards, and multimedia content creates an environment where participants can engage with Songket-related learning content in an enjoyable, personally meaningful way. Importantly, the results indicate that participants' motivation was not primarily dependent on external rewards, suggesting that the cultural content and interactive gameplay themselves provided meaningful sources of engagement. Nevertheless, because the present findings are based on self-reported perceptions, further research using longitudinal or experimental designs would be necessary to determine whether this intrinsic motivation is sustained over repeated gameplay sessions.

TABLE II. INTRINSIC MOTIVATION ELEMENT

Item	Statement	M	SD
IM1	Game was personally enjoyable	3.92	0.76
IM2	Motivated to explore and master challenges	3.96	0.79
IM3	Continued playing because of curiosity	4.00	0.91
IM4	Wanted to improve performance	4.00	0.91
IM5	Motivation from interest and enjoyment	4.04	0.89
	Overall Mean/SD	**3.98**	**0.84**

3) Problem-solving: Among the four dimensions examined, problem-solving achieved the highest overall mean score (M = 4.08, SD = 0.80), indicating a high level of perceived cognitive engagement during gameplay, as shown in Table III. Participants generally perceived the game as requiring active cognitive processing, including critical thinking, strategic planning, reasoning, and decision-making. The highest-rated item was "The missions tested my reasoning and decision-making skills" (M = 4.16, SD = 0.75), followed by "The game improved my ability to plan and adapt" (M = 4.12, SD = 0.78). These findings suggest that the game's mission structure and challenges successfully encouraged participants to actively process information and make decisions rather than passively consume cultural heritage content.

The strong problem-solving results provide important support for the design rationale underlying the proposed model. The integration of challenges and clear goals, supported by feedback and rewards, provides a structured mechanism for learners to engage progressively with Songket-related content. Rather than presenting Songket knowledge solely through conventional information delivery, the game requires learners to interact with content through tasks and challenges, thereby encouraging active cognitive participation. The results also suggest that the serious game has the potential to transform cultural heritage learning from a predominantly receptive activity into a more participatory experience. However, the findings should be interpreted as evidence of perceived engagement in problem-solving rather than direct evidence of improved problem-solving ability, as the study did not employ a pre-test/post-test design or objective performance measures. Future studies could therefore incorporate behavioral game analytics and learning performance assessments to determine

whether the perceived cognitive engagement observed in this study translates into measurable improvements in problem-solving performance.

TABLE III. PROBLEM-SOLVING ELEMENT

Item	Statement	M	SD
PS1	Game required critical thinking	4.04	0.79
PS2	Developed new strategies	4.08	0.91
PS3	Enjoyed finding solutions	4.00	0.82
PS4	Missions tested reasoning and decision-making	4.16	0.75
PS5	Improved planning and adaptation	4.12	0.78
	Overall Mean/SD	**4.08**	**0.80**

4) Learning transfer: The results also demonstrate a high level of perceived learning transfer, with an overall mean score of 4.02 (SD = 0.81) as in Table IV. This finding indicates that participants generally perceived the knowledge and skills acquired through the game as relevant beyond the immediate gameplay context. The highest-rated item was "The game encouraged me to use my new knowledge elsewhere" (M = 4.12, SD = 0.83), followed by participants' perceived ability to apply what they learned to real-world situations (M = 4.04). These findings suggest that participants recognized the relevance of the Songket-related knowledge presented through the game beyond the immediate digital environment.

The learning transfer outcome is particularly significant for cultural heritage education because the primary purpose of a heritage-oriented serious game extends beyond providing an engaging gameplay experience. The learning experience should encourage learners to recognize, understand, and appreciate cultural knowledge in contexts beyond the game itself. Within the proposed model, integrating cultural heritage content with interactive gameplay and multimedia elements has supported participants' perception that the knowledge acquired through the game can be applied or recalled in other contexts. Nevertheless, the results represent perceived learning transfer rather than objectively demonstrated transfer. The absence of an external knowledge assessment means that the findings cannot establish whether participants transferred Songket knowledge to real-world situations. Future research should therefore incorporate pre-test and post-test assessments, delayed retention tests, or authentic cultural heritage tasks to provide stronger empirical evidence of perceived learning transfer.

TABLE IV. LEARNING TRANSFER ELEMENT

Item	Statement	M	SD
LT1	Applied learning to real-world situations	4.04	0.84
LT2	Knowledge/skills useful beyond the game	4.00	0.82
LT3	Connections between gameplay and real-life contexts	3.92	0.81
LT4	Confident using learning in other settings	4.00	0.82
LT5	Encouraged to use new knowledge elsewhere	4.12	0.83
	Overall Mean/SD	**4.02**	**0.81**

V. CONCLUSION

This study successfully designed and empirically evaluated a Cultural Heritage Serious Game Model for Enhancing User Engagement Based on Flow Theory for Learning Songket. The proposed model integrates Flow Theory-informed serious game elements, namely feedback, clear goals, challenges, rewards, and attention-supporting mechanisms, with multimedia components comprising graphics, sound/music, and cultural heritage content. The model was implemented using a Songket learning prototype and evaluated across four dimensions of perceived cognitive engagement: focused attention, intrinsic motivation, problem-solving, and perceived learning transfer. The evaluation results indicated positive levels of perceived engagement across all four dimensions, with problem-solving (M = 4.08) achieving the highest mean, followed by learning transfer (M = 4.02), intrinsic motivation (M = 3.98), and focused attention (M = 3.63). The findings provide preliminary empirical evidence that the implemented prototype was associated with positive perceived cognitive engagement, consistent with the engagement propositions of the proposed model.

The study contributes to the theoretical and practical development of serious game design in three key ways. First, it provides a conceptual model that integrates serious game elements and multimedia components grounded in Flow Theory, demonstrating how these components can be structured to support multidimensional user engagement in cultural heritage learning. Second, the model offers a reference framework for researchers, educators, and serious game developers seeking to design engagement-oriented learning applications, particularly within the cultural heritage domain. Third, the study demonstrates the potential of an engagement-driven serious game approach to facilitate more interactive and immersive learning experiences while supporting the transmission, appreciation, and preservation of cultural heritage knowledge. Thus, the proposed model extends the application of Flow Theory beyond general digital learning contexts by providing a structured approach for integrating engagement mechanisms into the design of serious games for cultural heritage.

Future research should further refine and validate the proposed model by exploring alternative interaction techniques, expanded cultural heritage content, and more adaptive game mechanisms to strengthen sustained attention and deeper user engagement. Longitudinal studies involving larger and more diverse participant groups are also recommended to examine learning effectiveness, knowledge retention, continued user engagement, and user retention over extended periods. In addition, future research could investigate the model's scalability and transferability across different forms of tangible and intangible cultural heritage, cultural contexts, and learning environments. Such investigations would strengthen the model's generalizability and contribute to the development of a more comprehensive framework for leveraging serious games as sustainable digital tools for cultural preservation, heritage education, and intergenerational knowledge transmission.

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DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors used ChatGPT and QuillBot for language refinement and grammatical improvement of the manuscript. These tools were used solely to enhance the clarity and readability of the text. The authors take full responsibility for the integrity of the research content, the accuracy of all data and findings, and the overall scientific contribution of this work.

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