JOURNAL OF DIGITAL SYSTEM DEVELOPMENT

https://e-journal.uum.edu.my/index.php/jdsd

How to cite this article:
Che Mat, R. & Wan, W. A. (2025). Projection Mapping as a Medium for Cultural Heritage: The Case of Thai Menora. *Journal of Digital System Development*, *3*(1), 56-67. https://doi.org/10.32890/jdsd2025.3.1.5

PROJECTION MAPPING AS A MEDIUM FOR CULTURAL HERITAGE: THE CASE OF THAI MENORA

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Received: 11/11/2024 Revised: 25/3/2025 Accepted: 6/4/2025 Published: 28/04/2025

ABSTRACT

Projection mapping is a video projection technology in which video is mapped onto a surface. Then, it turns everyday objects such as buildings, walls, runways, stages, or any surface that can be manipulated in interactive displays and graphical videos. Projection mapping is very suitable for presenting creative content based on historical storytelling. It provides uniqueness to attract the public's attention to get a new experience in projection mapping and add general knowledge about history today. However, traditional methods of presenting historical narratives often struggle to capture public interest, especially among younger audiences, resulting in declining awareness and appreciation of cultural heritage. The main objective of this paper is to develop an interactive and creative storyline of the history of Thai Menora as a projection mapping for people interested in knowing about history. Next, the methodology used to make this projection mapping is the ADDIE model, which consists of analysis, design, development, implementation, and evaluation. The completed projection mapping has been successfully developed using Adobe After Effects, Adobe Audition and Filmora software, which uses content and audio elements to map the historical content. Based on the results from the usability testing on the public, all the feedback from the respondents agreed that projection mapping is very effective in presenting the storyline history of Thai Menora. Overall, the research investigated the interactive storyline history of Thai Menora through projection mapping.

Keywords: Projection mapping, History of Thai Menora, Cultural heritage, Interactive storytelling, Educational technology

INTRODUCTION

Projection mapping is an innovative video projection technology that maps visual content onto a surface, transforming everyday objects such as buildings, walls, stages, or any suitable surface into dynamic visual canvases. The content is displayed so that it interacts with the surface's shape and texture, creating a visually engaging experience that blends light, illusion, and motion. This technique can be used in various fields, including theatre, concerts, historical storytelling, and exhibitions, offering new ways to engage audiences with immersive experiences (Punpongsanon et al., 2020; Takeuchi et al., 2024).

In cultural heritage, this technology presents new opportunities for preserving and communicating traditional narratives in ways that resonate with modern audiences. One such narrative is Nora, or Menora, a traditional dance-drama native to Southern Thailand and parts of Malaysia. Known for its intricate choreography, vibrant costumes, and mythological themes, Menora reflects the deep-rooted cultural identity of the region. The central character, often a female heroine, embodies traditional values and historical legacy (Walailak University, 2021). This traditional art form not only represents the region's cultural heritage but also serves as a powerful means of preserving and conveying historical narratives through performance (Figure 1).

Figure 1

The performance of Thai Menora Dance by researchers from Walailak University (adapted from Walailak University, 2021)

By leveraging digital projections, projection mapping has become a significant tool in enhancing the storytelling experience. This technology allows for the dynamic augmentation of real-world surfaces with animations and visuals synchronising with the surface's characteristics, offering a captivating way to experience history. In recent years, the integration of projection mapping in creative industries has revolutionised how historical events and narratives are presented to the public. By adding interactive elements, projection mapping creates a visually immersive environment that captivates audiences and enhances their understanding of history (Sato et al., 2023). In the context of Thai Menora, projection

mapping can bring the ancient narratives of this dance-drama to life, offering audiences a more engaging and interactive way to explore its rich cultural heritage.

The primary objective of this paper is to develop a creative and interactive storyline of the history of Thai Menora using projection mapping. This approach offers a modern, innovative method for engaging audiences with historical content, mainly through cutting-edge technology to preserve and disseminate cultural knowledge. By blending tradition with modern technological advancements, this paper explores the potential of projection mapping as a tool for cultural preservation and education.

RELATED WORKS

Recent studies underscore the potential of projection mapping in cultural heritage education, particularly in enhancing engagement with historical artefacts, narratives, and spatial contexts. Nikolakopoulou et al. (2022) explored the integration of interactive storytelling and projection mapping within cultural heritage, highlighting its potential to engage users deeply with historical narratives and architectural elements. Their case study on Greek cultural heritage uses projection mapping to enhance visitors' experience and learning in museum environments by bridging tangible and intangible cultural elements. Expanding on the educational benefits, Barbiani et al. (2018) discuss "video projection mapping" for cultural heritage, demonstrating its educational and engagement benefits by converting static historical artefacts into dynamic displays that enrich visitor interaction. This study supports the transformative potential of projection mapping in creating immersive experiences that captivate audiences and deepen their historical understanding. On the other hand, Khaled and Aldakheel (2021) investigate using projection-based augmented reality in collaborative learning, focusing on history and heritage settings. This work examines projection mapping's potential for collaborative learning and engagement, which directly applies to teaching history at the secondary level.

In the context of virtual museums, recent research has focused on improving accessibility and user engagement. A study by Komianos et al. (2024) introduced a comprehensive workflow for developing virtual museums, addressing compatibility, usability, and interaction design challenges. The proposed design schema aims to attract broader audiences by enhancing the immersive experience of virtual cultural heritage exhibitions. Furthermore, eye-tracking technology has provided new insights into how different cultural groups perceive architectural heritage. A study by Deng et al. (2024) in Buildings employed eye-tracking to assess visual perception of Southern Fujian's traditional architecture, revealing significant differences in attention and appreciation across diverse cultural backgrounds. These findings underscore the importance of considering audience diversity when designing projection mapping content for cultural heritage sites.

The role of projection mapping extends into architectural and performance art contexts, whereby El Ashmawy (2020) delves into its use within historical architecture, where 3D projection mapping utilises optical and auditory effects to animate and transform physical structures into dynamic, interactive exhibits. This technology enables large-scale outdoor displays that blend artistic expression with historical narratives, fostering more profound engagement with cultural heritage. Saed Abbas (2021) further expands on this by exploring the philosophical and aesthetic links between projection mapping and optical illusion art. His research highlights how these visual techniques alter perception, creating illusions of movement, depth, and alternate realities that reframe viewers' experiences of space. Additionally, integrating Building Information Modelling (BIM) with Virtual Reality (VR) has enhanced the visualisation of architectural heritage. A recent study by Fiorenza et al. (2025) introduced a semi-automated workflow that facilitates the transition from Heritage BIM (HBIM) models to VR environments. This integration allows for more

immersive and interactive exploration of historical buildings, offering new possibilities for education and engagement in cultural heritage.

These contemporary studies demonstrate the evolving landscape of digital technologies in cultural heritage preservation and education. Integrating projection mapping, interactive storytelling, and immersive technologies offers innovative avenues for engaging audiences with historical narratives and architectural heritage. These transformative potential projects map an innovative educational tool with applications that captivate audiences and enrich learning environments through immersive storytelling.

METHODOLOGY

The paper employed the ADDIE instructional design model to develop and evaluate a projection mapping prototype to enhance the visual storytelling of the Thai Menora history. The ADDIE model, widely used in educational technology design, consists of five phases: Analysis, Design, Development, Implementation, and Evaluation (Molenda, 2021; Kurt, 2018). Each phase in this study is tailored to create an interactive learning experience that effectively presents Thai Menora's cultural heritage through projection mapping.

Analysis

In the Analysis phase, the study identified the projection mapping application's instructional goals, target audience, and specific learning outcomes. Research was conducted to understand the historical and cultural context of Thai Menora, including an exploration of its themes, visual aesthetics, and narrative structure. This phase also involved analysing the potential impact of projection mapping as a medium for enhancing public engagement with traditional performing arts and identifying technical requirements such as projector specifications and space configurations for optimal display.

Design

During the Design phase, the team conceptualised the storyline and visual elements for the projection mapping display. This phase focused on creating a storyboard that illustrated the key narrative moments of Thai Menora to be highlighted in the projection. Special attention was given to aligning visual effects with the traditional motifs of the Thai Menora, ensuring cultural accuracy while maximising audience engagement. Technical planning also took place in this phase, including mapping software selection (Adobe After Effects), graphical content creation, and synchronising the visuals with audio elements to produce an immersive experience.

Development

The Development phase involved creating the prototype based on the design specifications. This included producing digital content such as animations, graphics, and audio depicting Thai Menora elements. Specialised projection mapping software was used to map the content onto physical surfaces, simulating the intended display environment. Continuous testing was conducted to refine the visuals and ensure the content aligned well with the surface's contours and textures. This iterative phase allowed the research team to address technical challenges and adjust based on initial trials. Besides that, Adobe Audition allowed for precise audio adjustments, ensuring alignment with the visuals. Filmora was used to compile and finalise the video content, enabling an efficient workflow from content creation to projection. Iterative testing ensured the mapped content was visually cohesive and technically sound, allowing adjustments to be made in response to any display or alignment issues encountered.

Implementation

In the Implementation phase, the prototype was deployed in a controlled setting where participants could interact with the projection mapping display and the participants could experience the immersive display. The setup included projector calibration and environmental adjustments to maximise visual clarity and engagement. Participants engaged with the projection mapping in a controlled setting, and their interactions and engagement levels were observed to inform the subsequent evaluation.

Evaluation

The final phase, evaluation, was conducted through feedback sessions and surveys to assess the prototype's effectiveness in conveying the historical narrative of Thai Menora. Audience feedback was gathered to evaluate the impact of projection mapping on understanding and engagement with Thai Menora. The feedback was analysed to identify strengths and areas for improvement, providing insights into how projection mapping can be further refined as an educational tool for historical storytelling. Quantitative analysis of the feedback helped validate the design choices and offered a foundation for future enhancements.

By following the ADDIE model, this paper systematically developed and evaluated a projection mapping prototype that leverages digital technology to enrich the understanding of Thai Menora, thus contributing to the broader field of cultural preservation through immersive media.

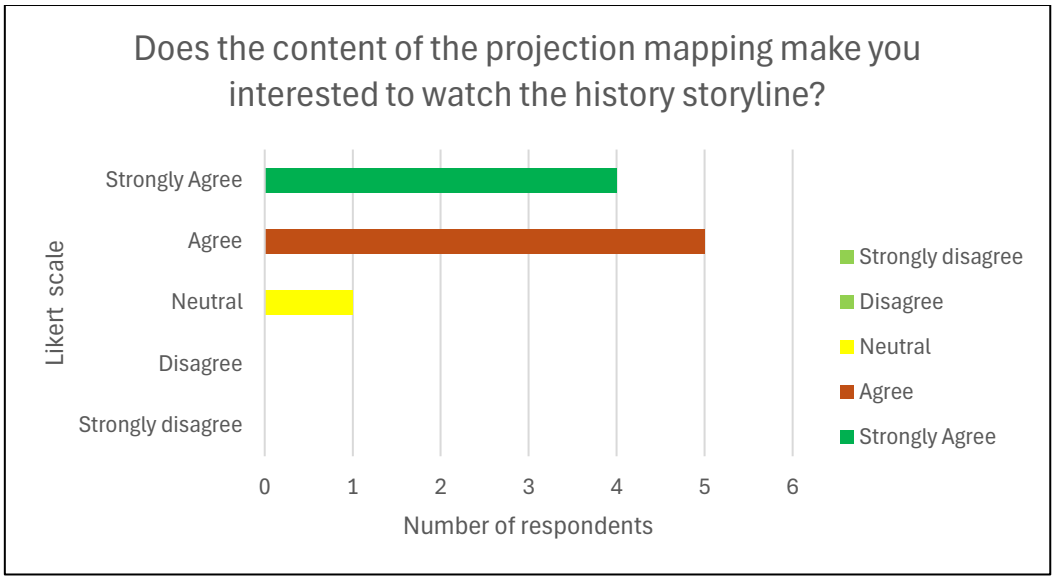
RESULTS AND DISCUSSION

After completing the development of the system, the project's effectiveness was assessed through an evaluation process. A survey was designed and administered to facilitate this evaluation. A total of 10 respondents participated in this assessment: 4 interacted directly with the project, while the remaining six provided feedback via questionnaires. Respondents shared their impressions after viewing the projection mapping on the history of the Thai Menora. The primary purpose of this survey was to determine whether the project successfully achieved its primary objective.

Engagement with Historical Storyline

In response to Question 1, a significant portion of respondents agreed or strongly agreed, with only a few showing neutrality or disagreement. Based on Figure 2, among the 10 respondents, five agreed that the projection mapping content made them interested in watching the historical storyline. Also, four respondents strongly agreed that the content encouraged their interest in the presented history. One respondent felt neutral about the impact of the content. This positive feedback suggests that projection mapping effectively captures interest, a critical component for educational engagement.

Figure 2
Q1: Does the content of the projection mapping make you interested in watching the history storyline?

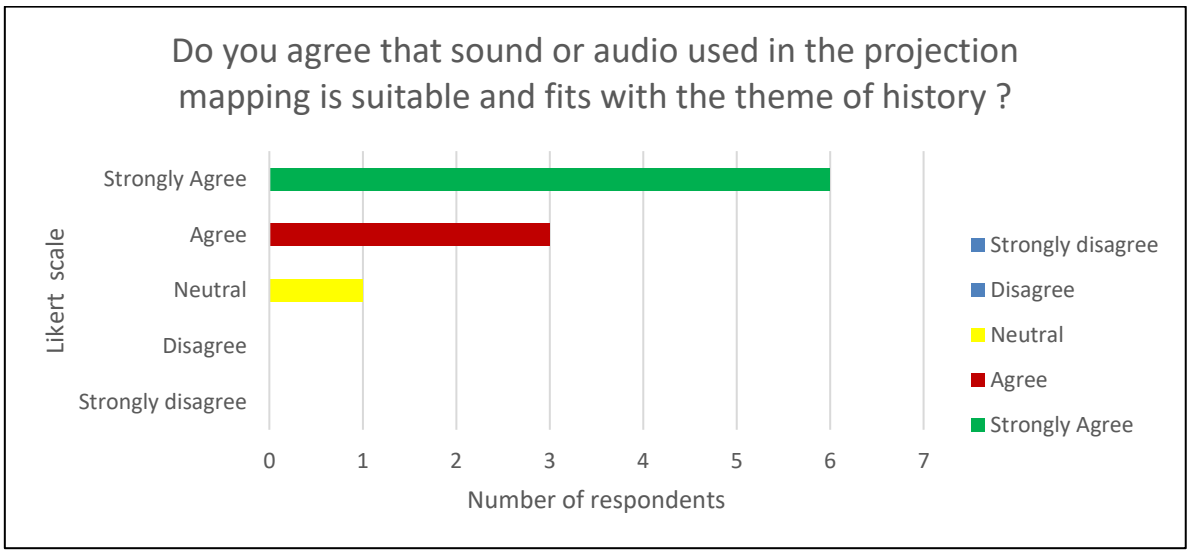


These results suggest that interactive historical storytelling through projection mapping can effectively engage viewers, providing them with both knowledge and a novel experience of historical narratives. According to Zhang et al. (2024), immersive technologies like projection mapping can stimulate engagement by providing a multisensory learning experience, making historical events and cultural elements more accessible and appealing to modern audiences.

Appropriateness of Audio for Historical Theme

According to Figure 3, which surveyed 10 individuals, 6 participants strongly endorsed the appropriateness and historical theme compatibility of the sound or audio used in projection mapping. Additionally, three respondents agreed with this sentiment, while 1 participant remained neutral regarding the suitability and historical theme alignment of the audio employed in the projection mapping. Respondents were also asked if they believed the audio used in projection mapping was suitable and aligned with the history theme. Most respondents strongly agreed, with a few expressing neutrality. In this case, traditional sounds that resonate with the Thai Menora theme likely contributed to a more cohesive and compelling historical narrative.

Figure 3
Q2: Do you agree that sound or audio used in projection mapping suits the theme of history?

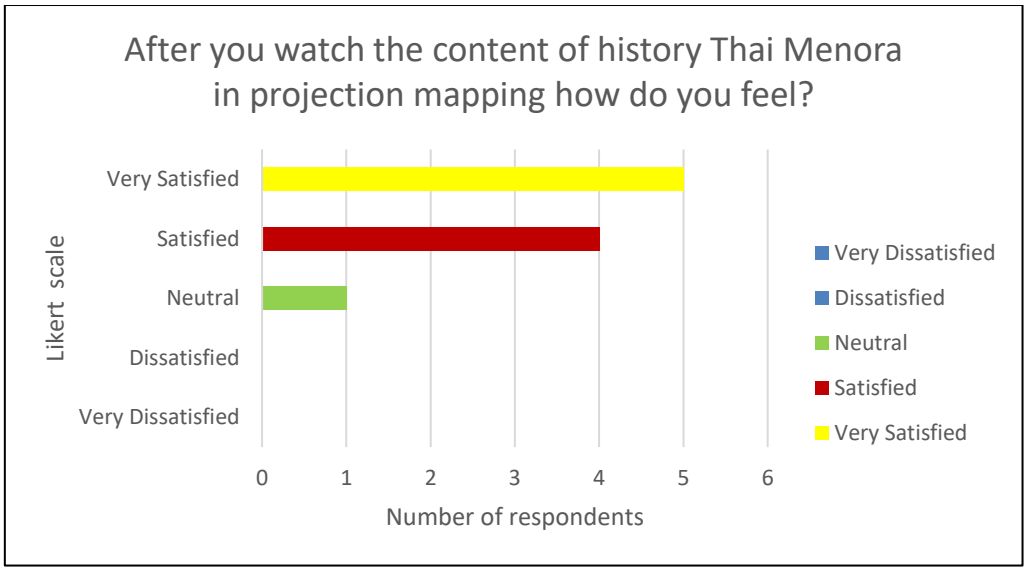


Satisfaction with the Content

The survey asked participants how satisfied they felt after watching the Thai Menora history content through projection mapping (Figure 4). The majority expressed either satisfaction or further satisfaction, with very few remaining neutral or dissatisfied. Out of 10 respondents, 5 expressed high satisfaction after viewing the content of Thai Menora history in projection mapping. Additionally, four respondents reported satisfaction, while one respondent remained neutral regarding the content. These findings suggest that projection mapping demonstrates the potential for presenting historical narratives through innovative technology, superseding traditional storytelling methods. Consequently, projection mapping offers an opportunity for individuals to acquire new knowledge while simultaneously gaining novel experiences. The high satisfaction rate supports the potential of projection mapping as an effective tool for conveying cultural heritage. The findings by Shi et al. (2024) on interactive media confirm that immersive content delivery methods like projection mapping can significantly enhance user satisfaction by enabling audiences to connect with historical narratives personally.

Figure 4

Q3: After you watch the content of history Thai Menora in projection mapping, how do you feel?

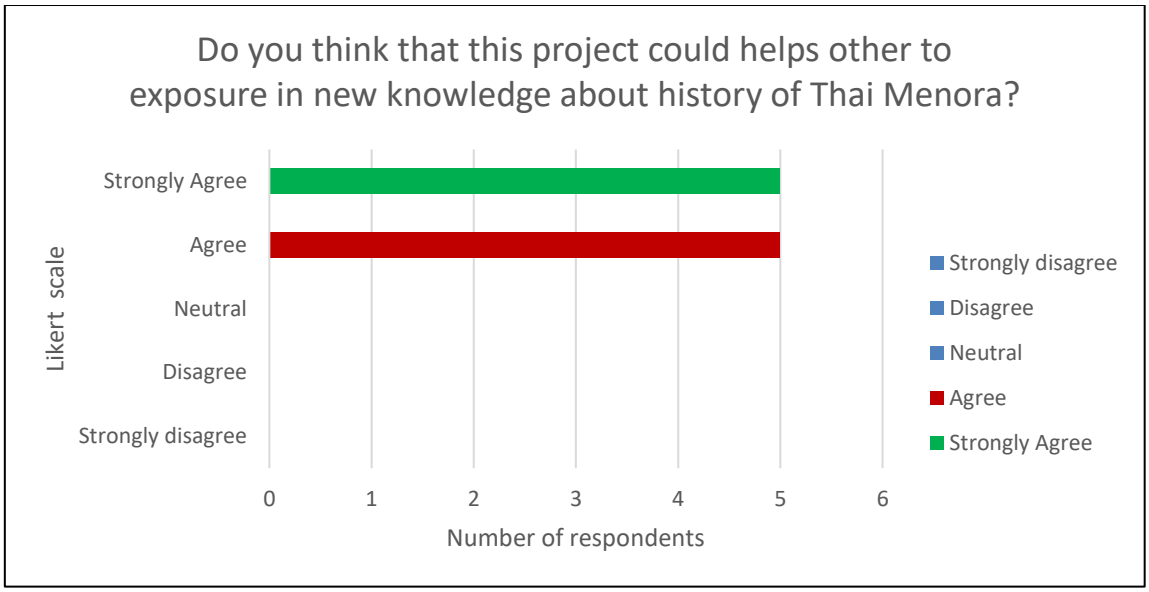


Potential for Knowledge Dissemination

As illustrated in Figure 5, the survey results indicate respondents' perspectives on whether the project enhances exposure to new knowledge about the history of Thai Menora. Out of 10 respondents, half (5) strongly agreed that the project effectively introduces and promotes new historical knowledge regarding Thai Menora, while the remaining five respondents agreed with the project's potential to contribute to historical learning. This feedback underscores a unanimous positive reception, with all participants acknowledging the value of the project in fostering greater awareness and understanding of Thai Menora's cultural and historical significance. This result demonstrates that projection mapping is perceived as an engaging and valuable educational medium. It shows that projection mapping fosters knowledge retention by making information visually impactful and memorable, which is especially useful in history education where abstract concepts or distant events can otherwise feel disconnected (Sato et al., 2023)

Figure 5

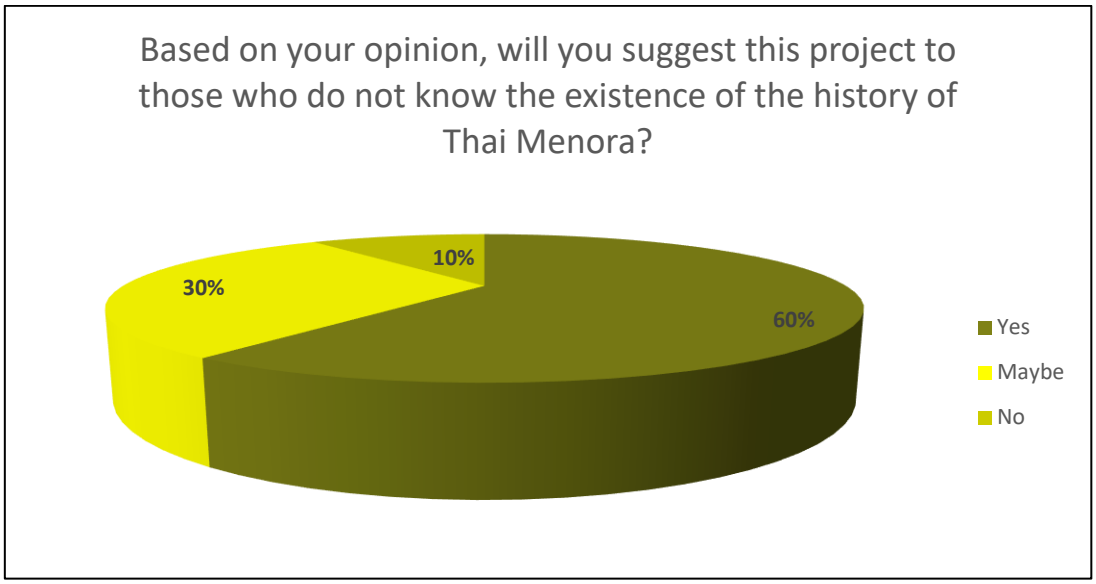
Q4: Do you think this project could help others to gain exposure to new knowledge about the history of



Overall Perception of Educational Value

The final question used a pie chart to gauge whether participants believed this project could help others learn about Thai Menora history, with 60% saying "Yes," 30% saying "Maybe," and 10% saying "No." The high percentage of positive responses suggests that projection mapping has considerable potential in history education. Presenting history in an interactive and innovative format can significantly increase interest and engagement, encouraging people to learn and retain more knowledge about historical topics. This suggests that projection mapping holds considerable potential to enhance historical learning by transforming traditional content into an immersive experience. Projection mapping may foster a more profound and sustained interest in cultural heritage and historical understanding by offering a visually dynamic way to explore history.

Figure 6
Q5: Based on your opinion, will you suggest this projection mapping project to those who do not know the history of the Thai Menora?



CONCLUSION

In summary, the findings from this research demonstrate the effectiveness of using projection mapping with an interactive storyline to raise awareness and enhance knowledge about the history of the Thai Menora. By incorporating traditional dance movements and cultural elements, this project aimed to develop a creative, immersive narrative that engages a broad audience in learning about the historical significance of the Thai Menora. The project was designed to be accessible and engaging for people of all ages and genders, and the results indicate a positive reception across these demographics. Most respondents agreed that the project delivered a unique learning experience, with high satisfaction ratings on content understanding, design, and user engagement. This feedback underscores the potential of projection mapping as a valuable tool in cultural education, providing an interactive platform for historical storytelling that fosters more profound understanding and appreciation.

While the research successfully achieved its objectives, including positive participant responses, there are areas for further refinement. Improvements could enhance visual effects, colour schemes, and additional video content to comprehensively represent Thai Menora's history. Overall, this study suggests that projection mapping holds significant potential for historical and cultural education, offering the public an innovative medium for learning. Hopefully, this research will contribute to developing projects that leverage projection mapping to enrich educational experiences.

ACKNOWLEDGMENT

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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