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The Development of Cloud-Powered Interactive Multimedia Using Digital Storytelling Techniques on the 350th Anniversary of the Mission of Siam

Sarawut Mungsoongnern[1], Athcha Chuenboon[1], Nareerat Kitiarasa[1], Manowut Jiradilok[1], Saranyu Pongprasertsin[2], Chayarat Boonputtikorn[3], Vitsanu Nittayathammakul[4]

[1]The General Education Office, Saint Louis College, Bangkok, Thailand

[2]Department of Christian Education, Saengtham College, Nakhon Pathom, Thailand

[3]Faculty of Industrial Education, Rajamangala University of Technology Suvarnabhumi, Suphanburi, Thailand

[4]Faculty of Technical Education, Rajamangala University of Technology Krungthep, Bangkok, Thailand

Correspondence: Athcha Chuenboon, 19 Saint Louis College, South Sathorn Road, Yannawa, Sathorn, Bangkok 10120, Thailand.

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Abstract

The objectives of this research were to (1) develop cloud-powered interactive multimedia using digital storytelling techniques to commemorate the 350th anniversary of the Mission of Siam, (2) compare participants' levels of comprehension before and after interacting with the developed multimedia, and (3) evaluate participants' satisfaction with the multimedia. The ADDIE model was employed as the framework for both the development and evaluation processes. The sample consisted of 600 undergraduate students from St. Louis College during the 2023 academic year. Data were analyzed using descriptive statistics, and a dependent t-test was conducted to determine differences in comprehension levels between the pre- and post-engagement periods. The research findings revealed that: (1) The developed cloud-powered interactive multimedia consisted of three episodes organized into a dedicated playlist on the YouTube platform, utilizing YouTube's Media Symbol System to incorporate essential features such as symbolic formats (e.g., Play/Pause buttons, Like and Subscribe buttons, Notification Bell), visual and auditory content (including texts, graphics, images, animations, and audio elements), tags and descriptions for enhanced discoverability, a language and subtitling system to accommodate diverse audiences, and social connectivity through comments, likes, and shares; (2) Content experts rated the multimedia quality as acceptable, while media experts rated it as highly acceptable; (3) The preliminary tryout yielded an effectiveness index (E.I.) of 0.53; (4) Participants' comprehension of the Mission of Siam significantly improved after interacting with the multimedia ($p < .05$); (5) Participants expressed a high level of satisfaction, with an average rating of 4.20 and a standard deviation of 0.71.

Keywords: cloud-powered media, interactive multimedia, digital storytelling, the mission of siam, YouTube

1. Introduction

The commemoration of the 350th anniversary of the Mission of Siam offers a distinct chance to examine how modern communication technologies and methods can enhance historical and cultural education. Conventional approaches frequently face difficulties in effectively communicating the complexities of significant events, and they often fall short in capturing the interest of contemporary learners who prefer digital and interactive materials. In order to cater to the changing preferences of undergrad students, it is necessary to modify educational communication strategies to both maintain historical narratives and ensure their accessibility to the digitally savvy generation. By utilizing appropriate educational communication technology, we can enhance students' comprehension and admiration of cultural heritage.

Throughout the last decade, cloud-powered interactive multimedia (CPIM) has emerged as a powerful force in new media, combining interactive multimedia and cloud technology. This combination has revolutionized the process of creating, delivering, and engaging users with content, enabling unparalleled levels of interactivity, scalability, and accessibility (Lian & Vasilakos, 2012; Li et al., 2021). Cloud-based platforms offer flexible and digital learning environments that cater to the varied requirements of digital natives (Napaporn et al., 2023; Rattanasak, 2023; Sarkar et al., 2017). Notable instances of such platforms encompass YouTube, Vimeo, and TikTok, all of which are abundant in multimedia content.

Educational contexts commonly utilize YouTube and Vimeo (Al-Maroof et al., 2021; Marone & Rodriguez, 2019), while TikTok is increasingly receiving attention for its ability to produce captivating educational content in a concise format (Khlaif & Salha, 2021; Perrotti et al., 2023). Out of these platforms, YouTube has emerged as a crucial tool for creators of educational media. It is extensively employed for the creation, viewing, and distribution of video content worldwide, making it an indispensable tool for both educators and learners in the digital era (Lehner et al., 2014a; Lehner et al., 2014b).

Among these platforms, YouTube has surfaced as a pivotal tool for educational media developers. It is widely utilized for creating, viewing, and sharing video content on a global scale, making it an invaluable resource for educators and learners alike (Lehner et al., 2014a). By utilizing cloud technology, YouTube efficiently stores and streams vast amounts of video data, facilitating seamless content access from anywhere without requiring local storage (Sahoo et al., 2019). The platform's interactive features—such as likes, comments, shares, uploads, and live streaming—further facilitate real-time engagement between content creators and viewers (Liebeskind et al., 2021). Moreover, YouTube's integration of multimedia elements—including video, audio, text, and graphics—creates a comprehensive communication tool for news, entertainment, educational communication, and on-demand content (Kohler & Dietrich, 2021).

Cloud-powered hybrid learning has shown significant promise in boosting critical skills like analytical reading among digital natives. As showcased by Napaporn et al. (2023), the adoption of a cloud-powered hybrid learning process can effectively enhance analytical reading skills by integrating emerging learning technologies with traditional pedagogical approaches. Similarly, extensive research has explored the use of multimedia in educational settings during challenging periods like the COVID-19 pandemic. Thamwipat et al. (2024) synthesized studies on the use of public relations multimedia in educational institutes, unveiling that formats like infographics, video motion graphics, and electronic books were highly effective in maintaining engagement and satisfaction among stakeholders during the pandemic.

The amalgamation of technological advancements with digital storytelling has demonstrated to be an exceptionally potent intervention. Digital storytelling combines traditional narrative techniques like character creation and plot development with multimedia components like video, audio, and graphics. This combination allows educators to develop immersive learning experiences that fully engage students, thereby making complex concepts more relatable and memorable. Digital storytelling enhances education by transforming passive learning into an active and interactive experience. It caters to different learning styles and promotes cognitive, emotional, and social engagement. This ultimately improves the overall effectiveness of lifelong education (Robin, 2008; Gunder & Buckner, 2023; Wuthnow, 2023).

The Cognitive Theory of Multimedia Learning (CTML), which posits that learners benefit more from a combination of words and images than from words alone, forms the foundation of this approach (Rahimi, 2019). According to CTML, the integration of visual and verbal information facilitates deeper cognitive processing, enabling learners to construct more robust mental models and thereby enhancing their comprehension and retention of material. In line with this theory, digital storytelling projects are particularly effective because they harness multimedia as a powerful communication tool, blending narrative with visual elements to create engaging and memorable learning experiences. This combination not only aids in the understanding of complex concepts but also improves long-term retention of information by making the content more relatable and easier to recall (Mirkovski et al., 2019; Verhoeven, Schnotz, & Paas, 2009). By embedding educational content within a compelling story, digital storytelling can captivate learners' attention, thus fostering a more immersive and effective learning environment.

This research and development, recognizing the potential of cloud-powered interactive multimedia with digital storytelling to enrich historical educational experiences to commemorate the 350th anniversary of the Mission of Siam, a significant event in Thai Catholic history, aims to deepen understanding of this historical event among students at Saint Louis College, one of Thailand's Catholic higher education institutions. We integrate interactive multimedia and cloud technology to develop cloud-powered interactive multimedia using digital storytelling in historical education. This approach not only enhances learner engagement, comprehension, and satisfaction but also aligns with the digital preferences of contemporary learners. The multimedia content covers key aspects of Thai Catholic Church history, such as the Mission of Siam, the mission's organizational structure, and the influential figures who shaped its legacy. As a result, this study contributes to the field of educational communications and technology.

2. Research Objectives

1. To develop the cloud-powered interactive multimedia using digital storytelling to commemorate the 350th anniversary of the Mission of Siam.

2. To compare participants' levels of comprehension before and after they have interacted with the developed multimedia.

3. To evaluate participants' satisfaction with the developed multimedia.

3. Research Hypotheses

1. The developed cloud-powered interactive multimedia using digital storytelling techniques will be rated as acceptable by content and media experts, as measured by the Scale-Level Content Validity Index (S-CVI) (Lynn, 1986; Polit & Beck, 2006). Additionally, the preliminary tryout is expected to yield an Effectiveness Index (E.I.) exceeding 0.50 **(**Panasan, M., & Nuangchalerm, P., 2010), indicating a significant advancement in learners' cognitive development related to the 350th Anniversary of the Mission of Siam, with an improvement of at least 50% in learning progress.

2. Participants are expected to demonstrate a statistically significant enhancement in their comprehension of the 350th Anniversary of the Mission of Siam after interacting with the multimedia, as determined by a dependent t-test with a p-value less than .05.

3. Participants are anticipated to report high satisfaction with the developed multimedia, with average scores exceeding 4.00 on a 5-point Likert scale (Likert, 1932).

4. Methodology

4.1 Expert Panel

The expert panel was chosen using purposive sampling to ensure highly qualified individuals evaluated the developed multimedia. Purposive sampling is widely recognized for selecting participants who possess specific expertise critical to the research (Palinkas et al., 2015). The panel consisted of two groups: 1) Content experts, consisting of five individuals with expertise in the history of the Mission of Siam, and 2) Media experts, consisting of five professionals with expertise in multimedia development, cloud technology, and digital storytelling. All experts hold a master's degree in a related field and at least five years of relevant experience.

4.2 Participants

The participants in this study were 600 undergraduate students enrolled at St. Louis College during the 2023 academic year, selected using a quota sampling method to ensure representation across all academic levels. The sample included 150 students from each level, including freshmen, sophomores, juniors, and seniors, to provide a balanced representation of perspectives. Quota sampling is commonly used to ensure that subgroups of the population are adequately represented (Battaglia, 2008).

4.3 Research Procedures

The research procedures employed in this study were systematically organized according to the ADDIE model, which encompasses five distinct phases: Analysis, Design, Development, Implementation, and Evaluation (Waiwingrob, P., Thamwipat, K., & Princhankol, P., 2023). The following section outlines each phase in detail, reflecting the actual processes undertaken during the research.

1. **Analysis:** In the initial phase, a comprehensive documentary investigation was conducted to gather historical content related to the Thai Catholic Church, the Mission of Siam, and key historical figures involved in the story. This content, sourced from reputable books, archival documents, and credible websites, served as the foundation for the multimedia development. This phase involved the following key substeps:
   1) Content Analysis and Synthesis: The research team conducted a detailed analysis and synthesis of the gathered historical content to ensure accuracy and relevance for the multimedia. This thorough analysis aimed to create a multimedia product that was both educationally sound and engaging, accurately representing the 350th Anniversary of the Mission of Siam.
   2) Identifying Clear Learning Objectives: The research team defined specific learning goals that the multimedia content aimed to achieve.
   3) Defining the Content Scope: The content was carefully scoped to cover essential aspects without overwhelming learners. This was guided by the principle of maintaining an appropriate cognitive load, ensuring that learners could process information effectively (Verhoeven, Schnotz, & Paas, 2009).
   4) Structuring the Multimedia: The content was organized into three concise episodes, each lasting 5-8 minutes to maintain engagement.
   5) Selecting the Distribution Platform: YouTube was chosen due to its wide accessibility and ability to effectively reach the target audience, aligning with research that emphasizes YouTube's effectiveness as a platform for educational content (Marone & Rodriguez, 2019; Al-Maroof et al., 2021).
2. **Design:** The design phase was grounded in the principles of digital storytelling, which combines traditional narrative techniques with multimedia elements, as emphasized in Robin (2008). This phase involved the following key substeps:

1) Determination of Multimedia Format: The research team selected the most appropriate multimedia formats to effectively convey the story of the Mission of Siam, ensuring the narrative was both engaging and accessible to a diverse audience.
2) Script Development: A detailed script was crafted, integrating narrative elements to ensure accuracy in historical presentation, clarity of language, and the appropriate use of illustrations. The storytelling approach followed Gunder & Buckner (2023), who emphasize the importance of narrative flow in multimedia-based education.
3) Visual and Audio Design: Visual elements, including graphics and backgrounds, were created using Adobe Creative Cloud to support the narrative flow. Sound effects were carefully selected and integrated to complement the visuals, enhancing the overall storytelling experience and ensuring that the content was aligned with cognitive development principles as outlined by Rahimi (2019) in the Cognitive Theory of Multimedia Learning (CTML).
4) Exporting Files: The multimedia content was finalized and exported as video files, ready for distribution.

3. **Development:** In this phase, the cloud-powered interactive multimedia was developed, incorporating digital storytelling techniques into three episodes uploaded on YouTube. This phase involved the following key substeps:

1) Creating the YouTube Channel and Uploading Video Files: The research team created a dedicated YouTube channel for the project and uploaded the multimedia video files. The channel was optimized for accessibility and engagement by utilizing YouTube's Media Symbol System. This included integrating features such as play/pause buttons, hyperlinks, and interactive components like likes, comments, and shares, all of which enhanced viewer interaction and the overall effectiveness of the multimedia.
2) Expert Validation: A panel of experts, including five content experts and five media experts, rigorously evaluated the multimedia for content accuracy, clarity, and technical quality.
3) Revisions and Finalization: Based on the feedback from the expert panel, necessary revisions were made to refine and improve the multimedia product. After these revisions, the content was finalized and exported as video files, making them ready for distribution on the YouTube platform.
4) Preliminary Tryout: A preliminary tryout was conducted with 30 participants who shared similar characteristics with the main sample. This step was used to further assess the multimedia's effectiveness, utilizing the Effectiveness Index (E.I.) method.

4. **Implementation:** After refinement, the multimedia was implemented with 600 participants from St. Louis College. This phase involved deploying the multimedia, ensuring participants had easy access and could engage with the content effectively. The implementation was crucial for assessing the multimedia's practical use in a real-world educational setting.
5. **Evaluation:** The final phase focused on evaluating the multimedia's effectiveness. Pre- and post-tests were administered to measure participants' comprehension of the Mission of Siam, providing insights into the educational impact of the multimedia. Additionally, a satisfaction survey was conducted to evaluate participants' satisfaction with the developed multimedia.

4.4 Research Instruments

The research instruments utilized in this study were carefully designed to ensure the collection of valid and reliable data, consistent with the objectives of the research. The following instruments were employed:

1. The primary instrument in this study was the cloud-powered interactive multimedia, developed using digital storytelling techniques to commemorate the 350th Anniversary of the Mission of Siam. This multimedia, accessible via a dedicated YouTube channel, served as the central educational tool, delivering content to participants and facilitating their engagement with the learning medium as a digital intervention.
2. Quality Validation Instruments: To ensure the quality and effectiveness of the developed multimedia, two specialized validation instruments were employed. These included 1) Content Quality Validation: Content experts utilized the Content Validity Index (CVI) to assess the multimedia's accuracy, relevance, and educational value, ensuring that the content was both precise and aligned with the learning objectives. 2) Media Quality Validation: Simultaneously, media experts applied the CVI to evaluate the technical aspects of the multimedia, including auditory media, visual media, and interactive media, thereby confirming that the media elements effectively engaged users and met the required technical standards (Lynn, 1986; Polit & Beck, 2006).
3. Comprehension Assessments: A set of 23 multiple-choice questions was administered as pre-test and post-test assessments to measure participants' comprehension of the 350th Anniversary of the Mission of Siam before and after their interaction with the multimedia. These assessments were validated for content accuracy using the

Item-Objective Congruence (IOC) index, which met the required criteria with a value of 0.80, indicating an acceptable level of content validity (Turner & Carlson, 2003).

4. Satisfaction Survey: A 23-item, five-point Likert scale questionnaire was employed to measure participants' satisfaction with the multimedia (Likert, 1932). This survey assessed various aspects of the user experience, including both content and media satisfaction. The reliability of the survey was analyzed for internal consistency using Cronbach's alpha coefficient, with a focus on achieving a value of 0.70 or above to ensure the reliability of the responses (Tavakol & Dennick, 2011).

4.5 Data Analysis

Data were analyzed using both descriptive and inferential statistical methods:

1. Calculation of the Content Validity Index (CVI): Experts utilized the CVI to assess the relevance and clarity of both content and media elements within the multimedia. Each element was rated on a 4-point scale, with 1 indicating "not relevant" and 4 indicating "highly relevant." Scores of 3 and 4 were considered indicative of acceptable relevance and clarity. The CVI score for each element was calculated by dividing the number of experts who rated the item as 3 or 4 by the total number of experts. An S-CVI (Scale-Level Content Validity Index) score of 0.80 or higher was considered the passing criterion (Lynn, 1986; Polit & Beck, 2006).
2. Calculation of the Effectiveness Index (E.I.): The Effectiveness Index (E.I.) was calculated to measure the degree of learning progress achieved by participants after engaging with the multimedia. An E.I. value greater than 0.50 indicated a significant positive impact on learning outcomes, confirming the multimedia's effectiveness in enhancing cognitive development (Panasan & Nuangchalerm, 2010).
3. Inferential Statistical Analysis: A dependent t-test was conducted to compare participants' comprehension before and after using the multimedia. This analysis identified statistically significant improvements, with the significance level set at $p < .05$, confirming the educational impact of the multimedia.
4. Descriptive Statistical Analysis: Descriptive statistics, including mean scores and standard deviations, were used to summarize participants' satisfaction across dimensions like content relevance, ease of use, and overall experience. These results provided key insights into how well the multimedia met participants' educational needs.

5. Results

The results of this study are presented in alignment with the three research objectives, which focused on the development and evaluation of the cloud-powered interactive multimedia, the comparison of participants' comprehension levels before and after interaction with the multimedia, and the evaluation of participants' satisfaction with the developed multimedia.

5.1 The Developed Cloud-Powered Interactive Multimedia

The development of the cloud-powered interactive multimedia was completed with a focus on using digital storytelling techniques to commemorate the 350th anniversary of the Mission of Siam. The multimedia content was structured into three episodes, each of which was organized within a dedicated playlist on the YouTube platform. These episodes were designed to be highly engaging and accessible, utilizing YouTube's Media Symbol System to incorporate various essential features (as shown in Figure 1):

1. Symbolic Formats: The multimedia leverages essential YouTube features such as Play/Pause buttons, Like buttons, Subscribe buttons, and the Notification Bell to enhance user interaction and engagement. The Progress Bar helps users track and navigate the video, while Volume Control and Playback Settings (including playback speed and video quality) allow for a customized viewing experience. Additionally, Full-Screen Mode enables a more immersive focus on the content.
2. Visual and Auditory Content: Each episode was enriched with a mix of texts, images, graphics, animations, and audio elements. These multimedia components were carefully crafted to enhance the storytelling experience and support the educational objectives, making the content both informative and engaging. The Thumbnails and Previews visible in the sidebar provide additional visual cues, helping users to identify and select related content easily, which supports continuous learning.
3. Tags and Descriptions: To enhance discoverability, each episode was accompanied by well-thought-out tags and detailed descriptions. These elements were designed to improve searchability on YouTube, ensuring that the content could reach a wider audience interested in historical and educational materials. The Related Videos and Playlist features further assist in maintaining the narrative flow and guide users through the educational content, making it easier to access sequential episodes or related materials.
4. Language and Subtitling System: Recognizing the diversity of the audience, a language and subtitling system

was implemented to accommodate viewers from different linguistic backgrounds. This feature ensured that the content was accessible to a global audience, further broadening its educational impact. Playback Settings also contribute to accessibility by allowing viewers to enable closed captions, which can be crucial for non-native speakers or those with hearing impairments.

5. Social Connectivity: The multimedia leveraged YouTube's social features, such as comments, likes, and shares, to foster community engagement. These interactive elements encouraged viewers to connect with the content on a deeper level, share their thoughts, and engage with others in discussions, thereby increasing the reach and impact of the multimedia. The Comments Section serves as a platform for discussion and inquiry, enhancing the educational experience through peer interaction. Channel Information and Subscription options ensure that viewers can remain engaged with the content over time, easily accessing new episodes or related educational materials.

Figure 1. The Developed Cloud-Powered Interactive Multimedia Using Digital Storytelling Techniques on the 350th Anniversary of the Mission of Siam

As shown in Figure 1, the integration of these features within the YouTube platform was specifically designed to enhance educational communication by optimizing user interaction and creating a more engaging and immersive learning experience.

The developed multimedia was evaluated by both content and media experts. Content experts, who assessed the historical accuracy and educational value, rated the quality of the content as acceptable, with a Scale-Level Content Validity Index (S-CVI) score of 0.80. Media experts, who evaluated the technical aspects, including design quality and interactivity, rated the multimedia as highly acceptable, with an S-CVI score of 0.90.

Additionally, a preliminary trial of the multimedia was conducted to assess its effectiveness. The trial, involving N = 30 participants, resulted in an Effectiveness Index (E.I.) of 0.53, indicating that learners' cognitive development and engagement improved by 53% relative to the maximum potential effectiveness. Given that an E.I. of 0.50 is generally considered the acceptable threshold for educational effectiveness, this result demonstrates that the multimedia played a substantial role in enhancing participants' understanding of the Mission of Siam.

Figure 2. An example of screenshots displaying digital storytelling techniques used on the 350th Anniversary of the Mission of Siam

5.2 The Comparison of Participants' Comprehension Levels Before and After Interaction with the Multimedia

Participants' levels of comprehension were measured before and after interacting with the developed multimedia using a pre-test and post-test design. As shown in Table 1, there was a significant increase in the participants' comprehension following their interaction with the multimedia. The mean score before using the multimedia was 9.58, with a standard deviation of 2.93. After the interaction, the mean score rose to 12.83, with a standard deviation of 3.67. The results of the t-test indicated a value of -18.78, with a significance level (p-value) of 0.00, confirming that the improvement in comprehension was statistically significant at the $p < 0.05$ level.

This improvement in comprehension can be attributed to the use of effective digital storytelling techniques within the multimedia, as illustrated in Figure 2. The integration of visual elements, narrative structure, and interactive features, as seen in the screenshots, played a crucial role in engaging participants and enhancing their understanding of the historical content.

Table 1. Comparison of Pre-Test and Post-Test Comprehension Scores Before and After Interaction with the Multimedia (N = 600)

Measurement Period	M	SD	t	p
Before Interaction	9.58	2.93	-18.78	.000*
After Interaction	12.83	3.67		

Note. p* < .05 indicates statistical significance.

5.3 The Evaluation of Participants' Satisfaction with the Developed Multimedia

Participants' satisfaction with the developed multimedia was analyzed, and the descriptive statistical results, presented in Table 2, revealed high levels of satisfaction across various issues, including content and media. The overall satisfaction score was high, with a total mean score of 4.20 and a standard deviation of 0.71.

Table 2. Descriptive Analysis of Participants' Satisfaction with the Developed Multimedia (N = 600)

Dimension	Evaluation issues	M	SD	The satisfaction level
Content	1. Educational content	3.92	0.81	High
	2. Storytelling	4.28	0.97	High
	3. Character	4.19	0.75	High
Media	4. Auditory media	4.23	0.78	High
	5. Visual media	4.28	0.76	High
	6. Interactive media	4.28	0.76	High
Overall Evaluation Results		4.20	0.71	High

6. Discussion and Conclusion

The findings of this study confirm the research hypotheses and demonstrate the effectiveness of cloud-powered interactive multimedia developed using digital storytelling techniques in commemorating the 350th Anniversary of the Mission of Siam. This section discusses the results in light of the research hypotheses and integrates relevant literature to provide a comprehensive understanding of the outcomes.

The first hypothesis proposed that the cloud-powered interactive multimedia would be rated as acceptable by both content and media experts, with an effectiveness index (E.I.) expected to exceed 0.50. The results confirmed this hypothesis, as the multimedia achieved an overall E.I. of 0.53. This finding is consistent with the literature on cloud-powered media, which highlights the ability of cloud infrastructures to enhance media quality through efficient resource allocation and content management (Ali, Soar, & Yong, 2016), as well as the importance of cloud technology in supporting high-quality multimedia experiences (Li, Drew, & Liu, 2021). The high ratings from content and media experts reflect the multimedia's success in integrating various forms of media—text, audio, graphics, video, and animation—into a cohesive and interactive educational experience, a hallmark of effective multimedia development (Garrand, 2020), and essential for enhancing learning outcomes (Lehner et al., 2014b). Additionally, the use of digital storytelling techniques, grounded in the Cognitive Theory of Multimedia Learning (CTML), significantly contributed to the multimedia's effectiveness by combining visual and auditory elements to enhance understanding and retention (Rahimi, 2019).

The second hypothesis predicted a statistically significant increase in participants' comprehension of the Mission of Siam after interacting with the developed multimedia, as evidenced by a dependent t-test showing a p-value less than 0.05. The study's findings strongly supported this hypothesis, with a significant increase in mean post-test scores compared to pre-test scores. This result aligns with previous research demonstrating how interactive multimedia can enhance learning outcomes by enabling active engagement and customization of content based on user inputs (Cvetkovic, 2019; Smirnova et al., 2020). A crucial factor contributing to the improvement in comprehension was the implementation of YouTube's media symbol systems, which are known to enhance user engagement by allowing users to control their learning experience (Liebeskind, Liebeskind, & Yechezkely, 2021). Features such as Play/Pause buttons, Progress Bar, and Volume Control allowed participants to control their learning pace, which is critical for effective cognitive processing (Wang, M., & Shen, R., 2012). The ability to pause, rewind, or adjust the playback speed provided learners with the flexibility to engage deeply with the content at their own pace, reinforcing their understanding of complex historical events. Moreover, the integration of visual and auditory content, including texts, images, graphics, animations, and audio elements, was instrumental in delivering a rich, multimodal learning experience that aligns with the Cognitive Theory of Multimedia Learning (Rahimi, 2019). These multimedia components were carefully crafted to support the educational objectives, making the content more

relatable and easier to recall (Espada et al., 2017). The seamless access to high-quality content through cloud-powered technologies further enhanced these educational outcomes by ensuring that participants could interact with the media without interruptions, thereby maintaining cognitive engagement throughout the learning process (Lehner et al., 2014b).

The third hypothesis suggested that participants would report high levels of satisfaction with the developed multimedia, with an average satisfaction score exceeding 4.00 on a 5-point Likert scale. This hypothesis was confirmed by the study results, which showed an overall satisfaction score of 4.20, with high ratings across all evaluated aspects, including both content and media. In terms of content, the educational content ($M = 3.92$, $SD = 0.81$) was well-received, though slightly lower than other aspects, suggesting room for further improvement in delivering more depth or clarity in the educational material. However, storytelling ($M = 4.28$, $SD = 0.97$) and character ($M = 4.19$, $SD = 0.75$) were particularly praised, demonstrating the powerful role of narrative in engaging learners and making the historical material more relatable and memorable, aligning with Robin (2008). On the media side, auditory media ($M = 4.23$, $SD = 0.78$), visual media ($M = 4.28$, $SD = 0.76$), and interactive media ($M = 4.28$, $SD = 0.76$) all contributed significantly to the high satisfaction scores. The inclusion of well-designed auditory and visual components supported participants' learning and immersion, while interactive features allowed for greater user control and engagement, reinforcing findings from Visa (2016) that highlight the importance of interactivity in multimedia environments.

The study, while yielding promising results, has limitations. The multimedia content focused exclusively on the Mission of Siam, limiting the generalizability of findings to other historical or educational contexts. Broader applications would require adaptations to suit different subjects or cultural narratives. Additionally, the evaluation measured only short-term outcomes, such as immediate comprehension and satisfaction, leaving long-term impacts on retention and engagement unexplored. The reliance on YouTube's specific features further constrains the design, as these functionalities may not be available or function equivalently on other platforms, potentially affecting adaptability and scalability.

These limitations highlight significant opportunities for future research. Longitudinal studies could examine how knowledge retention and engagement evolve over time, providing deeper insights into the lasting impact of cloud-powered multimedia. Expanding the scope to include diverse subjects—such as other historical events, cultural narratives, or STEM education—could enhance the methodology's versatility. Comparative research across platforms like Vimeo, Canvas, or Moodle would also help establish universal principles for designing and delivering interactive educational content effectively.

The broader implications of this study extend beyond historical education. Digital storytelling is a powerful tool for preserving cultural heritage by documenting and sharing traditions with global audiences, ensuring their survival for future generations. For example, interactive multimedia could be used to teach local folklore or endangered languages, making them accessible to younger generations in a modern, engaging format. In vocational training, multimedia applications can support skill development in industries such as healthcare or engineering by providing immersive, customizable learning experiences. Its adaptability makes this approach ideal for global education initiatives, where multilingual and multicultural elements can be integrated to foster inclusivity. Addressing these limitations and exploring broader applications positions this methodology as a transformative educational tool for diverse contexts and disciplines.

In conclusion, the outcomes of this research demonstrate the successful development and implementation of cloud-powered interactive multimedia using digital storytelling techniques to commemorate the 350th anniversary of the Mission of Siam. These results suggest that the media symbol systems on YouTube significantly contributed to both the comprehension and satisfaction of participants. The media symbol systems, such as familiar YouTube features like Like buttons, Subscribe buttons, and the Notification Bell, played a significant role in achieving these high satisfaction levels. These features provided participants with a sense of control and familiarity, crucial for user engagement, while customization options such as playback settings and volume control enabled a personalized learning experience, further enhancing satisfaction. Visual elements like thumbnails and previews not only aided in navigation but also added to the overall aesthetic appeal, making the learning process more enjoyable and engaging. Additionally, the tags and descriptions accompanying each episode improved content discoverability, allowing users to easily find and access related materials, which contributed to a coherent and satisfying learning journey (Visa, 2016). The language and subtitling system ensured that the content was accessible to a diverse audience, a critical consideration in global educational contexts (Espada et al., 2017). Finally, the social connectivity features, including the comments section and sharing options, enabled participants to engage with both the content and each other, fostering a sense of community and enhancing the overall educational experience through peer interaction.

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Authors contributions

Sarawut Mungsoongnern and Athcha Chuenboon were responsible for the study design and revisions. Nareerat Kitiarasa, Manowut Jiradilok, and Saranyu Pongprasertsin were responsible for data collection. Athcha Chuenboon drafted the manuscript, and Chayarat Boonputtikorn and Vitsanu Nittayathammakul revised it. Vitsanu Nittayathammakul also contributed to developing the research framework. All authors read and approved the final manuscript. There were no special agreements concerning authorship, and all authors contributed significantly to the study.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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No additional data are available.

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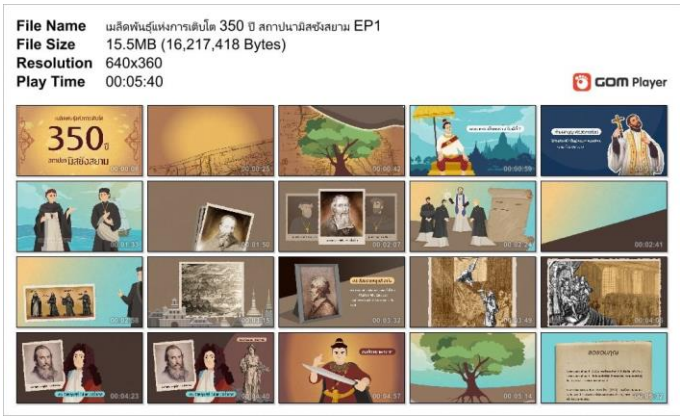
Appendix A

QR code for accessing the cloud-powered interactive multimedia using digital storytelling techniques on the 350th anniversary of the Mission of Siam.



www.youtube.com/watch?v=2YbB3JUzznM

www.youtube.com/watch?v=28_jcXqXnl0

www.youtube.com/watch?v=prJVB3yxB0A