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MUSEUMX: DEVELOPMENT AND EVALUATION OF A GAMIFIED ROBLOX-BASED MOBILE PLATFORM FOR EXPLORING THE UUM MANAGEMENT MUSEUM

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ABSTRACT

Museums play an important role in preserving institutional heritage and supporting the educational and learning process. However, conventional museum exhibitions often offer limited opportunities for interaction, particularly in attracting younger generations. This study aims to develop MuseumX, a Roblox-based mobile platform that integrates gamification elements, allowing users to explore the Management Museum of Universiti Utara Malaysia (UUM) interactively. The team developed MuseumX in Roblox Studio using an Agile software development methodology, and it includes exploration activities, quizzes, puzzles, and user interactions with virtual museum exhibits. The team evaluated the application through formative and summative assessments. The engagement evaluation involved 30 UUM students who completed the Game Engagement Questionnaire to measure engagement. MuseumX achieved a high level of user engagement, particularly by creating an attentive, immersive, and interactive museum exploration experience. Overall, MuseumX shows potential as a digital museum learning approach that combines gamification with Roblox-based virtual environments. This study benefits students, educators, and museum management by providing an alternative way to explore the institution's heritage, increase user engagement, and raise awareness of the UUM Management Museum's collection and history.

Keywords: game engagement, game-based learning, gamification, Roblox, UUM Management Museum.

INTRODUCTION

Museums are important institutions that preserve, document, and convey historical and cultural heritage to the community. Beyond storing collections, museums also provide informal learning environments that let visitors gain knowledge through observation and experience with exhibition materials. However, conventional exhibition delivery, which relies on static objects, explanatory text, and passive visitor movement, may not be enough to sustain attention and encourage deeper interaction. Advances in digital technology allow heritage collections and narratives to be presented in more accessible, interactive, and relevant forms for younger audiences. Previous studies show that using virtual and augmented technologies in museum exploration can improve learning outcomes and provide a more interactive experience than conventional exhibition approaches (Zhou et al., 2022). Therefore, museums must explore digital approaches that not only convey information but also actively encourage visitors to explore, interact, and deepen their understanding.

Gamification and immersive virtual environments can address the limitations of conventional museum exhibitions by applying elements such as goals, challenges, storytelling, exploration, quizzes, and rewards in museum learning experiences. Gamification in cultural heritage can enhance user interaction and help visitors understand an exhibition's historical and cultural significance (Wang et al., 2024). In addition, museum learning activities that combine goals, storytelling, and role-playing encourage visitors to pay closer attention to exhibits and build a more meaningful relationship with the museum's content. In this context, Roblox offers interactive features, active creation, simulation, game-based learning, and immersive experiences suitable for a virtual learning platform (Han et al., 2023). Accordingly, this study developed MuseumX, a Roblox-based mobile platform that lets users explore the Management Museum of Universiti Utara Malaysia interactively. MuseumX integrates virtual museum space exploration, quizzes, puzzles, and interactive exhibits to increase user engagement, support learning about the institution's history and heritage, and expand awareness of the UUM Management Museum.

LITERATURE REVIEW

Digital Transformation and Museum-Based Learning

A museum not only preserves collections and heritage but also provides an informal learning environment where visitors can gain knowledge through observation, exploration, and interaction with exhibition materials. Digital developments have changed how museums deliver content, shifting from static exhibitions to more interactive, accessible, and user-oriented experiences. J. Li et al. (2024) explain that digital transformation technologies, including artificial intelligence, immersive technologies, the Internet of Things, and cloud computing, have the potential to enhance the attractiveness, accessibility, inclusivity, and the educational value of museum exhibitions. These technologies also allow museums to collect data on visitor experiences to improve exhibition management. However, the effectiveness of digital transformation depends not only on technological sophistication, but also on whether the technology fits the content, learning objectives, and context of museum use.

Virtual reality and augmented reality are gaining increasing attention in museum exploration because they can provide visual, spatial, and interactive experiences that conventional exhibition materials lack. Zhou et al. (2022) examined 51 studies on virtual reality and augmented reality in museum learning and

conducted a meta-analysis of 17 experimental studies. Their findings show that these technologies positively affect academic achievement and users' perceptions of museum learning. While virtual technology can increase interest and help users understand content visually, activity designs still need to provide clear instructions, feedback, and learning goals. Without appropriate learning design, users may focus more on the technology's novelty than on the knowledge museums aim to convey.

Beyond enhancing the visitor experience, virtual museums can expand access to collections limited by location, operating hours, space capacity, or the physical condition of artefacts. Srdanović et al. (2025) developed the InHeritage application, which combines three-dimensional artefact modelling, augmented reality, virtual reality, and gamification in a metaverse environment. This approach shows that mobile applications and virtual environments can preserve, promote, and communicate cultural heritage to a wider range of users. Li et al. (2024) also developed a virtual museum curation experience related to Chinese bronze artefacts that combines text, video, exploration, and game-based activities. This combination aims to stimulate curiosity, encourage active exploration, and help users build knowledge about artefacts. These studies show that an effective virtual museum must go beyond digital displays by giving users opportunities to explore, make decisions, and interact with content.

Gamification and Roblox in Legacy Learning

Gamification uses game design elements in non-game contexts to increase user motivation, engagement, and participation. In museums and cultural heritage, gamification can be implemented through goals, challenges, points, rewards, badges, leaderboards, storytelling, quizzes, and problem-solving. A systematic review by Marques et al. (2023) shows that gamification applications in cultural heritage largely focus on historical, architectural, and archaeological heritage. Its main purposes are to increase user motivation and engagement and to support creativity in heritage exploration. However, the study also found that several gamification developments in cultural heritage remain isolated projects and have yet to be established as ongoing research programmes. This situation indicates the need for more empirical studies that assess not only users' initial acceptance but also their engagement, learning outcomes, and awareness of cultural heritage.

Previous empirical studies show that gamification can improve the user experience in virtual museums, but its impact on learning is not uniform. Chernbumroong et al. (2024) compared a gamified and non-gamified virtual reality (VR) museum version among 76 participants. The findings show that gamification has a greater impact on the reward dimension of engagement and on effort in motivation, while its impact on learning outcomes is more limited. These findings suggest that adding rewards or challenges alone is not sufficient to ensure that learning occurs. Instead, each gamification element needs to be directly linked to the content and the learning outcomes to be achieved.

Sangamuang et al. (2025) also compared gamified and non-gamified virtual museum designs in a quasi-experimental study involving 70 participants. The results show that gamification can improve users' hedonic experiences, including enjoyment, engagement, and satisfaction, and promote longer periods of interaction and exploration. However, more enjoyable experiences do not necessarily lead to higher levels of self-reflection or development. Therefore, a collaborative museum design needs to balance entertainment with content description, reflection activities, and tasks that require users to apply the knowledge they acquire.

Roblox can support a gamified virtual museum learning approach because it enables the development of a three-dimensional virtual environment that combines exploration, simulation, social interaction, collaborative activities, and game mechanics (Alhasan et al., 2023). Systematic highlights by Han et al. (2023) show that Roblox has been used in social learning environments, collaborative learning environments, as well as in Science, Technology, Engineering, and Mathematics (STEM) education, to support programming learning. Roblox use is also associated with users' positive attitudes and the development of their cognitive and non-cognitive abilities. Nevertheless, educators must consider challenges such as cybersecurity, cyberbullying, and inadequate instructional design. Therefore, educational Roblox experiences need accurate content, clear instructions, safe interaction mechanisms, and activities aligned with learning objectives.

Based on previous studies, most virtual museum applications use virtual reality, augmented reality, or three-dimensional environments for cultural heritage and general museums. Studies that specifically combine the Roblox platform, accessed via mobile devices, university institutional heritage, and gamification for museum learning remain limited. However, several studies that integrated gamification into virtual museums consistently show greater improvements in enjoyment and engagement than in learning outcomes, underscoring the need to connect game elements directly to educational content (Chernbumroong et al., 2024; Sangamuang et al., 2025). Accordingly, MuseumX is a Roblox-based mobile platform that combines virtual space exploration, quizzes, puzzles, and interaction with the UUM Management Museum exhibition. This approach differentiates MuseumX from a virtual museum environment that only displays collections by providing structured activities to increase user engagement, learning about the institution's heritage and awareness of the UUM Management Museum.

Comparative Analysis

Table 1 shows seven mobile game applications that use different gaming approaches to deliver museum-themed experiences. Idle Museum Tycoon: Art Empire focuses on museum management simulation, allowing players to build and overhaul museums, manage resources, attract visitors, expand galleries, and collect artefacts. The application's strength lies in its use of real-time 3D graphics and trivia quizzes on art, history, culture, and science that assess users' knowledge (PIXO GAMES, 2026). However, the large number of management tasks and game components may potentially overwhelm players. My Museum Story: Mystery Match combines match-3 puzzles, artefact quests, mission solving, and museum decorating activities. The mix of puzzles, storytelling, and museum restoration makes it accessible to casual players, though its strong puzzle focus may limit independent exploration of museum spaces (ZiMAD, 2026). Meanwhile, Papo Town History Discovery provides five historical settings, more than 30 mini-games, treasure-related facts, and a variety of interactive objects to stimulate players' creativity and imagination. However, repeated similar mini-games may reduce user engagement over long-term use (Colour Network Co., Ltd., 2023). Mystery Spot: Hidden Objects offers an investigative experience in a wax museum through hidden object searches, document collection, 360-degree location exploration, and puzzle-solving activities. The application's strength lies in its ability to create an immersive investigative atmosphere and encourage attention to detail. However, the story's linear progression may limit player freedom and replay value (Crisp App Studio, 2025).

The other three applications place greater emphasis on gathering, open-ended learning, and exploration of virtual environments. TAP! DIG! MY MUSEUM! allows players to develop abandoned museums through activities such as digging, collecting, and assembling dinosaur fossils before displaying them to visitors. The fossil excavation mechanism, levelling-up system, and exhibition space development

provide clear game progression, complemented by attractive pixel-art visuals. However, reliance on idle-game mechanics and repetitive digging may limit the user experience (ORIDIO Inc., 2025). My Town: Museum History combines entertainment and education through five exhibition spaces: span space, prehistory, the Middle Ages, Ancient Egypt, and art. The application supports creative and open-ended play through customizable characters and manipulable objects. However, the level of challenge and game complexity is limited because it is primarily designed for imaginative games among children (My Town Games Ltd., 2026). In Roblox, the Roblox Museum offers classic Roblox history exhibits, valuable objects, dinosaur skeletons, and interactive buttons in a three-dimensional environment. The application offers nostalgic value and encourages exploration, but its content focuses on Roblox platform history and does not provide structured learning or assessment activities (Tokaisho, 2010).

Overall, existing applications have strengths in museum management, puzzles, exploration, artifact collection, and creative games. However, most do not integrate institutional heritage content, immersive exploration, and educational gamification activities within a single platform. This gap supports developing MuseumX as a Roblox-based mobile platform that integrates UUM Management Museum exhibits with virtual explorations, quizzes, puzzles, and more structured educational interactions.

Table 1

Comparative Analysis of Existing Museum-Themed Game Applications

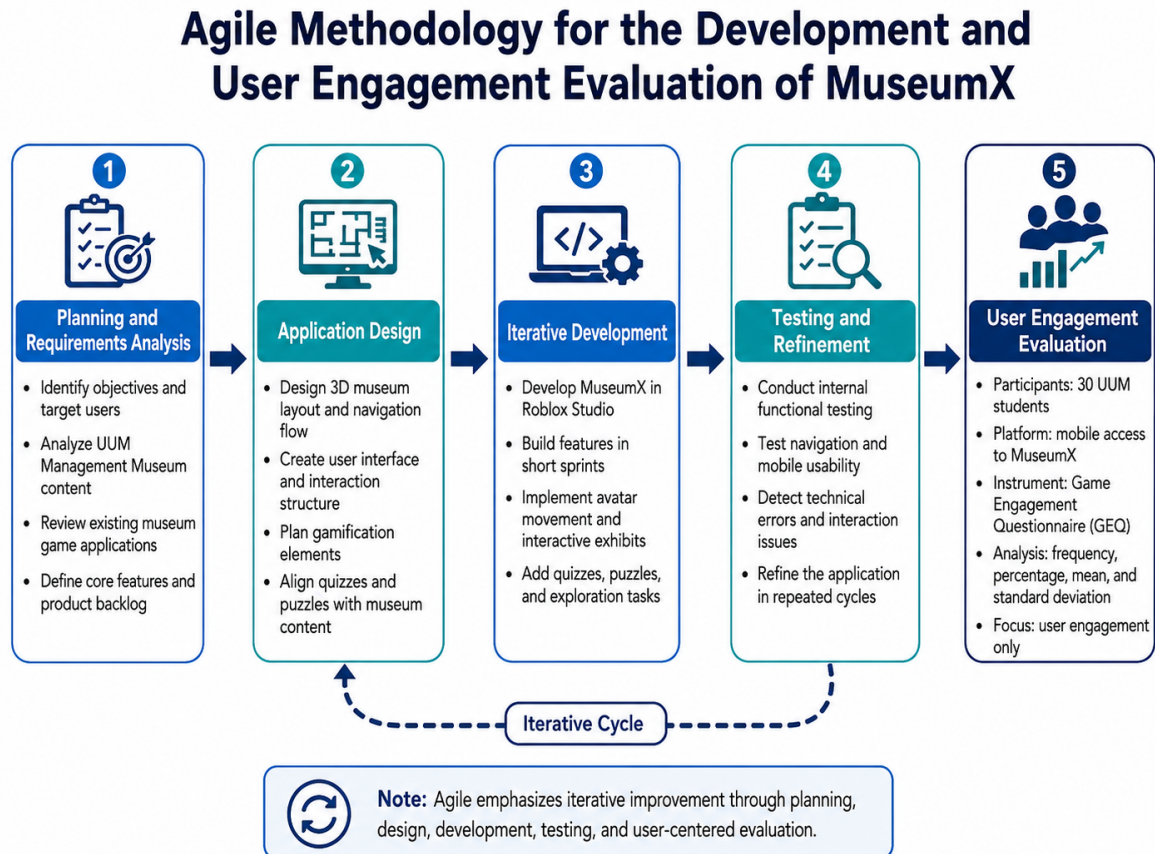
No.	Game Application	Aim	Strengths	Weaknesses	Key Contents
1	Idle Museum Tycoon: Art Empire (PIXO GAMES, 2026).	Build and manage a museum.	Real-time 3D graphics; knowledge quizzes.	Too many management tasks may overwhelm players.	Artefact collection; exhibitions; trivia quizzes.
2	My Museum Story: Mystery Match (ZiMAD, 2026)	Restore a museum through puzzles.	Combines puzzles, storytelling and decoration.	Puzzle-focused gameplay limits exploration.	Match-3 puzzles; quests; artefact collection.
3	Papo Town History Discovery (Colour Network Co., Ltd., 2023)	Explore historical settings through mini games.	Encourages creativity and imagination.	Mini games may become repetitive.	Historical exhibits; character customisation; mini games.
4	Mystery Spot: Hidden Objects (Crisp App Studio, 2025)	Find objects and solve museum mysteries.	Immersive 360-degree scenes; detailed exploration.	Linear storyline limits replayability.	Hidden objects; puzzles; artefact collection.
5	TAP! DIG! MY MUSEUM! (ORIDIO Inc., 2025)	Build a museum by collecting fossils.	Engaging excavation and clear progression.	Relies heavily on repetitive idle mechanics.	Fossil excavation; exhibitions; museum upgrades.
6	My Town: Museum History (My Town Games Ltd., 2026)	Explore history and science exhibits.	Varied themes and open-ended play.	Limited challenge and complexity.	Historical exhibits; interactive props; characters.
7	Roblox Museum (Tokaisho, 2010)	Explore classic Roblox exhibits.	Nostalgic and interactive virtual environment.	Limited educational content.	Roblox history; virtual exhibits; interactive buttons.

METHODOLOGY

This study uses Agile software development methodologies to develop MuseumX through iterative stages, as illustrated in Figure 1. The Agile approach emphasises working product development,

collaboration, continuous feedback, and adaptive development in response to changing needs (Beck et al., 2001). In this study, the development process is divided into several short cycles or sprints. Each sprint involves planning, design, development, testing, and improving specific functions. This approach aligns with the principle of iterative and incremental development, allowing problems to be identified and fixed before the final product is evaluated (Schwaber & Sutherland, 2020).

Figure 1
Agile Methodology for MuseumX



Phase 1: Planning and Needs Analysis

The first phase identifies MuseumX's key goals, target groups, and requirements. The application was developed to let users explore the Management Museum of Universiti Utara Malaysia virtually on mobile devices. The team identified and organised content related to the museum's history, collections, and exhibitions based on its suitability for presentation in a three-dimensional environment.

In this phase, we also analysed existing museum-themed game applications to identify appropriate features, strengths, weaknesses, and game elements. Based on the analysis, the team identified several key functions for MuseumX: exploring virtual museum spaces, interacting with exhibit materials, quizzes, puzzles, and discovery assignments. The team then compiled these requirements into a product backlog to set development priorities for each sprint.

Phase 2: Application Design

The design phase focuses on developing the museum space structure, navigation flow, user interface, and gamification mechanisms. The museum's layout plan guided the creation of a virtual space that resembles the UUM Management Museum environment. This phase also determined the placement of exhibit materials, user pathways, information boards, interactive objects, and game activities.

The interface design includes a main menu, user instructions, navigation buttons, quiz display, puzzle hints, and feedback on user actions. The gamification elements are directly tied to the museum exploration activities. For example, players must explore specific exhibits to gather information before answering a quiz or solving a puzzle. This approach aims to ensure that the game elements serve not only as entertainment but also encourage users to pay attention to the museum content.

Phase 3: Recurring Development

MuseumX was developed using Roblox Studio, which provides tools for building three-dimensional environments, writing scripts, running tests, and publishing applications on the Roblox platform (Roblox Corporation, n.d.). Development was carried out through several sprints, with each sprint focusing on a specific component, such as the museum environment, avatar movements, interactive exhibits, quizzes, or puzzles.

At the end of each sprint, we evaluated the developed functions to ensure they met the application requirements. The team identified and fixed issues related to navigation, content display, object arrangement, the quiz mechanism, or system response in the next cycle. This iterative process allows flexibility in developing MuseumX, as changes to content or functionality can be implemented without waiting for the entire application to be completed.

Phase 4: Testing and Improvement

Internal testing ensured that all MuseumX functions operated properly before the user evaluation. Testing covered avatar movement, exploration paths, button functions, exhibit interactions, information displays, quizzes, puzzles, and feedback systems. The team also tested the application on mobile devices to ensure the text size, buttons, motion controls, and interface layout worked well on smaller screens.

Roblox Studio provides several testing modes that let developers test applications from the starting location or from a specific location within the game environment. The team repeated testing to identify technical errors, inaccessible objects, unclear commands, and game functions that did not respond as planned (Roblox Corporation, n.d.). The team fixed all identified issues before using the final version of MuseumX in the user engagement assessment.

Phase 5: User Engagement Assessment

After completing development and testing, we conducted a user engagement assessment involving 30 students at Universiti Utara Malaysia. Participants used MuseumX on mobile devices and explored the surroundings of the UUM Management Museum. They interacted with the virtual exhibit and completed the activities provided, including quizzes, puzzles, and exploration assignments.

After using the application, participants answered a questionnaire adapted from the Game Engagement Questionnaire by Brockmyer et al. (2009). The instrument measures the psychological involvement a person experiences when playing video games. In this study, the questionnaire assessed user experience in terms of concentration, preoccupation, immersion, and sense of presence while exploring MuseumX. This instrument allows the level of user engagement to be assessed systematically based on participants' experiences after using the application.

We analysed questionnaire data using descriptive statistics, including frequency, percentage, mean score, and standard deviation. This analysis described participants' response patterns and determined the level of user engagement with MuseumX. The score for each item and dimension is described based on the measurement scale used in the questionnaire. This study evaluated only user engagement and did not measure knowledge improvement or learning achievement. Thus, the findings provide insight into MuseumX's ability to attract attention, maintain interest, and create an immersive virtual museum exploration experience.

Overall, the Agile methodology allows MuseumX to be designed, developed, tested, and improved on an ongoing basis before user evaluations. The combination of sprint-based development, functional testing, and evaluation using the Game Engagement Questionnaire provides a systematic process to determine MuseumX's potential as an engaging and interactive virtual museum exploration platform.

THE PROPOSED PROTOTYPE: MUSEUMX

MuseumX combines a wide range of gamification elements such as scoreboards, points, quizzes, puzzles and interactive challenges with UUM Management Museum-related content. These elements encourage users to explore exhibitions, interact with multimedia content, and actively learn about the museum's history and collections. For example, users must obtain information from display boards or through interactions with non-player characters (NPCs), then use it to answer quizzes or solve puzzles. In addition, users need to explore several secret rooms in MuseumX that can be accessed only by scanning QR codes placed at selected locations within the UUM Management Museum. This integration between the gamified virtual environment and the physical museum location can encourage users to explore both spaces actively. Figures 2 to 4 show examples of screenshots of the MuseumX application.

Figure 2

Start Page of MuseumX



Figure 3

The Quizzes in MuseumX

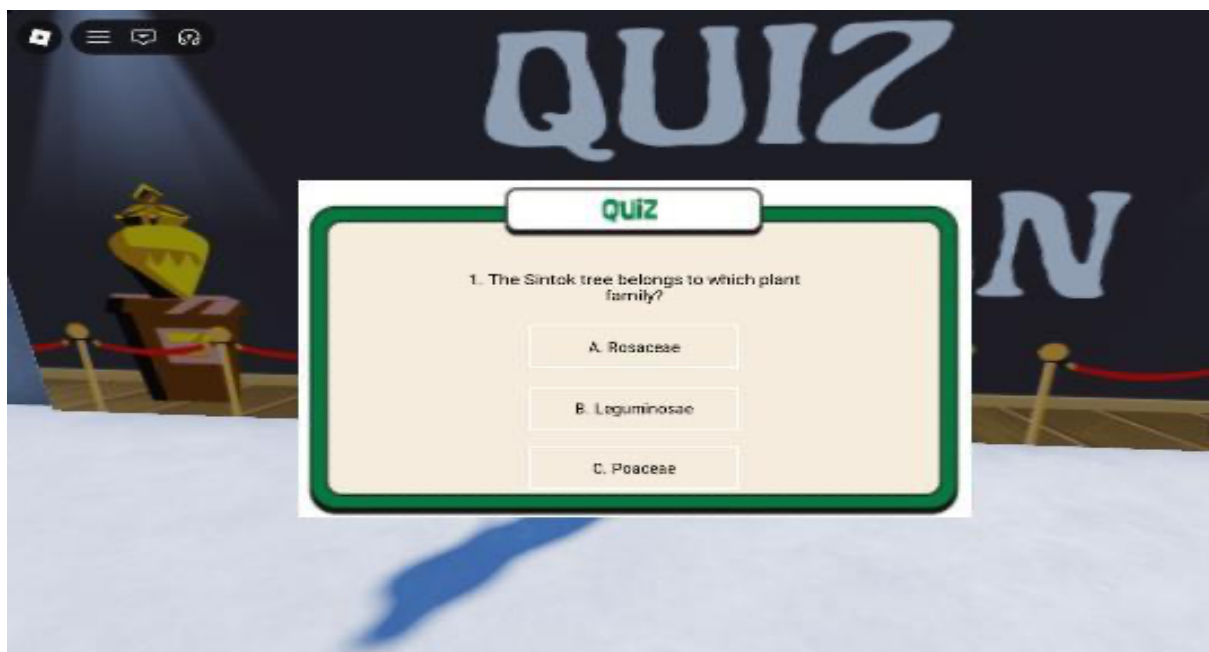
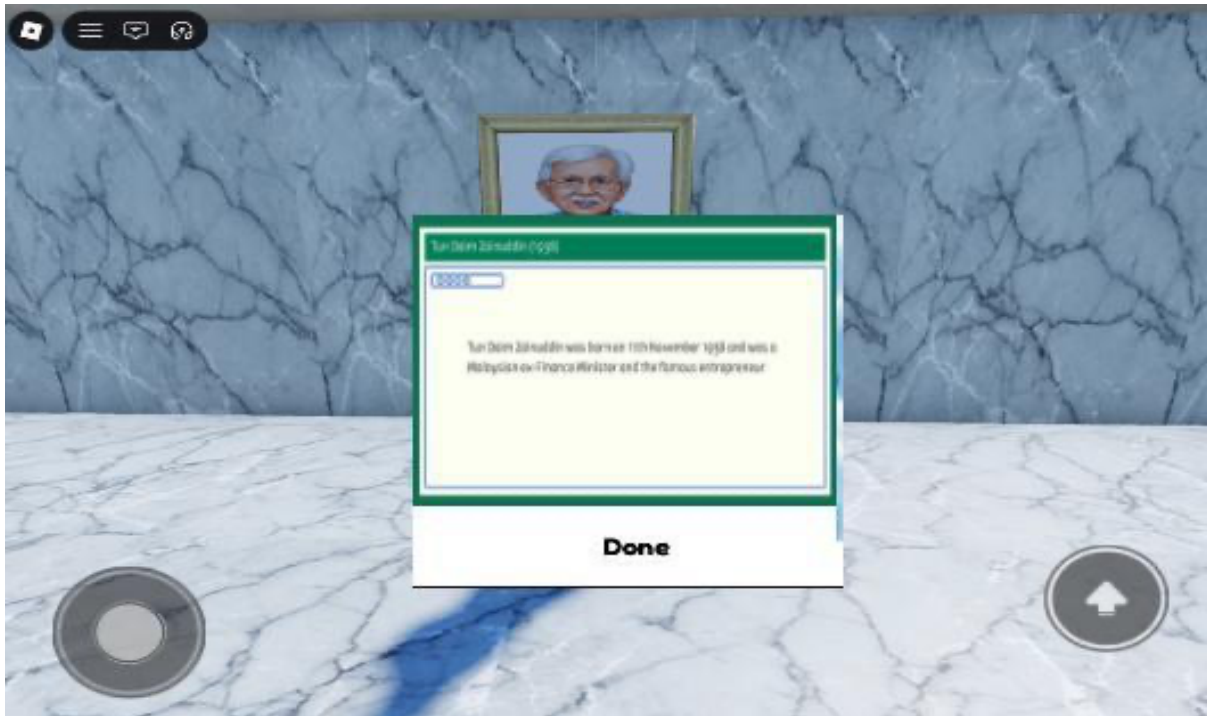


Figure 4

MuseumX Exhibit Information Display



MuseumX features are designed to transform the conventional museum experience into a more immersive, interactive, and engaging learning environment. Through exploration activities, interactions with exhibits and NPCs, and completing quizzes and puzzles, users can actively acquire historical information. This approach also encourages problem-solving, curiosity, and user involvement in understanding the institution's history, collections, and heritage on display at the UUM Management Museum.

RESULTS AND DISCUSSION

The user engagement assessment included 30 students from Universiti Utara Malaysia (UUM), representing MuseumX's target group. Participants were selected because they were potential users of the Roblox platform and the UUM Management Museum's virtual environment. Because MuseumX was developed to raise awareness of the UUM Management Museum through an interactive digital experience, involving students in this assessment allowed feedback based on their actual experience using the application.

The Game Engagement Questionnaire (GEQ), adapted from Brockmyer et al. (2009), was used to assess user engagement. The GEQ measures users' psychological engagement when interacting with digital games. This instrument was considered suitable for evaluating MuseumX because the application incorporates various gamification elements that encourage active participation in the virtual museum environment. This evaluation provides insight into MuseumX's effectiveness in creating an interactive, immersive, and meaningful experience for exploring the UUM Management Museum.

The questionnaire uses a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). A higher score indicates a higher level of user engagement with MuseumX. The questionnaire

items were adapted to fit the context of gamification on the Roblox platform while maintaining the instrument's original purpose of measuring user engagement in a digital gaming environment. The collected responses were then analysed to identify users' perceptions of their engagement, experience, and interaction throughout their exploration of MuseumX.

Demographic

Based on the demographic data in Table 2, most participants were female (18, or 60 per cent), while male participants accounted for 12 (40 per cent). This distribution shows that the assessment included participants from both gender groups, although females participated more. Because the study did not aim to compare user engagement by gender, the demographic information is presented only to describe the participant profile. Nevertheless, the participation of both groups allowed MuseumX to be evaluated from a more diverse user perspective.

Table 2
Participants' Demographics

Demographic	Category	Frequency (n)	Percentage (%)
Gender	Male	12	40
	Female	18	60
Age	18 – 20 years old	3	10
	21 – 23 years old	19	63.3
	24 years old and above	8	26.7

In terms of age, most participants were 21 to 23 years old, comprising 19 participants, or 63.3 per cent. This was followed by eight participants (26.7 per cent) aged 24 and above, while only three participants (10 per cent) were between 18 and 20 years old. This distribution suggests the study findings mainly reflect the experiences of young adult students familiar with mobile technology and digital gaming environments. Therefore, the 21 to 23 age group is an appropriate initial target group for MuseumX. However, the predominance of participants in this age group also suggests that the findings should be generalised to younger or older age groups with caution.

User Engagement

Overall, MuseumX obtained a mean construct score of 4.21 (SD = 0.72), indicating a very high level of user engagement. Of the 19 items assessed, nine recorded very high engagement, while ten recorded high engagement. The mean scores for all items ranged from 3.80 to 4.53, indicating that participants generally responded positively to using MuseumX. These findings suggest that the combination of virtual museum exploration, quizzes, puzzles, interactions with non-player characters, eye systems, and multimedia content effectively attracted participants' attention and maintained engagement throughout their use of the application.

The item with the highest mean score was the participants' ability to connect the information learned through MuseumX with actual objects, locations, or exhibits at the UUM Management Museum (M = 4.53, SD = 0.68). These findings show that MuseumX is not only engaging from a gaming perspective but also helps users connect the virtual experience to the physical museum context. Items related to knowing what to look for and pay attention to during an actual museum visit also received very high scores (M = 4.43, SD = 0.73). These findings suggest that MuseumX can serve as a preparatory medium

before a museum visit and encourage users to explore physical exhibits more intentionally. These findings align with Zhou et al. (2022), who found that using virtual and embedded technologies in museum contexts positively affects users' perceptions and museum learning experiences.

Participants also rated the immersion stage of MuseumX positively. Participants felt truly part of the MuseumX experience ($M = 4.47$, $SD = 0.68$), felt immersed while playing ($M = 4.40$, $SD = 0.67$), and perceived the MuseumX environment as realistic ($M = 4.37$, $SD = 0.67$). In addition, the high score for the item related to full concentration ($M = 4.33$, $SD = 0.66$) indicates that the application was able to focus users' attention on the museum's activities and content. According to Brockmyer et al. (2009), game engagement refers to the level of psychological engagement that occurs when users pay attention to and engage deeply in the gaming experience. Therefore, high scores in concentration, presence, and immersion indicate that MuseumX's three-dimensional environment and interactive activities successfully provide an exploration experience that goes beyond passive observation of digital exhibitions.

Interest in museum content is also reflected in the item "I want to continue playing because I am interested in museum content", which received a very high score ($M = 4.43$, $SD = 0.68$). This finding matters because it suggests that participants' desire to continue playing was influenced not only by game mechanics but also by the UUM Management Museum content presented in MuseumX. Sangamuang et al. (2025) found that gamification in virtual museums can enhance users' hedonic experiences, including enjoyment, engagement, and satisfaction, and encourage longer periods of interaction and exploration. Therefore, quizzes, puzzles, points, secret rooms, and exploration activities in MuseumX are likely to contribute to participants' interest in continuing to interact with the museum content.

Although all items scored high or very high, several items related to reduced awareness of the real environment received lower mean scores and higher standard deviations. The items related to not responding when others speak recorded the lowest mean score ($M = 3.80$, $SD = 1.13$), followed by the item related to forgetting about the surrounding environment while exploring MuseumX ($M = 3.90$, $SD = 1.03$). The item related to not noticing fatigue also recorded the highest standard deviation ($M = 4.00$, $SD = 1.20$). The higher standard deviations indicate that participants' experiences of those items were less consistent. These differences may have been influenced by participants' familiarity with using Roblox, environmental conditions during the evaluation, individual playing style, and their ability to maintain focus. However, a lower score on the item about ignoring communication or the actual environment does not necessarily indicate weakness in the application because those responses are not essential to producing an effective learning experience.

Overall, the findings show that MuseumX successfully creates a focused, immersive, interactive, and engaging user experience. MuseumX's main strength lies in its ability to connect the digital experience with real exhibits, raise users' awareness of what to explore during a physical museum visit, and encourage users to keep playing out of interest in the museum content. However, these findings reflect only the level of engagement users report and should not be interpreted as direct evidence of increased knowledge or learning achievement. Previous studies also show that gamification more consistently increases enjoyment and engagement than learning outcomes or deeper reflection (Chernbumroong et al., 2024; Sangamuang et al., 2025). Therefore, future studies can incorporate pre- and post-use knowledge assessments to determine MuseumX's impact on history and heritage learning at the UUM Management Museum.

Table 3

User Engagement Evaluation of MuseumX

No.	Item	Mean	Standard Deviation	Interpretation
1	I was fully focused while playing MuseumX.	4.33	0.66	Very High
2	I felt truly part of the MuseumX experience.	4.47	0.68	Very High
3	I forgot about my surroundings while exploring MuseumX.	3.90	1.03	High
4	I felt immersed while playing MuseumX.	4.40	0.67	Very High
5	MuseumX felt real to me while I was playing.	4.37	0.67	Very High
6	I did not hear others when they spoke to me while I was playing MuseumX.	4.07	1.11	High
7	I felt that I was inside the MuseumX experience rather than merely observing it.	4.20	0.85	High
8	I felt detached from the real world while exploring MuseumX.	4.10	0.96	High
9	Time seemed to pass very quickly while I was using MuseumX.	4.13	0.86	High
10	I did not respond when others spoke to me while I was playing MuseumX.	3.80	1.13	High
11	While playing MuseumX, I did not notice that I was becoming tired.	4.00	1.20	High
12	I felt deeply engaged with the MuseumX gameplay and content.	4.20	0.76	High
13	My thoughts moved quickly while playing MuseumX.	4.23	0.77	Very High
14	I lost track of where I was while playing MuseumX.	4.03	1.00	High
15	I played MuseumX without consciously thinking about how to play.	4.27	0.76	Very High
16	Playing MuseumX made me feel calm.	4.17	0.99	High
17	I would know what to look for and pay attention to during an actual visit to the UUM Management Museum.	4.43	0.73	Very High
18	I could connect the information learned in MuseumX with actual objects, places or exhibits in the UUM Management Museum.	4.53	0.68	Very High
19	I wanted to continue playing because I was interested in the museum content.	4.43	0.68	Very High
Overall Construct Mean		4.21	0.72	Very High

CONCLUSION

Overall, MuseumX was successfully developed as a Roblox-based mobile platform that combines virtual museum exploration, multimedia content, quizzes, puzzles, NPC interactions, eye systems, and QR code-based secret rooms to introduce the UUM Management Museum in a more interactive manner. An evaluation of 30 UUM students showed very high user engagement, with an overall mean of 4.21 and a standard deviation of 0.72. These findings show that MuseumX can attract users' attention, create

a sense of presence and immersion, and help users connect information presented in the virtual environment with real objects and exhibits in museums.

Although this study focused only on user engagement and did not measure learning achievement, the results suggest that MuseumX could serve as an alternative medium to increase awareness, interest, and engagement in exploring UUM's institutional heritage. Further studies may use larger samples and include pre- and post-use knowledge assessments to more comprehensively determine MuseumX's impact on museum learning.

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REFERENCES

- Alhasan, K., Alhasan, K., & Al Hashimi, S. (2023). Roblox in higher education: Opportunities, challenges, and future directions for multimedia learning. *International Journal of Emerging Technologies in Learning (iJET)*, 18(19), 32–46. <https://doi.org/10.3991/ijet.v18i19.43133>
- Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001). *Manifesto for Agile software development*. Agile Alliance. <https://agilemanifesto.org/>
- Brockmyer, J. H., Fox, C. M., Curtiss, K. A., McBroom, E., Burkhart, K. M., & Pidruzny, J. N. (2009). The development of the Game Engagement Questionnaire: A measure of engagement in video game-playing. *Journal of Experimental Social Psychology*, 45(4), 624–634. <https://doi.org/10.1016/j.jesp.2009.02.016>
- Chernbumroong, S., Ariya, P., Yolthasart, S., Wongwan, N., Intawong, K., & Puritat, K. (2024). Comparing the impact of non-gamified and gamified virtual reality in digital twin virtual museum environments: A case study of Wieng Yong House Museum, Thailand. *Heritage*, 7(4), 1870–1892. <https://doi.org/10.3390/heritage7040089>
- Colour Network Co., Ltd. (2023). *Papo Town History Discovery* [Mobile game]. App Store.
- Crisp App Studio. (2025). *Mystery Spot: Hidden Objects* [Mobile game]. Google Play Store.
- Han, J., Liu, G., & Gao, Y. (2023). Learners in the metaverse: A systematic review on the use of Roblox in learning. *Education Sciences*, 13(3), Article 296. <https://doi.org/10.3390/educsci13030296>
- Li, J., Zheng, X., Watanabe, I., & Ochiai, Y. (2024). A systematic review of digital transformation technologies in museum exhibition. *Computers in Human Behaviour*, 161, Article 108407. <https://doi.org/10.1016/j.chb.2024.108407>
- Li, Z., Zhang, Q., Xu, J., Li, C., & Yang, X. (2024). Gamification of virtual museum curation: A case study of Chinese bronze wares. *Heritage Science*, 12, Article 348. <https://doi.org/10.1186/s40494-024-01464-2>
- Marques, C. G., Pedro, J. P., & Araújo, I. (2023). A systematic literature review of gamification in/for cultural heritage: Leveling up, going beyond. *Heritage*, 6(8), 5935–5951. <https://doi.org/10.3390/heritage6080312>
- My Town Games Ltd. (2026). *My Town: Museum History* [Mobile game]. App Store.
- ORIDIO Inc. (2025). *TAP! DIG! MY MUSEUM!* [Mobile game]. Google Play Store.
- PIXO GAMES. (2026). *Idle Museum Tycoon: Art Empire* [Mobile game]. Google Play Store.

- Roblox Corporation. (n.d.). *Roblox Studio*. Roblox Creator Hub.
- Sangamuang, S., Wongwan, N., Intawong, K., Khanchai, S., & Puritat, K. (2025). Gamification in virtual reality museums: Effects on hedonic and eudaimonic experiences in cultural heritage learning. *Informatics*, 12(1), Article 27. <https://doi.org/10.3390/informatics12010027>
- Schwaber, K., & Sutherland, J. (2020). *The Scrum Guide*. <https://scrumguides.org/scrum-guide.html>
- Srdanović, P., Skala, T., & Maričević, M. (2025). InHeritage: A gamified mobile application with AR and VR for cultural heritage preservation in the metaverse. *Applied Sciences*, 15(1), Article 257. <https://doi.org/10.3390/app15010257>
- Tokaisho. (2010). *Roblox Museum* [Roblox experience]. Roblox Corporation.
- Wang, H., Gao, Z., Zhang, X., Du, J., Xu, Y., & Wang, Z. (2024). Gamifying cultural heritage: Exploring the potential of immersive virtual exhibitions. *Telematics and Informatics Reports*, 15, Article 100150. <https://doi.org/10.1016/j.teler.2024.100150>
- Zhou, Y., Chen, J., & Wang, M. (2022). A meta-analytic review on incorporating virtual and augmented reality in museum learning. *Educational Research Review*, 36, Article 100454. <https://doi.org/10.1016/j.edurev.2022.100454>
- ZiMAD. (2026). *My Museum Story: Mystery Match* [Mobile game]. App Store.