An Alternative Reality Museum Tour Game Integrating Realistic Historical Storyline and Role-Playing for Learning Cultural Heritage

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The Asian Conference on Education 2024
Official Conference Proceedings

Abstract
Although museums converted from cultural heritage are of high historical value, they may not be able to retain the old historical elements due to changes in business strategies and lose the historical value of the original scene. Museum tour guides can still take visitors back to the past through oral tours, there is still limited understanding due to insufficient information retained on site. Therefore, this study attempts to design an alternative reality museum tour game that combines simulated historical storylines and role-playing for a marine museum transformed from a thermal power station. Players can use their mobile phones to open the game and read the storylines to match the real historical scene in the museum park. Using first-person role-playing, players can walk around the existing museum park and explore the events of each historical site, interact with the virtual characters and solve the unexpected events that happened at the thermal power station at the time to immerse themselves in the simulated historical situation. Seventeen participants engaged in this study. The result revealed that the players had a high level of flow, and moderate anxiety. About cognitive loads, a certain degree of intrinsic cognitive load was generated by the long storytelling, the low level of extraneous cognitive load and the high level of germane cognitive load reported indicated that this game can increase the player's commitment to the game and advance the player to think about the content of the game simultaneously.

Keywords: Alternate Reality Game, Digital Game-Based Learning, Educational Game, Museum Tour Guide, Personal Digital Mobile Guide, Situated Learning

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Introduction

In order to promote the preservation and safeguarding of the world heritage, UNESCO launched the Memory of the World Programme in 1992, which has three main objectives: to preserve the world heritage using the most appropriate techniques, to facilitate access to and use of the world heritage, and to raise awareness among all human beings of the existence and significance of the world heritage (Edmondson et al., 2020).

Under the promotion of this project, more and more cultural heritage in Taiwan have been transformed into museums and preserved using adaptive re-use of old buildings. Unfortunately, many of the revitalized cultural assets can hardly show the historical features and values of the old venues due to the different management policies of the venues and the functions of the old buildings. Although many museums have used oral guided tours to recreate the appearance of the museums before the revitalization process, they still suffer from the problem of incomplete information or the limited number of guided tours.

As a result, many museums have turned to the development of digital educational games recreating the original appearance of cultural heritage through digital technology and game mechanisms. Many studies have pointed out that digital educational games can not only attract learners of different educational levels and knowledge areas to learn about cultural heritage but also raise learners' awareness of the preservation of cultural heritage (Petrucco & Agostini, 2016; Garcia-Fernandez & Medeiros, 2019).

Alternative Reality Game (ARG) is a type of game that uses digital technology to connect virtual reality and physical interaction. It is very suitable for educational games with cultural heritage themes (Zarraonandia et al., 2024) The characteristic of alternative reality games is that they use immersive narrative methods to attract players into the game, which can not only inspire players' literacy skills, but also create novel visiting experiences for museums (Davies et al., 2012).

However, some studies have said that many ARGs on the topic of cultural heritage lack interactivity and explorability, which makes it more difficult for players to feel like they are stepping into a historical context, and it is difficult for them to gain a deeper understanding of the historical content and preservation value of cultural heritage. The key reason for this may lie in the fact that these games are not designed from the experiences and perspectives of the educators in the field, which can lead to the production of games that do not meet the educational needs of the field and the game mechanisms of the learning context (Zarraonandia et al., 2024).

Therefore, this study attempts to design an alternative reality museum tour game that combines a simulated historical storyline and role-playing for a marine museum converted from a thermal power station, based on the museum's collection of literature and historical materials by educators familiar with the museum's background. Players can use their mobile phones to open the game and read the storylines to match the real historical scene in the museum park (Figure 1). They were using first-person role-playing, and the learning scaffolding of the digital system to understand the historical information of each site, summarize the answers to the puzzles from the dialogue between yourself and the virtual NPCs, and generate the immersive feeling of returning to the past historical scene, to achieve the effect of both learning scientific knowledge and historical immersion (Figure 2).

Figure 1: Players play the game through the graphic story in the ARG game against the real historical sites.
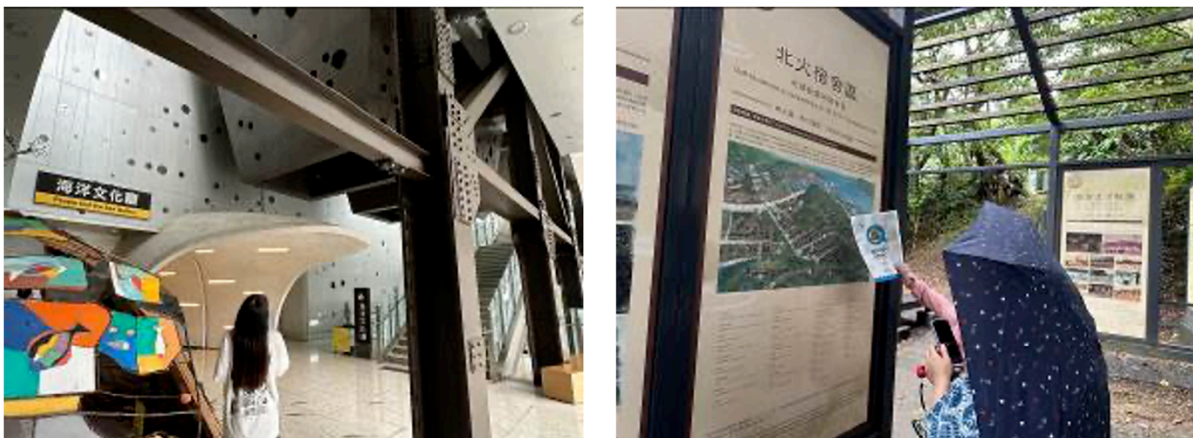

Figure 2: After entering the game, players can read the game content and puzzle clues to think, deduce, and summarize the answers.

The purpose of this study was to investigate the flow, activity anxiety, and cognitive load condition of the learners in an alternative reality museum tour game of cultural assets that combines a simulated historical storyline with role-playing, and to observe the historical immersive experiences generated by the learners during the game. Therefore, the following two research questions were asked in this study:

Q1: What are learners' state of flow, activity anxiety, and cognitive load during the game?

Q2: Can learners produce historical empathy phenomena in this game?

Method

The participants in this study were 17 university students and public people (8 males and 9 females) in Taiwan. We used the post-test questionnaire survey method in quantitative

research all experiments were conducted online. The Kiili Flow Scale (2006) translated and revised by Hou & Li (2014) was referred to in this study. The flow scale includes two dimensions: Flow Antecedents and Flow Experience. All scales were scored according to the Likert scale. The reliability of the flow questionnaire (Cronbach's alpha=0.792) indicated a high degree of internal consistency. In terms of the anxiety of the game by the learner, the AMAS anxiety scale proposed by Carey, Hill, Devine and Szűcs (2017) modified by this study and the Likert scale was used. The reliability of the anxiety scale (Cronbach's alpha=0.853), which has credibility. In terms of the cognitive load of the learning by the learner, the cognitive load scale proposed by Leppink, Paas, Van der Vleuten, Van Gog and Van Merriënboer (2014) modified by this study was used, which included three dimensions: Intrinsic Cognitive Load, Extraneous Cognitive Load, and Germane Cognitive Load, and the Likert scale was used. The reliability of the cognitive load scale, intrinsic cognitive load (Cronbach's alpha=0.846), extraneous cognitive load (Cronbach's alpha=0.817), germane cognitive load (Cronbach's alpha=0.899), three cognitive load dimensions has credibility. Historical empathy quantitative survey proposed by Endacott and Brooks (2013) historical empathy interview methods, which included three dimensions: Historical Contextualization, Perspective Taking, and Affective Connection, used to understand learners' cognitive understanding and emotional engagement with historical scenes and characters. Prior to the study, subjects would sign an institutional review board. The learning activity was an alternative reality museum tour game, which included game explanation (10 minutes), game activities (60 minutes), and post-test questionnaire (20 minutes).

Result

In this study, the Wilcoxon signed-rank test was used to analyze learners' flow, anxiety, and cognitive load, the results shown as Table 1. The result revealed that the overall flow (M=4.37) was significantly higher than the median (the median in a five-point scale=3). This indicates that the overall game activity design mechanism enables the learner to clearly understand the game's objective of the activity and is proactively engaged in the game to complete tasks, achieving a high level of flow experience. The result revealed that the overall anxiety (M=1.99) was significantly lower than the median. The result revealed that the cognitive load, intrinsic cognitive load (M=2.12) was significantly lower than the median. This indicates that the content of the game is designed to have a lower intrinsic cognitive load on the learner; extraneous cognitive load (M=1.12) was significantly lower than the median. This indicates that the game does not place too much external cognitive load on the learners; germane cognitive load (M=4.72) was significantly higher than the median. This indicates that the game design promotes learners to think more and generate useful cognitive. Furthermore, historical empathy surveys show that most of the learners said that they could feel that they were in Japanese colonial period in Taiwan when thermal power plants were still in operation, and that they could empathize with the difficulties faced by the staff of the power plants during emergencies, as well as the lives of the people living in the vicinity of the thermal power plants at that time.

Table 1: Flow, Anxiety and Cognitive Load Descriptive Statistical Analysis

Dimension	M	SD	Z	p
Overall Flow	4.37	0.34	3.626***	.000
Flow antecedents	4.31	0.46	3.625***	.000
Flow experience	4.42	0.35	3.625***	.000
Overall Anxiety	1.99	0.73	-3.386**	.001
Overall Cognitive Load				
Intrinsic Cognitive Load	2.12	0.98	-2.748**	.006
Extraneous Cognitive Load	1.12	0.20	-3.782***	.000
Germane Cognitive Load	4.72	0.39	3.711***	.000

$^{***}p < 0.001$; $^{**}p < 0.01$

Conclusion

In this study, we use design an alternative reality museum tour game that combines simulated historical storylines and role-playing for a marine museum transformed from a thermal power station. Players can use their mobile phones to open the game and read the storylines to match the real historical scene in the museum park. Using first-person role-playing, players can walk around the existing museum park and explore the events of each historical site, interact with the virtual characters and solve the unexpected events that happened at the thermal power station at the time to immerse themselves in the simulated historical situation.

The result revealed that the players had a high level of flow, and moderate anxiety. About cognitive loads, a certain degree of intrinsic cognitive load was generated by the long storytelling, the low level of extraneous cognitive load and the high level of germane cognitive load reported indicated that this game can increase the player's commitment to the game and advance the player to think about the content of the game simultaneously. After the initial analysis of this study, this study will continue to explore the effect of the study on the learners compared to the control group (join other learning scaffolds) by means of a quasi-experimental design.

Acknowledgments

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