explorAR: A Collaborative Artifact-based Mixed Reality Game

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Abstract
explorAR is a project that provides a new experience to learn the world of the past by exploring mixed reality with your phone. In this interactive experience, users engage with the museum and with each other by collecting artifacts which include fossils, paintings, statues, and other historical objects. Users will learn how to preserve historical objects by extracting fragments of artifacts, how to collaborate with each other by combining fragments of missing artifacts, how to express their creativity by designing their own virtual gallery, and how to participate in a crowdsourced research. We developed the concept using human-centered design approaches which includes interviews, personas, prototypes, and user testing.

Author Keywords
Mixed reality; game design; learning technology; gamification; digitization; collaborative learning.

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Figure 1: The main screen which shows an interface of functional buttons, a generated rock, and a map of the user's environment.

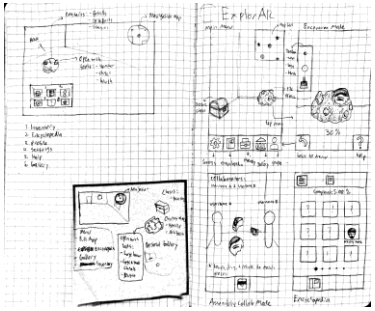

Figure 2: A rough sketch of the game design.

Introduction

Museums are places where both adults and children can spend their leisure time. They provide reliable, authentic, and understandable information where the public can find meaning and connection [5]. In this era of digital information where there are more alternatives to leisure activities, museums have a decline in interest as a result from lack of social participation [8]. As reported by the New Media Consortium, major museums & institutions start digitizing their collection by 3D scanning and exporting them into 3D models which helps museums expand their audience. There is a need for museums to engage their visitors, increase participatory experience through new media, and create a crowdsourcing environment [10]. Our solution is explorAR, a collaborative artifact-based mixed reality exploration game can offer a new learning experience.

This game is played through an immersive experience, which allows users to conceptualize key concepts and representations easier, enhance user experience, and increase engagement [6]. According to Falk, motivation, expectations, group social interaction, and exhibition design strongly affect learning [5]. Studies have shown that immersive experiences can improve education [2]. Augmented Reality for education enables users to interact with digital information within the physical environment [4]. Unlike other virtual reality museum tours and audio guided museum tours that have been existed, mixed reality gamification is the main aspect of this approach.

Our goal is to create a mixed reality game that demonstrates a new gamified learning experience based on exploration which supports public learning and empowers the engagement between users and museums.

Background Research

We interviewed two experienced museum curators who both have spent at least a decade in curating a museum. Based on the interviews, we learned that:

- They stated that museums seem to be overshadowed by other modern entertainment media.
- They believed that creating a mixed reality game based on museum artifacts would make people experience the sense of exploration that traditional museums could not offer.
- They were currently 3D scanning their artifacts collection as a part of their digitization program but had no clue how to utilize them.
- They stated a problem where there are some artifacts that have very little information, which would be difficult to be presented in the game because they need to have accurate information.

We also interviewed six students from different department and majors. Based on the interviews, we learned that:

- They thought the collaborative aspect of the game is very interesting because they can engage with other users who pursue the same learning objective and connect with other users who are playing the game at the same time.
- They thought the newer generations don't always find museums boring, which depend on their interests.
- They thought that a mixed reality game would be a great to create an engaging learning experience.

Persona

Based on the surveys and interviews, we created personas to conceptualize the user's goals and needs. (Figure 3)

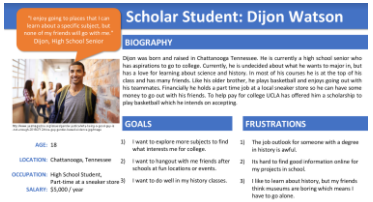

Figure 3: A persona which illustrates a potential user.

Figure 4: A fragment in a user's inventory is ready to be combined.

Concept Development

Our initial design of our concept was originally for the Microsoft Hololens. We decided to pivot the design into a phone-based augmented reality platform. We settled on using a phone-based application because it is relatively easier and faster process for people to engage with each other just by downloading the application from the app store

Prototype

We started designing the mobile application by creating a low-fidelity prototype from a rough sketch (Figure 2). As the concept evolves, the prototype eventually developed into a high-fidelity prototype created using Photoshop and Marvel.

Features

Scavenger Hunt

In scavenger hunt mode, users find fragments of artifacts with the help of the map which shows the closest fragments from their current position. (Figure 1) Artifacts in the game are collected as fragments. Each fragment contains a snippet of information related to the artifact. By completing an artifact, users can learn the whole information regarding to the completed artifact in their encyclopedia. Fragments of artifacts can be found in pile of rocks that appear in the augmented reality environment and are randomly generated and pinpointed to a geospatial coordinate which are based on the artifacts of the closest museum to the users' current location. Different museums will feature their own featured artifacts. In excavation mode, users extract a fragment of an artifact using the 3 offered tools. However, if users are not careful with their tools, they could damage the fragment and it can be destroyed. This game has different experiences for inside and outside of the museum.

Encyclopedia

The user's phone acts as an adventurer's log book & mini encyclopedia that tracks all of their discovered artifacts. Users can read facts about their findings and observe the model by rotating and zooming. After the completion of an artifact, it will show the whole information about the artifact including facts and its history. (Figure 5)

Virtual Gallery

Users can create their own virtual gallery where the virtual gallery is decorated by their collection of discovered items. Users can also visit another user's gallery and give ratings. This feature allows users to express themselves by presenting their most rewarded completed artifacts in their gallery.

Multiplayer Collaboration

In creating an engaging learning experience, users can collaborate with each other. Collaborative learning is a learning strategy that involves small groups that have shared goals of learning [7]. By having a common goal to collect and combine artifact fragments, users will collaborate with each other by combining missing fragments into a complete artifact. (Figure 4) Apart from completing artifacts together, users can visit another user's gallery. A mixed reality gamified learning environment increases social engagement, collaboration, motivation, and healthy competition between users [3].

Based on the five essential elements of collaborative learning by Johnson & Johnson [9], the game design uses *Positive Interdependence*, *Promotive interaction, Individual accountability, Interpersonal & small group skills, and Group processing*.

Interactive Learning

Research has shown that students find interactive augmented reality educational platforms easy, practical, and useful in learning [11]. Users give

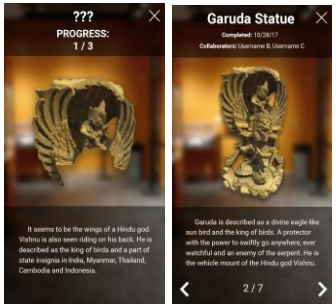

Figure 5:

Left: A fragment of an artifact which shows a hint of the whole artifact.

Right: A completed artifact which shows the completed information about the artifact.

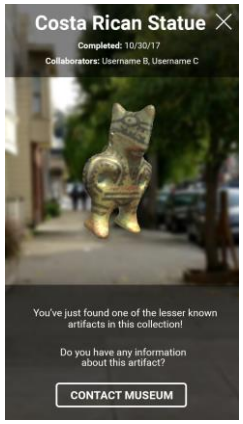

Figure 6: A lesser known artifact that users can contribute information about it.

positive responses and acceptance attitudes to the platform [1]. A fragment of an artifact shows a partial information which creates an information scent of the whole artifact. (Figure 5)

Crowdsourced Research

The game can feature lesser known artifacts from a museum collection. Users can submit their knowledge of an artifact to the museum moderators to confirm if the information is valid. (Figure 6) With this feature, museums can engage with not just their current visitors, but people around the world who are users of the game.

Conclusion

We have designed a collaborative artifact-based mixed reality game using human centered design methods. The goal of the concept is fulfilled, to create a new gamified learning experience based on exploration that supports public learning and empowers the engagement between users and museums.

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