Exploring Motivating Factors of Young Adults in a Museum Context Through Mixed Reality Games

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ABSTRACT
Museums are amongst the group of institutions that has developed the least in turn with modernization of digital technology. They rely on stationary physical objects as points of interest for their exhibitions, without much implementation of contemporary digital technology.
The purpose of the paper is to investigate and design Mixed Reality games implemented in the museum context, using particularly smart devices as the platform of deployment, as a means to encourage young adults in particular to explore more exhibits and locations.
Through an iterative design process, we develop two prototypes of Mixed Reality games - one analog and one digital. The prototypes are tested at the IT-University of Copenhagen, mimicking museum conditions using local test subjects. Subsequent interviews form the basis of documentation for a qualitative analysis of the tests.
We found that an Augmented Reality Treasure Hunt game was an effective means, of encouraging students to experience a larger number of exhibits and artefacts in an unintrusive way, as well as promoting cooperation, exploration, and portraying a familiar place in a different perspective.

Author Keywords

Mixed Reality; Pervasive games; Locomotive Computing; Playful Design; Augmented Reality;

ACM Classification Keywords

Design; Documentation; Experimentation; Human Factors.

INTRODUCTION

For over half a century, museums have changed very little in the way they present their exhibitions or engage their audiences. With the increased focus on the experience of the individual human being seen in other areas of social and cultural fora, most museums have been hampered by the limitations of their objects of exhibition to accommodate. Interaction with most art pieces is not allowed, and all the exhibitions within the museums can only be enjoyed on-location (McLean, 2007).

In terms of demographics, young people ages 14-29 in particular make up the least frequent museum visitors, consisting only of 16% of the total museum guests in Denmark in 2016, while this group makes up 23% of the population (Slots- og Kulturstyrelsen, 2015). Furthermore, 34% of these visitors attribute their motivations for going as being 'tagalong' - as in they are only there because they are accompanying someone else.

In 2016, 6 research partners and 10 different museums banded together in order to examine the design of mobile applications, specifically in order to '*facilitate meaningful complex interactions with museum exhibitions*' (The GIFT Project Website, 2016). Our project runs parallel to the GIFT project, basing our research on their ongoing work. The following paper is our study of the available literature in the field, and an examination of how to properly approach the research subject.

As for ways of encouraging young adults in particular to explore more exhibits, Walker & Froes (2011) propose that implementing playful activities changes visitors' behavior and enhances learning. Harnessing playful activities for museum learning is mostly undeveloped and is therefore an area with opportunity of investigating new ways of exploring new as well as familiar settings.

Our purpose is to examine ways of applying playful activities using mobile digital platforms in a museum-like context, with the goal of encouraging young adults to experience more exhibits, as well as exploring familiar settings. We hope to make observations about what motivates students from a modern digital society to engage in cultural self-education. In this paper, we build and prototype 'Art-Thief', a game using MR (Mixed Reality) technology in a museum or museum-like context in an attempt to tackle the challenge of visitor engagement. MR concerns the merging of reality and virtual reality, sometimes also known as augmented reality.

Related work

Our reasoning for testing with a game is that they are great at motivating people. The reason for this, according to cognitive science, is that games make people feel as if their minds and bodies have stretched into a new space (Gee P., 2003). Beyond this, motivation is also essential for people in order

to learn. Hence, we believe that games might be a good option to engage our target audience and teach them.

Further investigation into the topic of engagement through games, revealed a museum that had already made a game project. The Tate Modern museum made a digital card game about their art pieces called 'Tate Trump'. This allowed visitors to have the different exhibitions come to life and battle one another as game cards. The Tate project successfully managed to motivate and teach their participants (Tate, 2016). However, while Tate Trumps encouraged visitors to collect cards from actual exhibitions, the game itself does not require any interaction with the exhibitions beyond that point. As such, when you are actually playing the game, you are not using the surrounding context within the museum itself. In fact, you could just as easily bring and play the game anywhere. Finding a way to engage with the exhibitions directly might be more beneficial. Another museum is currently researching the use of mixed reality to engage young people. They do this by creating narrative tours based on personas that they have matched the visitors based on personal preference (Chess Consortium, 2011-2016). However, we feel that merely using mixed reality as a tool for generating customized tours is an underutilization of the medium.
We wish to further engage visitors during the tour, by using mixed reality elements to create interactive challenges related to the exhibitions that the visitor encounters. An added benefit of using mixed reality is that this form of augmentation does not require us to change the physical environment (Billinghurst, Clark, & Lee, 2014). With the widespread use of smart devices, we assume that most visitors will have access to one, thus the museum would not need to implement new mixed reality systems to accommodate. The increasingly powerful cameras on smartphones allow for precise tracking that is less intrusive than physical markers, which further reduces the potential disruption to the traditional museum experience (Bolter, Engberg, & MacIntyre, 2013).

With the understanding of how augmented reality and gamification has been used in museum context, In 2016 Hammady et. al elaborated on 'noise' in internal and external sources which has the possibility to interrupt the communication or confuse the visitor in its exploration of the museum. We see this approach as a potential way to ensure the incorporation of our augmented reality system which will lead us towards a successful method of communication with our visitors.
Considering further existing projects, Dini, Panternó & Santoro (2007) designed a game based on PDA and fixed-screen technology to be used within the confines of a museum, based on the observation that most digital solutions were either simulations of the museum experience, or replacement solutions for guiding visitors. They found that by implementing games into the museum experience, they enriched the user experience by encouraging further study of exhibits and cooperation between visitors.
Additionally, in 2009 Yiannoutsou et al. Conducted a similar project to ours, defining three levels of interaction between exhibits and visitors, as well as some design principles concerning unobtrusive design that has been applied in the work of this project.
While some of the presented museum puzzle games have succeeded in increasing motivation. Their puzzles didn't unanimously teach people much of anything about the exhibitions themselves, because the game designers focused on their game story and left the exhibitions in the background. We will attempt to keep the cultural artifacts in focus as described by (Yiannoutsou & M. Avouris, 2012)

It is relevant to mention that a certain design cannot necessarily be implemented in all exhibition contexts. As described my Mortara et al. 2013 cultural heritage in serious games can be concerned with archeology, art, historical reconstruction, architecture, cultural awareness, etc. These subjects relate differently to game genres such as puzzles, adventure, simulation, action, etc, as some might be superior to others in each case. This should also be acknowledged in case of The GIFT Project. Different genres might fit different contexts of cultural heritage, and a puzzle game might not be relevant in all cases.

METHODS
In order to examine how an implementation of digital technology through playful design could enhance a museum experience, a game called 'Art Thief' was designed. Art Thief followed a treasure hunt format known to many children and adolescents, utilizing clues and riddles to guide the player through areas and requiring them to locate certain objects and locations. Due to the withdrawal of the associated museum from the GIFT project at the beginning of our testing period, the IT-University (ITU) in Copenhagen was selected as an alternative location, due to both its layout and the fact that it hosts a small exhibition regarding the construction of the building back in the early 2000s. The chosen location had the advantage of being both accessible, and housing numerous students, increasing the probability of gathering willing participants for the testing of the designed game.
Two prototypes of Art Thief were developed, one analog and one digital. The first one was utilized to gauge whether or not the design of the game lend itself well to the context of a museum, while the second was designed to specifically utilize augmented reality through a smartphone, to enhance the experience beyond what an analog prototype can deliver.

The game
The analog prototype of 'Art Thief' consisted of 5 'goals' consisting of locations or art objects spread around the

premises of ITU. Three levels of riddles/clues were created for each goal, split into categories of 'Easy, Medium, and Hard'. The clues were printed on paper, and handled by a facilitator, who enacted 'the game' for the players. Players were either in pairs or by themselves, to examine whether their behavior and approach differed depending on if they had a partner to consult or were left to their own devices. This is based on the fact that above 75% of the visitors of Danish museums in 2010 were in groups of 2-6 people (Finansministeriet, 2015).
The player(s) were led to the middle of the atrium of ITU, as that was deemed the most central location in the building, and handed the hard clue for the first goal. They were told that easier clues were available in case they were stumped on their current one, and then left to their own devices, while our group observed their progress. Upon finishing one goal, they were given the next, and so forth, until they had located all the goals. Following this a short interview consisting of 4 questions was held, inquiring about their experiences, their past experiences regarding treasure hunt type games, and the likes, ending with a freeform suggestion session.

Figur 1 Picture used as target Exhibit at ITU

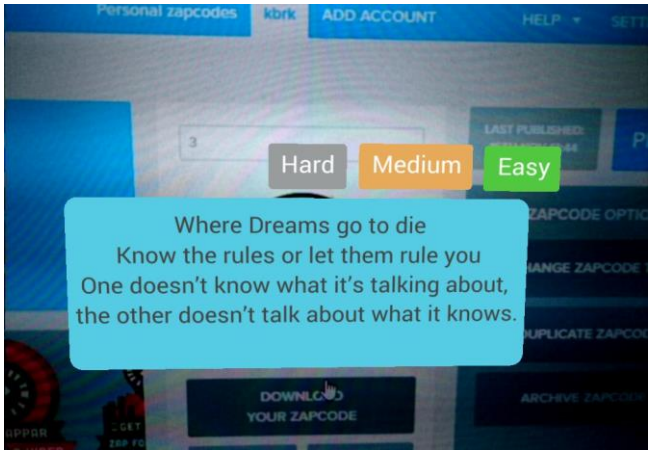
The digital prototype consisted predominantly of the same content as the analog prototype, however this time the augmented reality experiences software Zapworks (Zappar Ltd., 2016) was utilized in the creation of Art Thief. Stickers containing a 'Zapcode' were placed around the premises of ITU, allowing the player to scan these, and receive various results. Amongst these, were the clues created in the analog prototype, as well as 'success' and 'failure' messages hidden in select stickers. This was done particularly on the second floor of ITU, which houses the previously described collection of art pieces describing the construction and values of ITU. This area was selected due to its close ties in context with an actual museum, since most students at ITU have little idea what the pictures there are meant to represent, and might approach them similarly to an unknown piece of art or historical artifact located at a museum they would be visiting. This enabled the players to 'explore' the otherwise familiar space of ITU, looking for stickers, while simultaneously still requiring them to solve riddles, otherwise they would end up scanning the incorrect paintings/locations and receive 'failure' messages.

RESULTS

Analog Prototype

The first prototype had 6 participants. 2 of the participants were tested individually and 4 of them were assigned as pairs. The reason for this variation of individuals and groups is to account for the possibility of different reflections, given how people tend to visit museums either alone or in small groups as noted above. In the first prototype, the locations were scattered around ITU's building. Through the process, we observed the participants, following them around the building. In this way, we verified that the participants found the correct goals for each riddle.

Overall, the participants' experiences with the difficulties of the various riddles in Art Thief were positive. A general feedback was that the difficulty had to be at a balanced level. This was presented as important in order to ensure that the participants are able to relate to and decipher the riddles and their associations with the environment of ITU. By asking the participants about their current background with "treasure hunt", they had no memorable experience with it except as a child. As the last question, the participants had to describe two positive and negative things about the concept for Art Thief. The positive answers confirmed statements of pleasure in reflecting and finding objects in already familiar places. For the negative answers, the participants mentioned several improvements to the game. One of the participants described it important to have a pre-understanding of the context to be able to answer these questions. Other participants expected an increase in difficulty and in words. A remarkable answer was also the way one of the participants felt uncomfortable by the observers following him.



Figur 2 Augmented Reality Riddle Display.

Digital Prototype
For this prototype, the second objective was modified to include additional steps before all clues could be acquired. As such, the first clue would represent only a hard riddle for the end goal, as well as an easier clue leading to a riddle of medium difficulty. The medium difficulty riddle would then lead to the easy one, and a location close to the goal itself. This modification was done to further mobilize the user as well as potentially teaching them more about other areas/artifacts at the ITU than the end goal itself.
For this test, we recruited two master students at the ITU, being on their 4th and 5th semesters respectively. Before the test, both participants were quizzed on several questions pertaining to areas that they would be visiting during the test, as well as some not related to the test at all, as a means to make deducing the locations of the goals less likely based on the interview.

The two participants were presented with a smartphone with the Zappar (Zappar Ltd., 2016) app already installed for them to interact with the Zapcodes. After scanning the Zapcode for the modified second objective, they were presented with the hard riddle, and the information that the objective was on the second floor. The participants then chose to investigate artifacts on the second floor directly, finally finding the correct one without scanning any of the Zapcodes placed for misdirection. Similarly, they managed to quickly locate the remaining four goals based on the riddles themselves. They engaged each other in conversation, exchanging ideas on how to solve the riddle and what the correct answer could be. They seemed to focus on looking for Zapcodes and opportunities for scanning than they did reading the riddle itself. One of the participants even commented on the scanning app as being "fun to use", handing it over to his partner for him to try. After the test, both participants were interviewed using the exact same questions as before. The answers were almost identical to the first interview, with slightly more precision as to the description of a few of the locations.

ANALYSIS
As our test subjects are drawn only from students at ITU, the results from our tests are not necessarily representative of a test performed at a museum. Statistically, this demographic is the least represented group of museum-attendees age-wise (Slots- og Kulturstyrelsen, 2015). To accommodate this, some of the riddles and clues crafted for the game, were specifically designed with this demographic in mind, by relating to insider knowledge and using a mix of locations as well as artifacts. This was done in order to capitalize on their pre-existing knowledge and associations related to ITU. Other clues were created to test how someone without insider knowledge would fare, particularly the use of an exhibit of images on the 2nd floor.

Figur 3 Coding in progress, with post its containing statements

For our analysis, we have applied the method of initial coding, described by Grounded Theory (Smith A, Harré, & Langenhove V., 1996) to our data. We divided all the interview answers into statements numbering 32, and coded them individually, under six categories based on questions they reply to. The codes were then grouped into concepts, based on their content. Looking at our codes, we divided them into the following concepts: Demographics, Features, Vocabulary, Difficulty, Previous Experience. The concept 'Difficulty' had the most entries, which were overall positive. Similarly, 'Vocabulary' was one of the more popular concepts, once more with a predominantly positive response. These two concepts combine to more than a third of the entries coded from our data numbering 13, which shows a very heavy focus on the actual design of the challenges themselves. This implies that when creating a treasure hunting experience, ensuring that the challenges are tailored to the intended demographic is paramount. 'Features' was another frequently debated concept, in which particularly the treasure hunt was praised as being effective in facilitating and encouraging the exploration of a familiar place. As seen from the digital test, the use of a mixed reality scanner seemed to improve interaction with the environment, promoting searching for visual clues as a means of advancing through the riddles. Several participants enjoyed the opportunity to cooperate with their partner, in order to solve the riddles. We inquired regarding the participants' 'Previous Experiences' with treasure hunts, and six out of eight participants could confirm that they had previously participated in similar activities, albeit predominantly in childhood. The concept 'Demographics' received very little attention from our participants, which is most likely caused from them being from a student background, which is generally considered resourceful in cases of problem solving. We imagine that this subject would be more prominent in a test performed in a museum context, with a wider range of demographics.

CONCLUSION

It can be concluded that we are unable to directly relate our results to a museum context, as we performed our tests in a university environment, with students as our demographic.

However, we believe that some of the observations, made specifically in regards to treasure hunting, as a means to engage people in exploration, can be widely applied. The overall response to treasure hunting as a means of experiencing a location was positive, with a heavy focus on the design of the encountered challenges, as well as both the challenges and the features facilitating exploration. Specifically, the Augmented Reality element of the application provided incentive to visually examine the immediate surroundings. We found it particularly helpful to tailor the experience, to the target audience, to ensure that they are immersed in the activity. Similarly, tailoring the experience to the relevant context is paramount, to avoid being disruptive. Finally, designing the challenges to facilitate cooperation between visitors should be encouraged, as it had a visible effect on the engagement of the participants.

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