The 1677 Siege of Malmo - A Gamified Past Simulation for improving Cultural Heritage interpretation

Key Words: Digital Heritage interpretation, VR, Gamifies Simulations, Cultural Heritage, Virtual Heritage, Edutaining

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1. Introduction

Imagine where you would go if you could go back in time and safely witness any historical event. And, if that were the case, by actually being there, seeing the people, the architecture, touching the ancient artifacts, what could you learn and how impactful would this learning be? Would it be fun or scary? Would you remember what you learned for the rest of your life? Would the experience challenge your currently held ideas about that event? Well, we can't quite go back in time yet, but with the advancements of Virtual Reality we can get as close as possible to doing exactly that. This Master thesis will explore this phenomenon and the idea of, through VR technology, to go back in time and witness the historical 1677 Siege of Malmo - Sweden.

Figure 1: Visitor during the 1677 VR experience

The notion of heritage represents the human activity of a civilization or a population not only in terms of archeology, but also as human behaviours such as communication, art and tradition (Rahaman & Tan, 2011). At a first glance, heritage tourism is seen as a cultural experience which has been around for centuries, however, heritage tourism could also be more broadly defined as a process of engagement between a place/culture and a person, supported by tangible as well as intangible elements (Navarrete, 2019; Smith, 2009). Because of its broad appeal, heritage tourism is one of the largest and fastest growing segments of the industry (Timothy, Dallen J. Nyaupane, 2009; Chiu, Dzakiria, Kasim, & Scarlat, 2013).

Museums and other Cultural Heritage (CH) sites provide the public with these tangible and intangible historical cues so visitors can, through their imagination, explore the past and learn. However, people's expectations are changing and visitors want an update of the offers

boosted by the technological progress that influences their day-to-day lives (Building Design + Construction, 2018; Hillier, 2018).

Naturally following this evolution, CH sites and organizations are acting more like brands, adapting their strategy in communication towards digitalization by creating new content offers and changing their relationships with visitors (www.minsar.app, 2021).

In the 21st century, when technology is present everywhere, the notion of Digital Heritage (DH) has also taken a large place in the discussion of the tourism industry. Digital Heritage is defined by UNESCO as the unique resource of human knowledge and expressions created digitally or converted into digital-form from existing analogue resources (UNESCO, 2003).

Exploring DH development and the new realities of the 21st century digital media, museums are moving away from the static, old and dusty displays towards a more dynamic proposal in which technology, creativity and uniqueness are the main tools to implement change (Agyeman, 2020; Hillier, 2018). For the past decade DH development strategies have explored the idea that museums are not just places visitors go to look at artefacts but rather a place where they can have an immersive experience with the past (Building Design + Construction, 2018). The digital tools used for archiving this offer a fresh context for culture with access to places and situations which are difficult or impossible to go, and the possibility for a new type of encounter with the heritage through careful reconstruction of the past.

Among the various new ways for visitors to interact with DH, Virtual Reality (VR) is the one which currently offers the most immersive experience (Selmanović et al., 2020), although Augmented Reality (AR) is often perceived by professionals as the easiest way to move towards digitalization.

AR is a convenient digital tool since the majority of people own a smartphone, and the technology is relatively cheap to produce and implement (VentureBeat, 2018). AR’s role is mainly educational and supports people's cognition by allowing visitors to easily compare a current place or object to an old representation of it, or by adding layers of digital information into the artifacts. However, it is not a good choice for sharing emotions and providing genuine engagement (Jerald, 2016).

VR technology, on the other hand, allows humans to immerse themselves into any subject of study in a completely different way theoretically experiencing anything that can be imagined. A number of business sectors are spearheading this change through the use of VR, like the health, military, education and manufacturing industries (Perkins Coie, 2020). From literally getting inside molecules and watching chemical formulas being created to flying a jumbo jet without putting passengers and expensive equipment at risk, VR blasts the doors of our imagination right open and allows us to experience our wildest dreams.
Because of this potential, VR popularity has been growing at an alarming rate. According to Grandviewresearch.com (2018) the VR market was valued at USD 15.18 Billion in the year of 2020 and is predicted to grow by 18% per year until 2028. Thus, VR has received considerable attention from academics and big business alike. In 2014 Facebook acquired the company Oculus for 3 Billion dollars. It has also been announced that Google is jumping into the VR train and is currently working on developing inexpensive hardware which can be used in large scales in schools as well as top quality Head Mounted Displays (HMD) which promise to steer the market even further towards a virtual revolution (Jerald, 2016).

The creation of good VR experiences, however, goes beyond big investment, tech engineering and design. It depends also on the synchronized application of multiple disciplines including philosophy, art, physics, communication, neuroscience and social sciences so it can be said that, the advancements brought about with the development of VR are dependent on a balance between the new technology and our current anthropological understanding (Jerald, 2016).

Curiously, studies made in 2016 in the UK show that the interest for experiencing both culture and tourism through VR is increasing especially with the older population which are intrinsically less aware of the technology but rather attracted by the utility of the tool as a means to explore new worlds (ComRes, 2016a; ComRes, 2016b).

In France, studies made by Gérard, Bartoli and Gautier (2019) on “the access to patrimony and culture via numeric tools" highlights the need for people to have access to VR experiences that match their cultural expectations. Furthermore, they claim that more than 75% of teachers, young adults, teenagers, and people with disabilities have requested access to VR in France (Harris Interactive, 2019). This particular study also exposes the double interest from respondents to use VR with the purpose of seeing things as they were in the past

so they would increase their knowledge through acquiring multiple perspectives. A big difference, however, exists in the demand to participate in Gamified Past Simulations (GPS) with 74% of the 18-30 year old respondents wanting to be part of it, and only 32% for the 50+ demographics demonstrating interest (Gérard, Bartoli and Gautier, 2019).

Furthermore, 20% of standalone exhibits providing educational interactive experiences are digital exhibitions that are connected to artworks (Nesta, 2020) while an analysis of the current offer of VR in CH sites reveal that only one third of museums offer digital experiences specifically to complement their traditional displays.

For the minority of museum's that currently offer VR experiences, managers claim to be a useful tool to display and promote culture as it brings new perspectives through heritage engagement, attracting and educating more people with the accessibility of the content. The main problems, they claim, with the VR element are related to the cost, the lack of social interactions, the slow exhibition flow as well as a lack of complete technological acceptance from the audience (Shehade and Stylianou-Lambert, 2020).

Investigating digital heritage is a continuing concern for service management studies, particularly from a tourism perspective as these technologies can be viewed as tools for cultural heritage organizations helping providers as well as consumers.

1.1 Problematization

What this initial analysis reveals is that Cultural Heritage and it's many ambassadors (museums, historical sites, etc) are at the brink of a technological overhaul (Bekele and Champion, 2019). Institutions such as these, tend to engage with their public via traditional methods accompanied by written text which do not grab the attention or generate enthusiasm specially for the younger generation (Shehade and Stylianou-Lambert, 2020).

The same cannot be said about the solution proposed and facilitated by VR technology and its potential to send people "back in time" in a completely new and immersive way (Anderson et al., 2010). The upcoming use of VR for touristic purposes promises not only to anticipate the

future of touristic destinations and experiences, but also a way to grow the desire to engage with culture (Champion, 2020).

To analyze this phenomenon and gain first-hand understanding of its potential the authors of this thesis decided to create a Gamified Past Simulation (GPS) experience and host it at the Museum of Malmo (southern Sweden) so the empirical data collected would be buttressed on the real world experience of designing, creating and implementing a complex multi-stakeholder tourist attraction. They hope that this approach will put the current theories of VR in DH to the test, probing for flaws, finding new ways of implementing the technology and assessing its applicability as a commercial tool.

The experience itself which is fully described in chapter 4 is called "The 1677 Siege of Malmo" and simulates the historical Danish attempt to take over the Swedish Citadel of Malmo between June the 11th and July the 5th of 1677 at the bitter end of the Scanian War. https://drive.google.com/file/d/18sB9dwfiu8T6vdfSPztiZfb1Ozcv8o77/view?usp=sharing // https://bit.ly/3yPJ1G1

1.2 Research objectives

This thesis aims at furthering the understanding about current Digital Heritage interpretation and linking a theoretical framework to a practical case. In other words, the authors will explore how the theory of digital heritage interpretation from Rahaman holds up when applied to the creation of a new gamified past experience.

By implementing Rahaman's theories into the construction of a VR experience, the authors hope to evaluate its effectiveness as well as develop new service management guidelines to facilitate the design of future similar GPS as well as access its effects on people's overall experience at a museum.

Furthermore, the authors are interested in finding out the commercial applicability of GPS as museums and CH sites digitalize and move their content into the 21st century.

1.3 Research question

The main question this research aims to answer is:

What are the effects of a Gamified Past Simulations (GPS) in Cultural Heritage (CH) interpretation?

In parallel, authors will also explore the practical implementation of Digital Heritage theories and disclose their findings. To do this and explore the subject deeply, Digital Heritage Interpretation (a topic recently made popular among academics) is the most comprehensive theoretical framework. It was proposed by Rahaman in 2012 through his PhD thesis: A framework for digital heritage interpretation (Rahaman, 2012). His theory, which highlights the relationship between end-users and DH interpretation, is basically divided in the analysis of 4 crucial aspects:

Satisfaction
Provocation
Learning
Multiple perspectives

For decades, it's been claimed that emotions, when triggered, act as a key vector in the learning process (Loiseau et al., 2014). Educational theories such as the Multisource Nature of Learning (Iran-Nejad, Mckeachie, & Berliner, 1990) have reinforced the fact that education combined with experience through an entertaining environment, positively influences learning and skill development towards subjects so this thesis has an opportunity to also test that.

To combine education and gaming, especially in a VR media, is in principle an effective approach for generating interest throughout all age groups. This is in no small part because VR is a revolutionary cultural vector which triggers emotion, through unique content (Triclot, 2011).

Nevertheless, because this thesis focuses on both theoretical and practical aspects, Rahaman's theory has been complemented by Edutaining theories for both the research process and the design and development of the Malmo 1677 project. Doing so, authors hope to strengthen the credibility of their work by having a global perspective of each of the 4 aforementioned aspects applied to a concrete experience.

2. Literature review

2.1 Cultural Heritage

Cultural Heritage (CH) can have different definitions depending on the author and the focus of their research (Chiu, Dzakiria, Kasim, & Scarlat, 2013). UNESCO claims that cultural heritage is, in its broadest sense, both a product and a process, which provides societies with a wealth of resources that are inherited from the past, created in the present and bestowed for the benefit of future generations. (UNESCO, 2014)

The sites for CH tourism can vary extensively in their type, appeal, origin and function but generally, more developed areas include attractions such as museums, art galleries, theatres, music halls and, artistic performances while less developed areas focus more in traditional religious practices, handicrafts, cultural performances and archaeological digs (Chiu, Dzakiria, Kasim, & Scarlat, 2013).

The elements composing CH sites can be tangible as well as intangibles but their uniqueness and state of preservation have a clear socio-economic impact for local communities since they bring investment, development and help to form cultural identity. Therefore it could be said that CH represents a complex system of values including beliefs, traditions, lifestyles, objects, artistic expressions, production and social norms from a specific geographical location that are transmitted from generation to generation (Beycan & Edina, 2018; Affleck and Kvan, 2008).

On such sites, tourism officials tend to create narratives that help visitors interpret and connect with the culture and the outcome is usually educational as well as entertaining or even awe-inspiring. Typically, CH tourists are divided into a minority composed of those who purposefully seek CH activities and a majority willing to unwind from routine and casually visit attractions during their holidays. This means that products have to be accessible enough, engaging enough and developed in a way which will satisfy most tourists independent of their primary motivation (Chiu, Dzakiria, Kasim, & Scarlat, 2013).

2.2 Technological Innovations and Cultural Heritage

Technology affects the way society works and it's rapid development has an interesting impact in the way we manage, promote, experience and protect cultural heritage sites. "Digitalization of data, database storage, and applications such as Internet, social media, artificial intelligence, augmented and virtual reality are significantly contributing to the work on cultural heritage." (Beycan & Edina, 2018 pg.2).

The ever growing pace of technological progress aids the response to visitors' needs according to the advantages and uniqueness of each media. Augmented Reality (AR), Virtual Reality (VR), Augmented Virtuality (AV), and Mixed Reality (MxR) are making these types of experience accessible, affordable and readily available across multiple CH sites (Bekele and Champion, 2019). These technologies usually provide end-users with a much higher sense of interactivity and sensory feedback, so, when successfully used in CH sites they increase the level of visitor engagement (Bec et al., 2019).

Among the vast array of innovations, as a medium, Virtual Reality (VR) is the one that allows visitors to immerse into digitally created, three dimensional environments that can be engaged with in a seemingly real/physical manner. Possible experiences in VR are almost limitless but when applied to CH tourism they usually involve visiting or engaging with locations, artefacts and activities which, although often contested, genuinely represent the past (Bekele and Champion, 2019).

Despite this considerable potential and the fact that it is still in its early stages, VR is considered as the most immersive of all the technologies currently available (Jerald, 2016). Furthermore, VR is an excellent way for tourists to try-before-buy a particular touristic destination (Huang et al., 2016) as VR can conveniently provide tourists with a taste of how it feels to be at the attraction they wish to visit.

Another benefit of VR is the potential it has to become an effective way of management and preservation of CH since it provides an alternative for physical experiences minimising usage, overcrowding and damage on delicate sites (Guttentag, 2010).

However, this thesis argues that perhaps VR's biggest value for CH sites lies in the potential it has to convey subtle cultural cues and context, which are deeply engaging, entertaining and meaningful. The advantages for locals are also significant as they have the chance to better understand their own heritage which can lead to a rise in their sense of urgency and pride in protecting their sites (Champion, 2020).

2.3 Cultural Heritage Interpretation

Cultural Heritage is composed of both the tangible and intangible elements which offer a sense of authenticity (Affleck and Kvan, 2008). Interpretation for CH is defined as the story communicating the past heritage that not only supports visitors' understanding but also improves engagement (Rahaman and Kiang, 2017). In a cultural visit, interpretation is a mental process, rather than a fixed tool, for arriving at a better understanding of CH. Tilden, who is considered the father of CH interpretation, has redefined the approach of sharing CH with his "Interpreting our heritage" work.

His ideas suggest triggering people's curiosity rather than having a direct educational approach of just teaching facts. In other words, the narrator should be an interpreter, not a teacher. For Tilden, it is better for the visitor to leave a place (or an experience) with one or two pictures in mind, rather than a melange of information that will raise uncertainty and doubt in their interpretation process. Through 6 principles, he explains how interpreting CH is an art that should be created to provoke emotions into people's mind, avoiding a simplistic instruction process which is often related to a steril emotional response (Tilden, 1977).

For this process to be successful, provocation is crucial as it allows the narrator to display subtle informative cues that can then be filled by visitors' imagination based on their idiosyncrasies. To construct provocation, and not simply instruction, the narrator has to reveal specific information with style and poetry. His role of presenting the heritage can be viewed as both a science and an art. As mentioned by Tilden who was quoting Chesterton, the interpreter has to be "able to create his own style as: the soul of a landscape is a story, and the soul of a story is a personality" (Tilden, 1977 p28).

Arguably, the role of the narrator is the most important as he delivers the knowledge that will be reinterpreted by visitors based on their personal experiences and interest. From beginning to end, the storyteller stimulates the audience's curiosity, uses analogy to facilitate comparison and offers insight about the chosen heritage.

Finally, this way of provoking emotions by the storyteller could be viewed as art made by combining the elements which compose the heritage landscape and the ability to narrate it as a poem. The talent of the narrator is to reveal cultural elements (scientific, historical, architectural, etc) based on their values for an overall understanding of the culture, and to display them fluidly as a song rather than a recipe (Pagano et al.; 2020).

2.4 Edutaining as a tool of engagement

"Edutainment" is a hybrid term which merges the concepts of education and entertainment. Some have defined edutainment purely through digital gamified lenses suggesting that it relies heavily on technology and an interactive format (Buckingham and Scanlon, 2000). However, edutaining can be explored in a number of ways utilizing different mediums and tools although the goal is usually the same: To catch learners' attention and offer personal development for users (Fossard, 2008).

Through the use of digital technology, end-users can engage and have edutaining experiences which are individualized so they can explore and learn content to the satisfaction of their unique needs. With a combination of animation, sound text, graphics and storytelling, computer technology can aid education in helping students to absorb complex knowledge by interacting and having fun (Makarius, 2017).

It is worth mentioning that the technology currently used for recreational video games with no educational purposes has been described as being similar to the technology being used for digital edutaining in general. Therefore, the field of serious Gamified Past Simulations (GPS) shares most of the challenges and potential opportunities with the best video games in the market which means they both have a symbiotic relation and walk a parallel path in terms of

evolution (Marsh, 2016). However, different to video games, serious games focus more on pedagogy making the player experience more accurate and appropriate for a learning process (O'Connor, Colreavy-Donelly and Dunwell, 2020).

This is not to say that the value of CH games is primarily derived from good graphics and high quality animations and sounds which can be attained using top-of-the-food-chain hardware and software. Instead, as important as these technologies are, they are only mediums and have to work in conjunction with high-level fidelity, usability and interactivity, not to mention meaning making storylines in order to produce maximum enjoyment and create engagement between the interface and end-users (Anderson et al., 2010).

Through explicit educational claims, digital Edutaining methods also have an unexpected benefit. Because it is both a way of learning and an opportunity to play, children as well as parents welcome the innovation, rendering it as a healthy activity through familiar and cultural lenses (Buckingham and Scanlon, 2000). The reason behind this is that all sides can clearly see that edutaining games are not only more engaging but also more memorable for end-users (Makarius, 2017).

Some critics, however, have put doubt in the idea that learning should be mixed with entertainment. According to their claims, learners who are exposed mainly to video games, multimedia mediums and gamified experiences might develop a narrow perspective towards learning itself which is tied to the idea that it should always be fun (Champion, 2016). Bloom and Hanych (2002) observe that if students only learn while having fun, they cannot progress on creating essential sets of skills such as study discipline, critical analysis, deep reflection, contemplation and deliberation. In other words, learning becomes a challenge for students to overcome, therefore, edutainment critics claim that the approach doesn't promote learning but rather a trivial and less meaningful activity.

Nevertheless, these challenges have not gone unnoticed and after a thorough investigation on the subject, some precaution is advised for creating and utilizing edutaining methods in a reliable and productive manner:

1- The edutainment technology or format has to be appropriate for the lesson corresponding with the learning goal.

2- Too much animation and features might become distracting.
3- Users have to be mindful of how much time they spend in digital edutainment. Too long might result in boredom or disinterest.
4- The content should be as personalized as possible so it is relatable.
5- Edutainment should create an environment where feedback is always welcomed and lessons are constantly applied in order to improve the experience.
(Makarius, 2017)

The overall impacts of edutaining on the development of skills relates to the effectiveness of the mediums and their relationship with established learning theories used to blend the "edu" portion of the equation with "taining". Therefore, edutaining represents an opportunity for educators of the 21st century to use game-based learning as a complement (rather than a substitute) to traditional methods to promote relevant skills as well as creativity (Qian & Clark, 2016).

The creation of an effective Edutaining content in VR implies being aware of certain challenges and opportunities for the benefit of the audience. Firstly, designers should be oriented toward the development of compelling narratives to engage audiences and trigger their interest (Bec et al., 2019). Moreover, to reach the primary goals, experiences must have a careful balance between "edu" and "taining" so users can develop deep learning skills while engaged into the virtual environment.

Intrinsic motivation by end-users is also required for effective learning, otherwise, if creators focus exclusively on extrinsic motivation, mainly orienting visitors to look for stimulation and entertainment the medium might generate frustration or unpredictable results (Okan, 2003).

Despite the aforementioned challenges, the ability to reinterpret history through a new medium is also an opportunity for new types of storytelling that display emotions differently and are complementary to the traditional learning process. These emotions create a bond in the knowledge sharing which occurs between teachers, students and their parents.

Although an effective way of engaging and transmitting knowledge, the principles of edutaning are still lacking research, especially in VR but it's potential is clear and as a concept it is evolving in parallel with new technologies.

2.5 Gamified Past Simulations (GPS)

In 2021, VR has become mainstream (Jerald, 2016). Anyone with 10USD in their pocket can buy a simple VR goggle and try out the technology with their smartphones (Soda PDF Blog, 2019). Academically, VR and immersive environments have reached lines of research applicable to scientific and educational spheres and the need for a new Information and Communication Theory (ICT) is becoming paramount to design and create new forms of representing content suitable for immersive experiences (Rubio-Tamayo, Barrio, & García, 2017).

Using gamified simulation for learning and doing business is not a new idea but with the fast advancement of VR, creators of GPS have struggled to define which aspects are the most important in order to create an experience meaningful enough to actually support deep learning and interpretation. Champion, (2015a) one of the pioneers and an undisputed authority in this type of study, suggests three main aspects of virtual worlds that help role-playing to have meaning:

Environmental Presence: Virtual worlds should allow participants freedom of choice and a multitude of possible paths. This is related to a feeling of richness of the experience since end-users feel they are in control of their own virtual life and have freewill which, in turn, reinforces en-users notion that what happens to them is their own doing rather than an unavoidable predestinate outcome.

Social Presence: Virtual worlds must present end-users with socially mobile structures which allow them to improve or lose status among characters. This is due to the fact that humans (as well as lobsters and many other animals) are hard-wired to track our own social position within an environment and having this dimension allows the brain to accept the experience as something plausible and natural.

Cultural Presence: Virtual worlds should allow us to influence and be influenced by tradition and rituals. This factor is more subtle but still very powerful. The capacity of end-users to learn will be directly influence by their feeling of societal structure and values which allow end-users to act as “curators of tradition” (Champion, 2015a pg.14)

Champion's (2015a) claims that these three dimensions of presence are powerful tools GPS creators should have in mind when developing experiences as they support virtual worlds to appear real and help to provide a sense meaning.

"With environmental presence the individual affects and is affected by the outside world. If there is social presence we affect others in a virtual world. If there is cultural presence we should be able to detect a distinctly situated sense of inhabitation, of social values and behaviors preserved and transmitted through ritual, artefact and inscription." (Champion, 2015a pg7)

GPS can also be seen as a kind of Game-Based Learning (GBL) tool which offers a perspective that complements the offer for touristic destinations. To effectively reach a large audience of satisfied users, GBL theory is based on 3 concepts: intrinsic motivation, play theory and problem solving. The importance of understanding GBL theory for GPS in touristic destinations lies in its leveraging power. Indeed, GBL offers a personalisation of the proposition by adjusting and adapting 3 factors for cultural heritage promotion depending on the time and needs (Adcock and Van Eck- Seel, 2012) .

Based on Vygotsky's (1978) work, learning is more efficient when it comes from a social approach supported by the Zone of Proximal Development (ZPD) (Vygotsky, 1978). The use of cultural agents displayed as tutors helps a deeper understanding and orientation through a simplification, as well as offering an historical and located context for the visitor (Champion, 2015b; Vygotsky, 1978). In the adult learning approach, self-directed learning is important to understand that they want to lead their learning, and here more than ever, the use of agents would support the learning through social context.

2.5.1 GPS content that works

Game and play are two concepts that have a close relationship, and can almost be viewed as pleonasm. The notion of GPS content can easily be related to ideas of leisure and amusement, but it can also be related to seriousness (Seel, 2012).

Designers wanting to create GPS that works, should focus on writing stories that are made with certain elements through a defined context which allows users to fill up gaps of perception and interpretation by themselves. The engagement is not only physical but also mental, where the ultimate goal is to provide tools that will allow each user to create their own perception/version of the experience (Jerald, 2016).

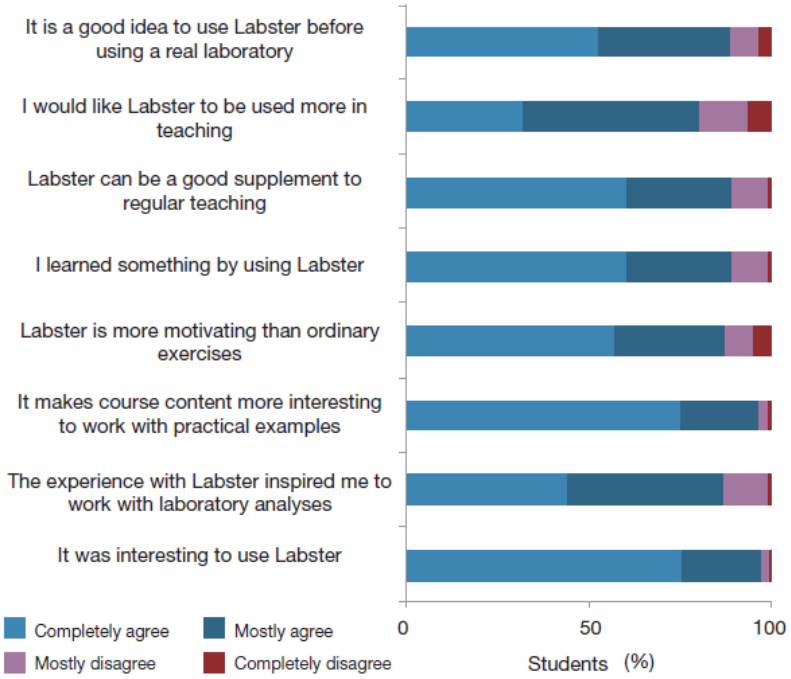
To accomplish that, the understanding of experiential fidelity is a major path to follow while crafting engaging storytelling for VR experiences. The experiential fidelity is an important factor to take in consideration as it allows to adjust what a VR content offers with the already existing beliefs users might have. Not only experiential fidelity will allow a better enjoyment of VR, but it will also reinforce the ability to trigger users' emotions and to let them appropriate the seriousness of the content through cognitives ressources (Aksal, 2015).

2.5.2 Gamified Simulations in education and business

Gamified Simulations have been used for education with success. Take the biotech industry, for example. It has been one of the first to include gamified simulations in the curriculum of assisting laboratory students and they had good reason for it. According to experts, the industry has a particular need for costly equipment as well as hazardous safety factors. Apart from that, gamified simulations allow students the possibility to explore unobservable phenomena and the chance of conducting a series of experiments in a short period of time (Bonde et al., 2014). As a result, educational games are frequently successfully used for learning biotech.

According to Bonde et al. (2014), “approximately 50% of students surveyed in physics classes found the subject “boring” or “very boring”” while “40 out of 41 students found laboratory simulations “interesting and relevant subject matter”” and 23 out of 41 found “more motivating than classroom or home wet labs” (Bonde et al., 2014, pg 3).

Figure 2 : Results from a research made by Bonde et al. (2014) on VR and Education



For businesses, on the other hand, VR signifies the possibility to represent situations and events which are sophisticated, expensive or even impossible in real life. It allows experimenting, discovering, understanding and engaging with things through a safe, simulated environment. From a purely business perspective, VR enables customers to get to know products by testing them without the need to fully commit financially. In the health industry, VR is used to a broad extend as the learning of skills for students or in the training for difficult/dangerous surgery (Javaid and Haleem, 2019)

To conclude, simulations in general and gamified simulations in particular, show plenty of potential to induce deep learning, save time and money as well as promote cultural heritage. As we've seen, the technology (software / hardware) is a paramount vector but not the main factor when recreating virtual experiences that work well. In order to achieve that, developers have to focus on the storytelling, meaning-making artifacts and the creations of complex virtual worlds that promote a multifaceted sense of presence as well as rich interactions.

2.6 Virtual Heritage

The aim of Virtual Heritage (VH) is often communicating CH elements via new media technology which entices visitors to engage (Affleck and Kvan, 2008). The definition of VH interpretation is still unclear and open (Jacobsen and Holden, 2007). Jacobsen and Holden (2007 p1) highlight the differences between the *what* and the *why* in VH: “While the main activity of Virtual Heritage is to create ancient artifacts, the real goal is to understand ancient cultures”.

Technology can clearly offer a sense of authenticity for the visitors by redefining the past, although it is important to distinguish two ways of representing it: recreation or reconstruction (Uzzell, 1994):

Recreation is defined as an attempt to objectively reproduce the past in a descriptive way, offering the ability to relive it “as it was” by staying accurate to scientific data and research. On the other hand, reconstruction is a subjective representation, with the goal of reproducing the past while using a contemporary vision. This disruptive approach doesn't try to be perfectly accurate, but offers more perspectives to reflect and to rely on (Rahamann, 2018; Uzzell, 1994).

The choice of using one over the other might be influenced by the location where the experience happens (Affleck and Kvan, 2008). For the 1677 Siege of Malmo experience (for example), an in-between approach utilizing elements of reconstruction as well as recreation facilitated overcoming budget and technology limitations. This was the case as the Castle itself (where the Museum of Malmo resides) already plays an important role in the notions of authenticity for the visitors. In VH interpretation, the concept of immersion is used to assist the cognitive process of engagement that triggers people's mental motivation to do things and to learn (Shin, 2018).

The two major aspects facilitated by VR in VH interpretation are the reproduction of tangible and intangible aspects.

Regarding the tangible, the reproduction of buildings, maps, artifacts, characters and other physical elements are related to what we can see directly. In parallel, VR has also demonstrated to be one of the best media to share intangible aspects of culture (Selmanović et al., 2020). The ability of exploring a place by being fully immersed, offers VR designers the possibility to trigger all the features from the technology. Intangibles are viewed as facial expressions, sounds, body and hand motions related to the specificity of a determined culture (Alivizatou-Barakou, Kitsikidis, et al, 2017).

3. Theoretical Framework

Defined by Rahaman, the framework developed for digital heritage interpretation is made to be oriented towards the relationship between the media (VR) and end-users. VR is a great tool to help visitors process their interpretation based on their experiences, abilities and beliefs (Rahaman and Kiang, 2011).

To begin with, the approach for translating CH into DH is guided by following 3 steps:
1- Documentation: collecting of data about both tangible and intangible aspects.
2- Global representation: the historical reconstruction through different senses (audio, vision, physical).
3- Dissemination: The way of communicating information through a new digital media. (Rahaman and Kiang, 2017).

These steps define the main characteristics of the heritage and will help crafting a multi-perspective experience (Rahaman and Kiang, 2011). From there, dialogue and interactions (between stakeholders) should be in the center of the creative process involving discussing with professionals and cultural experts first, and then presenting the result to a larger public audience in order to get feedback and improve upon the work.

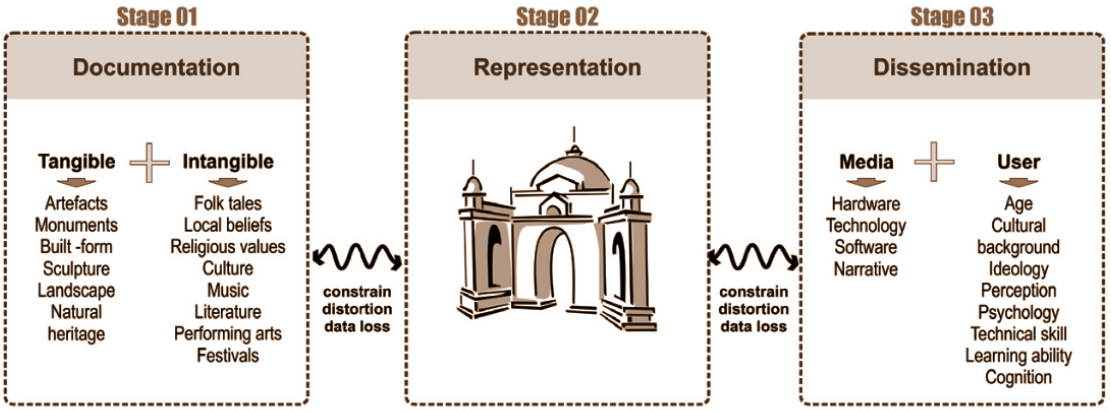


Figure 3 : Different stage of construction the digital heritage-end user relationship

From this approach, the role of technology into the process of digital interpretation is defined as a help to reach learning goals. Utilizing top-of-the-food-chain technology therefore, is not

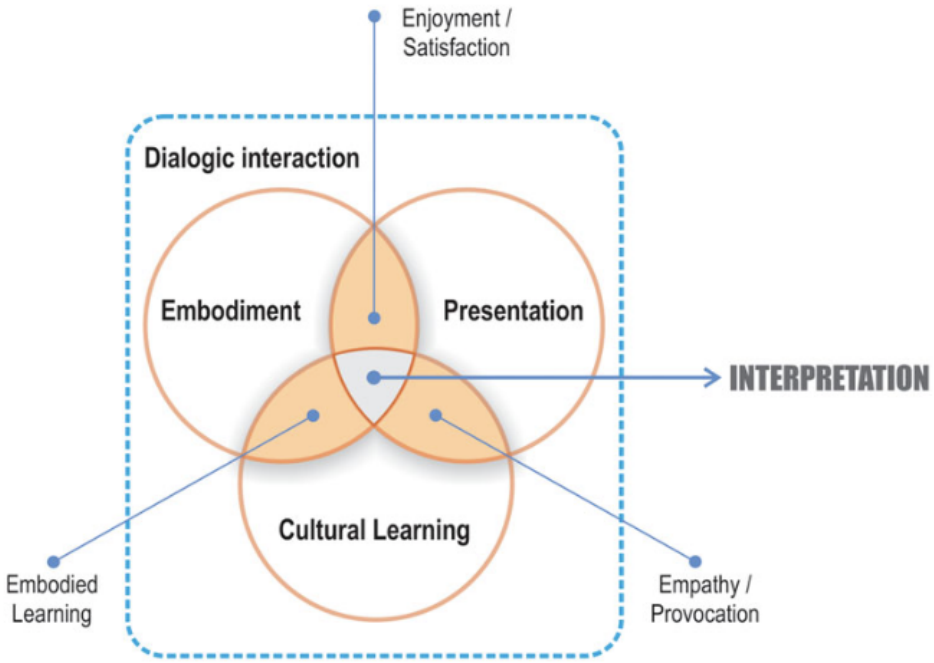
viewed as one of the main objectives, but rather as a support for expressing creativity as well as a vehicle for telling stories about the past. The art of using technology affects the global interpretation.

According to the literature, the most important goals of a DH experience are:
The satisfaction of user's interests through enjoyment: Satisfaction view through Rahaman's perspectives is about creating content that triggers end-users interest and stimulates their enjoyment.
The provocation (empathy) about the cultural heritage that stimulates the end-users' awareness: Provocation is the ability to encourage protective behavioral change towards heritage in terms of people, culture and location.
The learning by experiencing culture: Learning offers educational activities about the cultural aspect of the experience (Rahaman and Kiang, 2017).
Finally, the combination of these three aspects should produce a fourth one, which is both an aspect and a goal in the success of the experience. To give end users multiple perspectives of the past interpretation, which include alternatives in ways of understanding history avoiding the "linear interpretation": Multiple perspectives inspire creators of VH to offer a broader and different vision of it, seen by different angles to instigate deep learning which allows a more personalized interpretation (Rahaman, 2018).

These 4 aspects will be determinant in the construction of virtual heritage interpretation so achieving them will be dependent on the crafting process and the storytelling. Furthermore, the conceptual model highlighted by Rahaman suggests that achieving a comprehensive interpretation of digital heritage is based on a mix of 4 more key aspects:

- Effective presentation.
- Cultural learning.
- Embodied interactions.
- Dialogic Interpretation.

Figure 4 : Conceptual model for digital interpretation from Rahaman (2012)



Let's have a look on why each of these aspects are so crucial for a rich DH interpretation and how they can be applied on the creation of a new experience such as The 1677 Siege of Malmo:

- <u>Presentation:</u>

The way information is displayed by the narrator directs the interpretation that will be made by each visitor with principles emerging in order to ensure effective communication in the user experience (Rahaman and Kiang, 2017).
Visitors can be very different, with unique beliefs and backgrounds, so the narrator should propose an interpretation of the past that can be understood differently. That notion implies a more indirect approach in which the information is displayed and "up for grabs" but not necessarily formally presented/introduced by the narrator.

For the alchemy to be created with visitors, narrators should aim for a meaningful way of connecting their knowledge with visitors' own experience and use tools such as metaphors and analogies to convey ideas. To encourage participants to explore and engage in the VR experience it is necessary to create a novel that makes them go out of their comfort zone by requesting cognitive efforts to overcome challenges. The creation of conflicts and surprises in

the experiences increase mindfulness for visitors.
The technology is mainly used as a tool for emphasizing interpretation, and allows the creation of stimuli that are easily reliable to visitors' experiences. One key principle of technology is its ability to design intuitive content for the visitors to get oriented and navigate. Technology is also used to back up visitor's needs and interests through the ability of designers to propose different ways of exploring the past and creating challenges (360° videos, escape games, quests, etc...).

Finally, interpretation is a continual process that needs participation of multiple stakeholders with an interest in culture, so it is important to be open to new information and collective knowledge. Communicating about the past needs to consider a wide audience in a unique way that allows various interpretations (Rahaman, 2018).

- Cultural learning:

Learning is triggered when the internal willingness of the visitors to learn about the topic meets an offering interface that promotes the creation of relationships between visitors and the culture explored. This interface is crucial to display and influence visitor's perception of cultural values. Designers should aim not only to present them, but also to engage curiosity through self-exploration as this works in favor of a more personal interpretation of the culture.
Culture should be expressed through the display and creation of relationships/interactions with tangible or intangible cultural elements such as music, architecture, rituals or artefacts. Designers should encourage end-users to connect and communicate with these cultural elements by either sharing or collecting information, artefacts, and local knowledge (Rahaman and Kiang, 2017).
The giving of meaning to artefacts allow designers to influence the experience, and orient people's interpretation. Viewed as cultural agents, artefacts are the ambassadors of DH and facilitate the sharing of values.
In general, therefore, designers give even more meaning for the interpretation if self-exploration and self-discovery are promoted, allowing visitors to connect with what interests them by taking initiatives. This happens when visitors are given the freedom to explore their surroundings and discover new features previously overlooked. By doing that, they create a unique experience which is based on their own choices, enhancing their sense of

meaning.

- Embodied interaction:

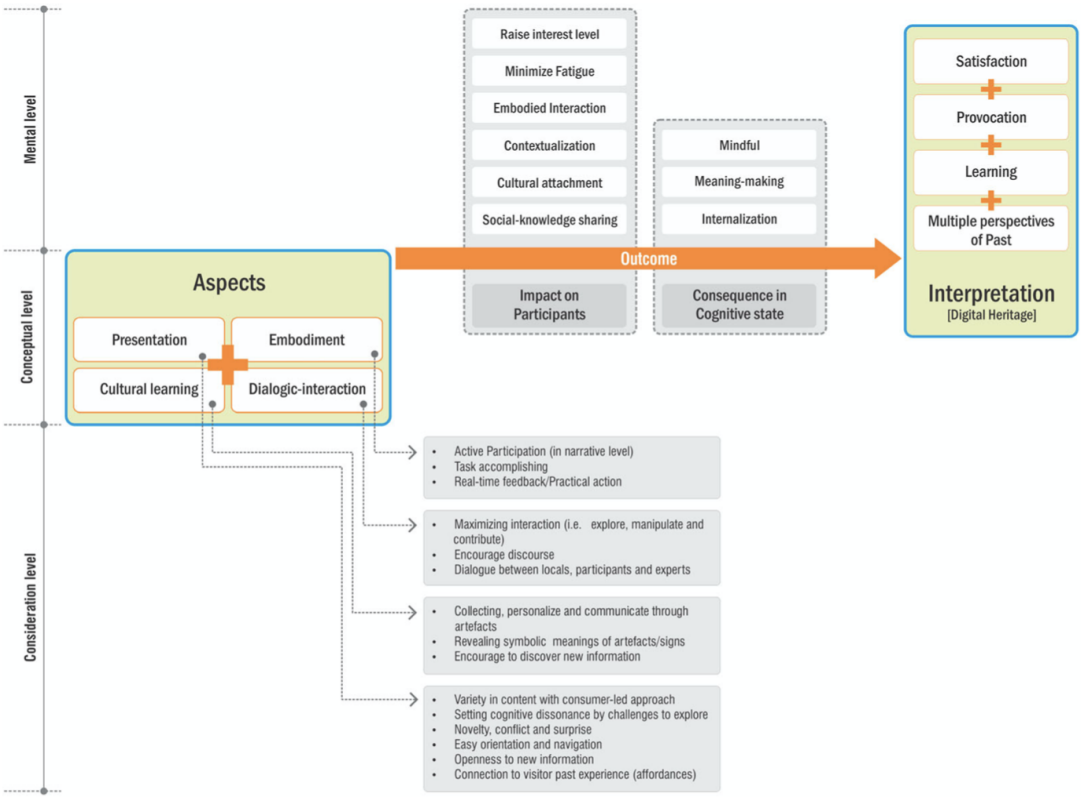
VR is considered a game-changer for both designers and end users, as all the experience gravitates around the player, which is no longer a viewer but a participant (Jerald, 2016). It offers designers the ability to leverage emotions and empathy by offering end-users freedom of action. That means that designers create the interpretation by offering possibilities of immersion, however, the end word belongs to the visitor, based on their idiosyncrasies (Shin, 2018).
These findings suggest that, to make the interpretation more meaningful, technology plays an important role as it ensures the possibility to offer real-time feedback, which are either practical or informational.

- Dialogic interaction:

Understanding interpretation as a process rather than a tool, highlights the important aspect of co-constructing VR experiences with different stakeholders. Involving participants through the entire process and always seeking further explanations, different opinions and to multiple ways of understanding the experience, allows for an integrating dialogic interaction.

In other words, co-designing the experience with end-users, locals and experts strengthens heritage interpretation by bringing more perspectives and content to it. It is important to facilitate this dialogue on and off the field and to maximize interactions from post-experiences feedback.

Figure 5 : Conceptual framework for interpreting digital heritage Rahaman (2012)



Rahaman's theoretical background (*Figure 5*) gives the research a clear path for the construction of a customised methodology which allowed the authors to gather relevant empirical data. Rahaman's framework helped to divide the investigation in pursuing answers for 4 interpretations indicators:

- Satisfaction
- Provocation
- Learning
- Multiple Perspectives

These indicators were used as guides for measuring the impact of the GPS experience on people's overall interpretation of digital Cultural Heritage.

Rahaman gives a step by step trail to follow which consists in firstly using the principles of data collection, global representation and dissemination (Rahaman and Kiang, 2017) for guiding the construction of the experience, followed by a specific investigation on the four indicators mentioned above to measure its effectiveness.

4. “The 1677 Siege of Malmo” experience

In order to test Rahaman’s framework and the applicability of the full content of this thesis’ literature review, the authors created a Gamified Past Simulation VR experience and ran it inside the Museum of Malmo for 15 days. Through partnerships and collaboration, it was possible to apply the principles of presentation, cultural learning and embodiment made in dialogic interactions to the creation so the experience would be a practical implementation of the theories previously discussed.

To begin with the design, the authors needed to choose a 3D landscape to display a historical fact and the ability to connect ideas through complex coding in virtual reality.

The researchers got the opportunity to recycle a great but discontinued project: Malmo 1692 (http://www.malmo1692.se/Sv/index.htm). This project was conceived primarily to allow visitors the ability to visualise Malmo as it was in 1692 when the architect of the Swedish King was ordered to do an official inventory of the city. The architect recorded and took impeccable notes of more than 3 000 houses and buildings, streets and places of interest as they were at the time. With access to this original document 3 archeologists and a small team of 3D designers recreated the city of Malmo in 3D, including all architectural details and street specifications.

Due to a professional fall-out, however, the map has never been used and it was “gathering dust” when the authors of this thesis finally managed to get access to it. This map was the basis for the creation process which was in itself, a respectable challenge.

4.1 Design requirements

Design requirements were developed with the main takeaways from the literature review as well as adapted to the museum’s needs and multiple stakeholder’s feedbacks. Current work with VR commonly highlights the lack of social interactions for visitors as a major setback for VR experiences to be successful (Shehade and Stylianou-Lambert, 2020). Despite having

designed a multiplayer experience, due to lack of budget for equipment and some technical difficulties, the authors had to settle for a single player experience in which visitors were fully immersed but alone.

Once the authors were granted access to the 1692 map, several steps needed to be taken in order to make it a viable VR platform. Firstly, authors needed to clearly define the educating goals and to design the storytelling around them.

Goals were:
- Offering insights about the siege of the city (a not very well known historical fact) and the Scanian war including the main political characters.
- Display a curious and fascinating historical fact: the hidden treasure.
- Offer a new perspective of how it was to live at that time.
- Entertain visitors through a good-natured atmosphere.
- Offering an accurate view of the city of Malmo as it was in 1677.

Once the goals were defined, it was important to pre-define a section of the city to place visitors since having the whole map would be technically unsustainable (due to latency) and practically not viable since visitors would have too much to explore in a short period of time. Thus, the map had to be converted to a 3D platform to be cropped and maximised. The experience therefore was decided to take place around Lilla Torg, the main market place at the time and still one of the most important tourist attractions of the city of Malmo.

The next stage was to research and select the historical artifacts to be displayed on the map. Through several exclusive visits at the Museum of Malmo, the authors chose to subdivide the artifacts chosen into 4 categories:

- Weaponry
- Cultural
- Historical
- Animals

Those were chosen for their specific historical value and to serve as parameters for measuring learning.

Because authors wanted to maximise the time available to run the experience in the museum and gather a large amount of empirical data, an estimated 10 - 15 minutes threshold was defined for each visitor to explore the VR map. This together with the use of "teleportation" was enough to give visitors time to explore the whole section of the city.
In parallel, in order to give the scenario substance and the feeling of the siege, authors determined that the experience would be complemented with carefully chosen sounds which gave the scenario a more dynamic and realistic feel.

Lastly, because the budget and time were so limited, after consulting with professionals from the VR world, the authors decided on an *Agile* approach which entails producing a minimum viable product to test the idea and slowly progress to more sophisticated versions. This meant that this initial experience was not as complex as they would have liked but had plenty of room for improvement.

4.2 Equipment Software/Hardware requirements

Developing the project with a limited budget was an opportunity for the authors to look for partnerships, open the doors to creativity and to think outside the box.

The main partner found to overcome budget issues was Ova (www.ova.ia), a Canadian company that offers creation of VR content through the software StellarX. The platform allows the design of VR experiences without the necessity to have developing and coding skills. The principal advantages to partnering with Ova were in terms of time and cost saving.

Authors used 3dsMax and Blender to import, modify and adapt the original 1692 map. This content needed a converter VRay to adapt textures and graphism to the 2022 version of 3dsMax as the original content was lastly updated in 2011. Furthermore, the exported FBX files were used in Blender, to be converted into a GLB/GLTF format which was compatible with StellarX requirements.

Some hardware requirements also needed to be fulfilled in order to run the experience without latency and to make it available for a large number of visitors to use it continuously

during 15 days. For that authors acquired a computer with an Intel i7 - 700 processor, memory of 16BG RAM and for the graphic NVIDIA GeForce GTX 1070.

On top of that, it was paramount to have HMDS of high quality so the authors opted for a HTC Vive Pro headset which includes 2 hand controllers.

4.3 Stakeholders

As it was clearly suggested by Rahaman (2018) the authors co-created the experience involving a number of stakeholders. Chief among them was the Museum of Malmo who granted the authors a prime space at the gate tower to host the experience. Not only that, but the Museum opened its doors before their official re-opening for the public following their Covid closure. That allowed the authors to check which artifacts were to be used, set up a back-office where interviews could be conducted, organize and put in place a robust Covid-friendly policy and strategy and get more familiarized with the past of the city of Malmo.

Authors also worked in partnership with the Venturi Lab who helped on the application for a 10K Sek grant which was successfully given and used to pay a professional 3d modeler who in turn, worked creating the historical artifacts and giving final touches on the map.

The VR lab of Lund was also a valuable contributor who received the authors and helped with technicalities and advice.

Independent consultants were activated through personal networks and through an array of contacts who connected the authors with specialists which were able to offer technical help and troubleshoot a number of glitches.

Another important support was given by the tourism office of the Region of Skane who not only helped networking with the aforementioned consultants but also reviewed plans, accessed the storyline and helped in the creation of the storyline. It is worth mentioning that the Region of Skane demonstrated interest in future partnerships.

Scholars and academics from Lund university were also contacted to review historical facts, design details and coherence of the story.

4.4 Storytelling

Arguably, the most creative and challenging part of the creation of the experience was the crafting of the storyline. The platform used (OVA) doesn't support Non-Player-Characters so it wasn't possible to populate the map with intractable characters. Instead, the authors used non-interactable characters positioned outside the reach of the players so they could be seen, making the whole scene more interesting and real. A background of human voices, animals (dogs, chicken and horses) were added to specific sections of the map to give life and dynamism as well as a medieval subtle soundtrack.

During the Siege, an old couple Anders Christensen and his wife Anne Aagesdaater buried a treasure in their backyard fearing a Danish takeover and the loss of their possessions. The couple died and the treasure was discovered during the 1800's after a dig to build a house in central Malmo. Because of the historical and aesthetic significance of the treasure, the authors decided to make it the main objective of players to find this treasure, which can be seen in real life at one of the museum's galleries.

Populated with indicators and artifacts, end-users had to explore and discover all of these artifacts which could be held in hand and played with so they would experience a range of emotions from fear to laughter.

The concepts of Edutaining underlined the story and while visitors engaged with the artifacts they discovered which kind of weapons were mostly used as well as getting in contact with daily common objects and custom made paintings of the main historical figures, the kings Cristian the V of Denmark and Charles XI of Sweden.

A study about Museum professionals highlights the importance of co-creating the experience to fit the museum's needs in order to fit in a digital strategy rather than just being a single

experience. The approach taken by the authors overcomes most of the main challenges highlighted by museum professionals as the lack of social interactions for visitors, the ability to augment the original content rather than replacing, and not interrupting the exhibition flow (Shehade and Stylianou-Lambert, 2020).

5.Methodology

5.1 Research Design

Combining quantitative with qualitative methods ensured a more deeper understanding of the effects of GPS in CH interpretation (the Why and the What) as utilizing both methods provides more comprehensive insights and enables contrasting results (Bryman, 2012).

The design, therefore, was composed of 4 stages:

-The first one was the fulfilment of Questionnaire 1 before participants went through the experience. Q1 asked basic demographics, a quiz, and questions about two indicators (Learning and Satisfaction).

-Questionnaire 2 was fulfilled immediately after participants had gone through the experience so the authors could have access to their fresh feelings and clear memory of the information just presented, without the effect of external biases. Q2 focused on all four indicators (Learning, Satisfaction, Provocation and Multiple Perspectives)

- Thirdly, through random sampling the authors asked 1 out of every 10 participants to be the subject of a 10 minutes semi-structured interview. All ethical considerations were verbally agreed and the interviews were recorded on mobile phones and then transcribed to a secure file. Interviews also focused on investigating all four indicators.

- Lastly, around 2 weeks after participants had taken part of the experience they received an email inviting them to fill in Questionnaire 3 (Q3) which was focused on measuring the retention of the information given as well as all 4 indicators.

For managing the logistics of these questionnaires the authors used Google survey as a reliable, professional and consistent way of gathering and storing answers.

The use of both qualitative and quantitative methods ensured that authors could complement the surveys with an in depth investigation on the effects the experience had on participants. Indeed it was through the combination of both methods that the authors managed to complement and gain a more clear picture of the full impact GPS has on participants.

5.2 Sampling

Following the chosen design method, authors aimed at a mixture of convenient and random sampling.

The quantitative study sample was conveniently composed of visitors of the Museum over the 15 days period in which the experience was held. From the 126 people who tried, the authors got 95 valid Q1 and Q2 questionnaires. Out of those, 24 also responded to Q3. From the 95 who took part and responded to Q1 and Q2, authors randomly invited 1 for each 10 participants, therefore conducting 10 semi-structured interviews in total.

Lastly, the researchers created 4 focus groups based on demographics to analyze and compare most of their replies. They were: a) visitors born in 1981 and before(17), b) visitors that were born in 2010 and after (18), c) visitors from Skane (48), and internationals visitors (28).

5.3 Aim of the research

The main aim of this research was to find the effects of GPS in CH interpretation by analyzing the 4 indicators of cultural heritage interpretation proposed by Rahaman.
The authors would also like to find out what unforeseen effects can arise when following the aforementioned literature when creating and hosting such experiences. For that, open questions were asked in the interview which were complemented by the authors' observations.

5.4 Quantitative

The Quantitative method is an interesting tool for this particular research as it helps to test hypotheses on a large and representative sample to have a global understanding. It is a low cost way of collecting a great amount of data, and the analyzing part is simpler as the answers are unambiguous and analyzed with software (Flick, 2019).

For respondents it is also pretty convenient as their anonymity is easy to secure and the questions are intuitive to understand and quick to answer. Quantitative surveys also overcome the geographical and sanitary context presented by the current COVID 19 situation as physical meetings are not mandatory.

This approach allowed the researchers to take maximum advantage of the relatively large number of people who answered the questionnaires, helping the research to have a general overview of the evolution of the different aspects of interpretation. Overall the approach was defined by the use of surveys to help understand behaviour and attitude from visitors towards GPS.

As the surveys were based on Rahaman's framework, the choice of quantitative is justified as it is the best way to measure the main effects made by the experience on visitors' interpretation, through clear and simplified questions (May, 2021).

5.5 Qualitative

The choice of complementing the research through the use of a qualitative element is justified by the approach's unique ability to focus on particular cases and differentiate the causes to the effects. By focusing on micro sociological context, the research could be measured at the same time as researchers reacted to the conversation with the subjects, recording and analyzing their emotions (Flick, 2019, May, 2021).

The specific reason to use semi-structured interviews is that it offers the best approach for accessing participants' true emotions and spontaneous reactions through their answers. In this case, the longer format communication was advantageous and happened in the context. Body

Language could also be evaluated, as well as clearer explanations could be given so the authors could construct a comprehensive picture when the answers were analyzed.

Being in a location with a context that was pertinent to the experience (inside the Museum of Malmo's castle) was a key advantage as it facilitated the crucial creation of an atmosphere of confidence between the authors and the participants (May, 2021). The authors could then understand how values were created and displayed. If the responses were more willing, it allowed a better understanding of the respondant's interpretation.

Participants could also use their own words to describe their feelings, and offer various points of views in comparison with the more rigid approach offered by structured interviews while at the same time being more organized and practical than the approach offered by unstructured interviews. It was also convenient, as the authors were looking to know more about the question, and obtain more knowledge about the issue (May, 2021).

Despite all these advantages, the process was less convenient and slower than the quantitative method. It also required more time to organize the transcripts and analyze the data. Indeed, the sample was smaller (only 10 participants out of 95 valid surveys) and people were less willing to accept answering. Nevertheless authors tried to be active, open for dialogue, accepting and trying to make the interviewee as comfortable as possible.

Finally, the qualitative approach allowed participants to provide insights and/or opinions beyond what the authors had predicted. That opened the scope of possibilities and allowed the research to be as unbiased as possible.

5.6 How data was analyzed

The breakdown of how data was analyzed:

1- For Learning, authors measured the progress with a quiz in each survey, and analyzed/compared the number of right answers obtained.
2- For Satisfaction, by creating a Likert scale, researchers aimed to gather data about

its evolution in terms of overall satisfaction.

3- For Provocation, measuring the central tendency was important, such as the willingness for people to pursue their own learning after the experience is measured and compared to what they actually reply 2 weeks later.

Also, dichotomous questions supported researchers to understand the percentage of people that shared the experience with others such as friends or family. Finally, provocation can be studied through the amount of people who shared contents about this experience on social media.

4- For Multiple Perspectives, the authors measured through dichotomous questions about their current perceptions of the past, if they had changed their ideas and if they had acquired a new perspective of the 1677 Siege.

5.7 Ethics

During this Master Thesis ethics was considered a fundamental part of the research design and the concepts were in the forefront of all planning and executing. This was especially the case because researchers came close to interviewees' private lives and perhaps touched upon sensitive issues surrounding themselves and society as a whole (Flick et al., 2004).

The need for a solid ethical basis in the qualitative part of the research was put in practice as the authors were aiming at a high level of transparency and strong credibility to generate trustworthy results (Bryman, 2012). To make sure the relationship between the authors and participants were handled in a straightforward manner, interviewees were informed beforehand of the aims of the study and their contribution (Brinkmann & Kvale, 2015). They were also informed that they were being recorded and guaranteed their right to withdraw at any stage, even after the interviews were finished. Giving them the opportunity to take breaks and speak off-the-record also helped our interviewees to feel reassured.

Considering the different cultures of our subjects was also important in order to better understand how they might have different values affecting the way they understand and feel empowered to use their right to withdraw (May, Tim. 2011) so the authors were mindful to calmly ask if they understood their own rights before and after the interview.

In order to avoid invasion of privacy and deception, during the semi-structured interviews, authors had a clear guideline about the subject inquired, a list of questions and a clock so the interviews would not exceed the estimated time. This was done by only working around the questions prepared and making sure participants did not deviate too far off-topic.

With concern to protect participants and their social relations, all interviews respected their right of anonymity and all the recording was kept safe so the authors could avoid misrepresenting the subjects or gather any sensitive material they would not feel comfortable with. In parallel, participant's contact information was used for the single purpose of sending the 3rd questionnaire 2 weeks after their visit.

In conclusion, all participants were given the explicit right to withdraw at any time, the chance to ask as many questions as they wanted and the authors were careful not to deceive or mislead interviewees while giving them the right to anonymity and being careful with how we structured the whole process (Flick et al., 2004).

6. Analysis

6.1 Quantitative

The study reached 126 people. Of those, 95 visitors, 60 males and 35 females completed and returned valid questionnaires 1 and 2. Out of the 95 valid population, 59 provided valid email addresses for sending questionnaire 3 but only 24 replied. The authors also conducted 10 valid semi-structured interviews.

The population of this research was born between 1956 and 2013 and has a median year of birth of 1997. In terms of general demographics the studie had 17 visitors born in 1981 and before (40 years old and plus), 18 born in 2010 and after (less than 12 years old) and the remaining 60 in between those age groups.
Geographically, 48% of the people who replied to the first two questionnaires (Q1 & Q2) are living in the region Skane, 32% are internationals and the remaining 20% live in Sweden but outside the region of Skane.

For 83% of the visitors, it was their first time trying VR. The majority of visitors 66% approached the experience with the goals of learning and having fun at the same time, 25% just wanted to have fun and 7% came primarily with learning objectives.

6.1.1 Learning

Figure 6 : Detailed results from the Quizz : Q1 and Q2 on 95 visitors of the experience, and numbers of the change between Q1 and Q2

First name	Q4	Q5	Q6	Q7	Q4	Q5	Q6	Q7	Good	Good	DK	DK	Wrong	Wrong	G to X	X to G	G to G	X to X	DN to X	DN to G	G to DN	X to DN	DN to DN
Total									**134**	**220**	**131**	**63**	**115**	**97**	**14**	**56**	**115**	**50**	**33**	**49**	**5**	**9**	**49**
Christoffer	X	DN	X	DN	X	G	DN	DN	0	1	2	2	2	1	0	0	0	1	0	1	0	1	1
Linus	X	G	X	X	X	G	DN	X	1	1	0	1	3	2	0	0	1	2	0	0	0	1	0
Stina	G	G	G	G	G	G	G	G	4	4	0	0	0	0	0	0	4	0	0	0	0	0	0
Isabella	X	G	G	G	X	G	X	G	3	2	0	0	1	2	1	0	2	1	0	0	0	0	0
Sasha	DN	G	DN	G	DN	G	X	DN	2	1	2	2	0	1	0	0	1	0	1	0	1	0	1
Niklas	G	G	G	G	G	G	G	G	4	4	0	0	0	0	0	0	4	0	0	0	0	0	0
Martin	DN	G	X	DN	X	G	G	DN	1	2	2	1	1	1	0	1	1	0	1	0	0	0	1
Pan Yaomao	X	G	X	G	X	G	G	DN	2	2	0	1	2	1	0	1	1	1	0	0	1	0	0
David	DN	DN	DN	DN	G	G	G	DN	0	3	4	1	0	0	0	0	0	0	0	3	0	0	1
Prab	X	G	X	G	G	G	G	G	2	4	0	0	2	0	0	2	2	0	0	0	0	0	0
Joel	X	G	G	X	X	G	G	G	2	3	0	0	2	1	0	1	2	1	0	0	0	0	0
ove Anderberg	X	G	G	X	X	G	G	G	2	3	0	0	2	1	0	1	2	1	0	0	0	0	0
Kak Roberts	X	G	G	X	DN	DN	X	X	2	0	0	2	2	2	1	0	0	1	0	0	1	1	0
Mina	X	G	G	G	X	G	G	X	3	2	0	0	1	2	1	0	2	1	0	0	0	0	0
Klara	DN	DN	DN	DN	X	G	G	G	0	3	4	0	0	1	0	0	0	0	1	3	0	0	0
Mans	DN	G	DN	X	DN	G	DN	X	1	1	2	2	1	1	0	0	1	1	0	0	0	0	2
Simon	X	G	X	DN	G	G	X	DN	1	2	1	1	2	1	0	1	1	1	0	0	0	0	1
Anton	DN	G	X	DN	G	G	X	DN	1	2	2	1	1	1	0	0	1	1	0	1	0	0	1
Deborah	DN	DN	DN	DN	DN	DN	DN	DN	0	0	4	4	0	0	0	0	0	0	0	0	0	0	4
Andreas	G	G	DN	DN	X	G	G	G	2	3	2	0	0	1	1	0	1	0	0	2	0	0	0
Gerwais	DN	DN	DN	DN	X	G	G	X	0	2	4	0	0	2	0	0	0	0	2	2	0	0	0

The quantitative learning section for understanding the cultural heritage interpretation has been made through the analysis of the aforementioned quiz which posed 4 similar questions on Q1 and Q2 (Figure). All the answers of the quizz were contained within the Siege of Malmo 1667 experience.

The quiz revealed in the Q1 that 35% (134) of right answers (“Good” or “G”) were found, 35% (131) of “don’t know” (“DK” or “DN”) and 30% (115) of wrong answers (“Wrong” or “X”). After going through the experience, on the other hand, Q2 revealed 58% (220) of right answers, 17% (63) of “don’t know” and 25% (97) were wrong.

Furthermore, it is noteworthy to say that the percentage of people who gave 3 or 4 right answers went from 16% (15) in Q1 to 44% (42) in Q2 (Figure with all numbers).
The quiz also revealed that 44% of answers in Q1 have changed in Q2. Following this finding, 27% (105) of the answers that were “don’t know” (49) or wrong (56) in Q1 became right in Q2. Similarly, 12% (47) of answers that were either “right” (14) or “don’t know” (33) in Q1 became wrong in Q2.

The authors found interesting comparing two age groups in particular: One composed of people born in 1981 and before (17 visitors) and the other of people born in 2010 and after (18). This way, they could clearly analyze the difference between the younger and older generations who tried the experience and explore how that could relate with what they observed in person.

People born in 1981 and before had an increase of right answers from 51% (Q1) to 65% (Q2). Surprisingly, the number of wrong answers also increased between Q1 and Q2; going from 20% to 25%.

For the group of people born after 2010, the number of right answers went from 36% to 44% while wrong answers dropped from 33% to 25%. These results could be explained by the fact that the older generation knew more about the culture and the history of Malmo, but the youngest seems to be more willing to use VR more proficiently and make the most of the learning opportunity. Another interesting difference is the fact that adults always replied to the questions, and took the risk of being wrong: for them, only 10% of previous "don't know" answers in Q2 remained the same while the younger generation had a much higher number 31%.

When comparing learning between locals and internationals, the authors found less right answers in both the Q1 and Q2 for the internationals when comparing to locals but both groups had significant improvement in right answers. Internationals went from 24% to 55% while locals went from 43% to 59%.

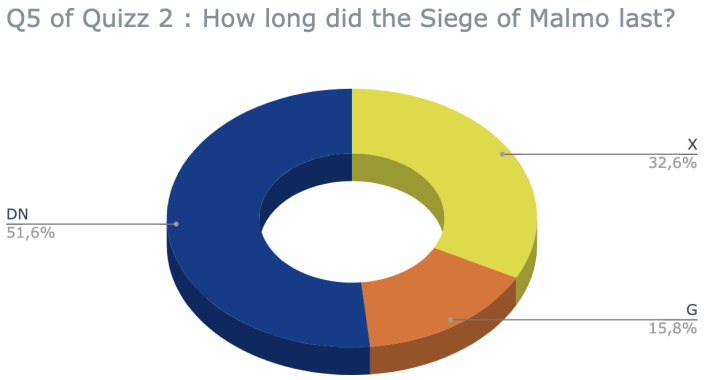
Taking the global population of participants, most of the visitors said that the main theme of the experience was a visit to the ancient Malmo (50/95), the siege was in second place (25/95) and thirdly the treasure (16/95). However, age group analyze shows that the younger generation see the experience as a treasure quest (8/18) as much as a visit (8/18) when the oldest viewed it more as a visit (9/17), then a siege (4/17) or a treasure hunt (3/17). Therefore, it could be said that the sense of game and the desire to play is emphasized by the younger generation who are more triggered by the treasure hunt than the older one.

In Q3, the visitors replied with 65% of right answers, 28% of wrong answers and 7% of "I don't know". Proportionally, there was no improvement in the number of right answers, as 9% of right answers became wrong and only 6% of wrong became right. However, the retention of the information conveyed was confirmed. Finally, 15% of wrong answers stayed wrong.

A final question about a subject not previously mentioned (how long did the Siege of Malmo last?) was added in the Q2 so the authors could assess learning of something not previously mentioned. For that particular question, authors found a high percentage of wrong (31/95)

and “don’t know” answers (49/95) when compared to the remaining questions previously mentioned on Q1.

Figure 7 : Percentage of answers on the Question 5 of the second quizz



In Q3, this question has been very equally answered as 33% were right, 33% didn’t know and 33% were wrong.

6.1.2 Satisfaction

For visitors, this experience is a great supplement to the overall museum’s exhibition, as 66%(63/95) rate is 5/5 and 28%(27/95) give 4/5. The 4 different study groups got similar results, obtaining 5 as a median for all of them.

Figure 8 : Percentage of the first likert-scale question on satisfaction of quizz 2 on 95 visitors

The majority of the visitors, 53% (50/95), found the experience unique and informative, 25% (24/95) gave 4/5 and 20% (19/95) stayed neutral by giving 3/5. In a similar way, 49% (47/95) of the visitor's gave 5/5 on the fact that the experience was more motivating than the other experiences, 32% (4/5) gave 4/5 and 16% (15/95) gave 3/5. For these two other satisfaction questions, results are similar to the overall answers of visitors for all the groups.

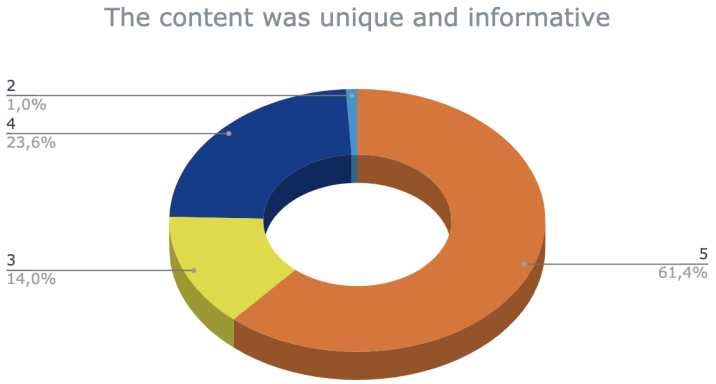


Figure 9 : Percentage of the second likert-scale question on satisfaction of quizz 2 on 95 visitors

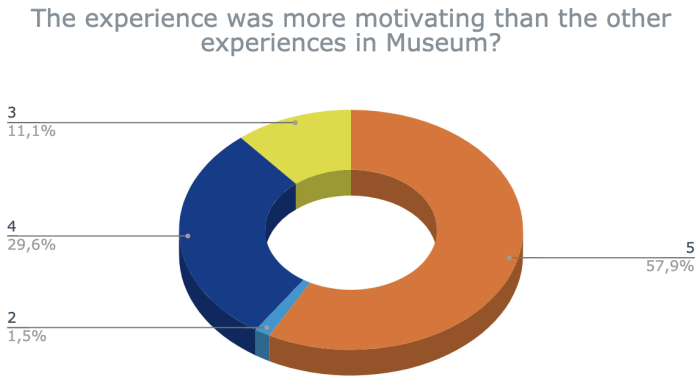


Figure 10 : Percentage of the third likert-scale question on satisfaction of quizz 2 on 95 visitors

More heterogeneous answers have been found for the questions regarding the level of interest created by the treasure hunt and the possibility to have the experience as multiplayer. The audience did not get similar interest in finding the treasure as 35% (33/95) gave 5/5 and

31%(29/95) gave 3/5, 22% (21/95) gave 4/4 and 11% (10/95) scored 2/5. Interestingly, the older group is mainly neutral on this question, with 53% (9/17).

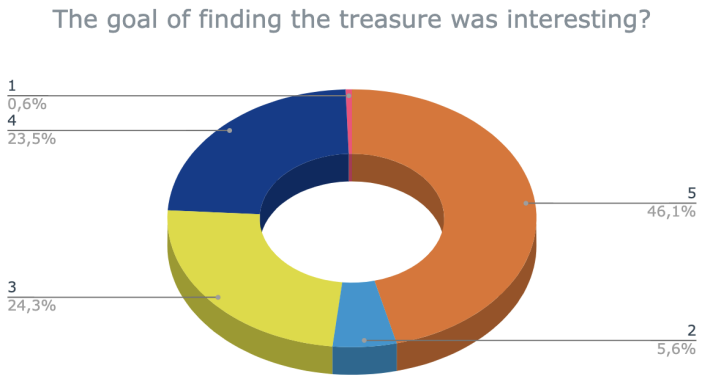


Figure 11 : Percentage of the fourth likert-scale question on satisfaction of quizz 2 on 95 visitors

Finally, the most heterogeneous answers came while asking if they would rather have the experience with another person (multiplayer). 42% (40/95) extremely agree by rating 5/5, 27% (26/95) are neutral by rating ⅗, 15% (14/95) rate it ⅘ and 12%(11/95) extremely disagree by rating ⅕. The median is 4. Similarly to the previous question, the older generation is not as enthusiastic as the rest of participants, where most of the replies are neutral as well as the median.

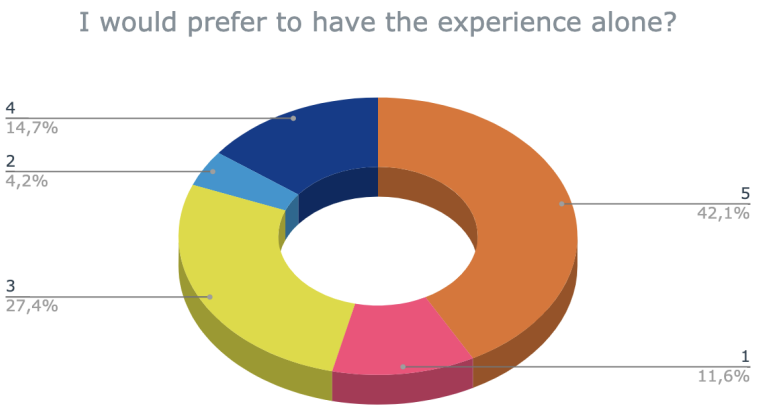


Figure 12 : Percentage of the fifth likert-scale question on satisfaction of quizz 2 on 95 visitors

The Q3, that was replied 15 days later reveals that 87% believes that the experience was a good supplement for the visit of the museums with 42%(10/24) of people that ranked 5/5 and 46%(11/24) (Figure)

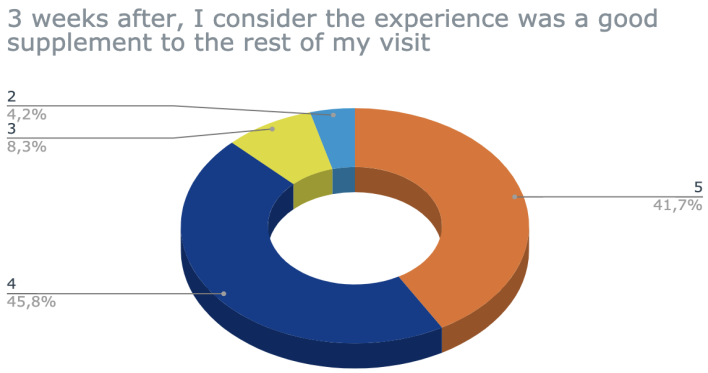


Figure 13 : Percentage of the first likert-scale question on satisfaction of the third quizz on 95 visitors

Further, the experience can be considered as satisfying as 92% (22/24) of the participants talked about the experience to their friends or family members, even if only 17% (4/24) shared their feelings/pictures of the experience on social media. It is important to remember that no communication has been pushed on social media or on site, where people were allowed to take pictures only with their own camera, if they wished.

The research also explored demographic characteristics against Satisfaction's indicators. Concerning the 78 visitors who never played VR, the highest degree of satisfaction was reached to approximately 80% (obtaining a score of either "4 or 5") for the experience, being a good supplement of culture (94%), being unique and innovative (80%) and for being more motivating than others exposition (81%). However, even if they have never played through this new media, visitor's expressed a lack of complexity in the treasure hunt objective by scoring "3 and less" at 45% (35/78) which probably affects their overall satisfaction. For the

same group of answers, the same results appear (38%) to participants who already played VR. Finally, a majority of visitors that are trying VR for the first time would be more likely to share the experience in person or social media 54% (42/78).

6.1.3 Provocation

The evaluation of the provocative effect of the experience on people's behaviour regarding the heritage has been evaluated through an interval ratio scale.

The first question relative to further involvement and possible investigations about the Siege of Malmo shows that 44% (42/95) of the visitors agree with that statement. 15% (14/95) highly agree, 29% (28/95) stay neutral and 11% disagree or highly disagree with it. The most common answer for the youngest generation is neutral (8/18), even if 6/18 agree and 3/18 highly agree. The oldest generation agree even more with 5/17 that agree and the same number that highly agree, while 6/17 stayed neutral. Locals are more neutral with 37% (18/48), 35% (17/48) agree and 15% highly agree, even if the disagreement is also higher than the average 13% (6/48). The internationals have a percentage of agreement superior to the average with 54% (15/28) and high agreement at 14% (4/28), however there are less neutral 18% (5/28).

The second question measuring provocation was related to visitors' intentions of going to the old citadel of Malmo where the experience took place. Most of the visitors either agree 60% (57/95) or highly agree 18%(17/95), and 12% stay neutral when 10% either disagree or highly disagree (9/95). The youngest and the internationals have a relatively similar percentage than the average with a combined agreement of 78% (66% agree and 12% High agree).

However, the average is slightly lower for the oldest generation 64% and the locals 67%, which are more neutral on this topic.

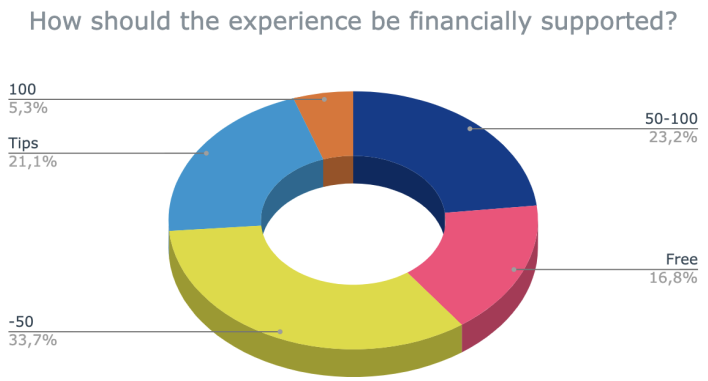
15 days later, 25%(6/24) admit they have been doing further research on the topic, while 75% (18/24) did not. Accordingly to the previous reply from Q2, going to the citadel once the experience is over is an activity that almost half of the visitors do to complete this cultural trip as 46% (11/24) went to Lila Torg. However, this experience has not really triggered

people to look for similar experiences as only 12% (3/24) looked for new VR experiences to try in the next two weeks.

The final question was about finance, and visitors' willingness to provide financial support to this kind of business. Following the most common answers, visitors are willing to pay for this experience, less than 50sek (5€) for 34%(32/95) of visitors, between 50Sek(5€) and 100Sek(10€) for 23%(22/95), and 20% (21/95) by donation only (tips). 17%(16/95) would like to have it included in their entrance ticket and for free.

The study of different groups highlight interesting stats such as 44% of kids (8/18) would like it for free. 43%(12/18) of the internationals and 37% (18/48) of locals are majoritary willing to pay less than 50 Sek for it.

Figure 14 : Responses from the financial question of questionnaire 2 on 95 visitors



6.1.4 Multiple perspective

In Q2, multiple perspectives as an indicator of interpretation has been studied through the ability of the experience to offer a new perspective of the past of Malmo. 86%(82/95) of the visitors replied positively, this rate of answers is similar for each of the groups. The rate is similar 15 days later, with 88%(21/24) of people finding this experience as a way to have a new perspective.

The researchers looked to find if there was a need for visitors to have a specific Danish perspective (the country fighting against Sweden in 1677) and 55% of the studied populations did not feel the need for it, even if 50% (9/18) of the youngest generation and the local (24/48) wanted it.

The ability of GPS to offer a new and complementary perspective is obvious, and expresses the change that VR as a media brings to museums. It seems that the younger generation as well as locals, which are more concerned with heritage, would be more willing to have both sides to get a better understanding of the past.

6.2 Qualitative

As part of the empirical data collection the authors conducted 10 random interviews which were recorded, transcribed and analized. The goal of these interviews was to get more closely involved with the participants of the experience so they could be questioned in a semi-structured manner and their answers, once transcribed, could be analyzed (Flick, 2019).

As mentioned in the Ethics chapter, interviewees were fully informed that they would be recorded and about their right of withdrawal at any time. Once the semi-structured interviews were underway, the authors asked 5 questions which analysis is as follows:

Q1- What was your favourite interactive artefact and why?

Aimed at measuring Satisfaction, the results were varied but the medieval sword was the most liked object and the reasons were very similar. The sword is an unusual but very well known object which is characteristic of the period and representative of war. These two characteristics seemed to address the idea of edutaining particularly well as in one artifact participants could learn and have fun. Also, the chicken and the apples were very appreciated by visitors as they represented fun and entertainment in the experience. The fact that visitors could hold all of those objects and throw them around or into a basket triggered people's attention and sense of play.

“The sword because it was interesting to handle a sword… normally we can’t do that in real life so it was very interesting.”

“Well… The apples because it was a challenge to hit the target and was fun to play with.”

Q2- Did the experience change your notion of how life in Malmo was in the 1600s?

Aimed at measuring Multiple Perspectives this question received a mixed response. 50% of participants said no while the other 50% said yes. However, as a community, all interviewees said they appreciated being able to see and be around the old city and enjoy it’s architecture.

“The best part was to see the architecture “live”.”

“No it didn’t but it was nice to see the environment as it was.”

“Yes...it was really good to be able to see it and explore the landscape in person. The architecture looks very good and feels realistic.”

Q3- What did you learn during the experience?

An open question which was used to measure learning from the participants' subjective understanding. The researchers received a mix of answers. The most common was regarding the architecture and how the city used to look like, followed by participants claiming they learned about history and the siege.

Some interesting answers, however, deserve closer inspection. One participant said:

“ ... mainly I learned about the potential of VR. This was my first VR experience … so I can only imagine what the future will bring.”

This answer points out that the experience itself was only part of the entertainment as perceived by the authors. Another interesting observation which was captured by this participant’s answer is the excitement and anticipation for using the technology and touching the controllers and goggles.

Q4- This experience was co-created with locals who gave us ideas and feedback. If we were to do something similar where you live, how interested would you be to get involved?

Question number four addresses the issue of provocation and is designed to enquire how likely to get involved on similar projects the public would be. All our interviewees gave us a positive answer with varying degrees of enthusiasm and justification. The most common was the idea that they would like to get involved because they found VR and this kind of experience as promising and an inevitable evolution of current exhibitions.

“Yes, of course. I think this is very interesting and would be great to help take the next step.”

“I think “yes” because it seems to be in tune with the future. My son is 14 now and for him and everyone around his age would be very cool. These kids don’t read books so it would be great to have this.”

Q5- What other (if any) effects did the experience have on you?

The last question was formulated as an open question so participants could give the authors more insight into any effects the authors didn’t foresee or predict. Most of the answers were not too creative. Participants said they wanted to have fun or that they felt excitement. The biggest nugget of new insight was the use of the word “curiosity” which relates to a sense of human discovery which unfortunately is seldom seen in adults.

“I was curious. I really wanted to do it. It was cool not to know what to expect and suddenly be there.”

7- Discussion

7.1 Learning

Those results show how important it is for end-users to start the experience prepared to seek specific information or content.

Following the large number of answers that change between Q1 and Q2, learning is sensitive to the communication approach and the way information is displayed. The principal learning

points come out of visualisation either from the architecture, or cultural agents and cultural indicators.

Those cultural agents are a great way to promote learning through entertainment, but also to trigger attention and interest. However, the authors lacked the ability to create more interest through the information panels that were displayed strategically inside the map. As reported by visitors, there is a strong need to correlate the visualisation with the audio in order to create more context and proximity between the story and visitors.

Furthermore, results show that an efficient way of learning is to not simply go and explore, but rather be aware of the main topics before getting into the cultural experience. In this case, the experience did not emphasize or highlight the specific information that was related to the quizz, which brought confusions/mistakes in visitors' surveys and minds.

This thesis has found that visitors are led to a better understanding of CH when they are made aware of the context and given cues to what to do and what to search for once inside the GPS. Exploration seems to be viewed as entertainment, when seeking specific information is an activity that stimulates learning. Supporting this theory, Question 5 of quiz 2 shows that subjects or specific themes are not always remembered or seen as significant if participants do not receive a specific request to look for beforehand.

In addition, demographically speaking, groups are not equally efficient in their use of technology, and some demand much more time and require more focus for exploring GPS. Older generations or internationals seem more affected by the lack of guidance towards key information, which reduces their learning ability through time. It is even more important as the older generation sees this experience as a visit rather than a siege or a treasure.

On the other hand, the younger generation which perceived the experience mainly as a treasure hunt, is more game oriented pushed by their desire to play and much more comfortable with the technology. They are willing to use their ability to get easily into the experience to increase their knowledge and correct their mistakes faster than adults. Then, they can keep exploring the map while playing a game through the treasure hunt.

Not allowing the visitors to have a correction of their quizz, negatively affects the learning of the cultural heritage via the lack of emphasis and awareness on key information. Their learning was too broad and not specific enough.

7.2 Satisfaction

For the satisfaction indicators, researchers found GPS is an excellent and innovative tool for improving people's global satisfaction about CH. It fulfills the gap often sought by museums, related to the ability to motivate visitors to interact with culture through a unique perspective/story relative to their current collections and history.

The interviews specifically highlighted the importance of interacting with artefacts that are familiar but also interesting and rare as that triggers their curiosity and sense of the experience “being worth it”. Most of the people enjoy these artifacts as they play and have fun in a way they could not do with the majority of historical exhibits in real life, leading the way for them to also learn.

As most people were interested in having fun and learning, or simply having fun, the playful aspect of GPS seems to improve in the overall museum experience. However, to reach a high satisfaction rate, the storytelling offered via GPS is the most important, and technology does not overcome the primary need of creating good storytelling to satisfy visitors.

In the case of the Malmo 1677 experience, the lack of complexity into the design of a meaningful treasure hunt, with possibility of interaction between characters, and the presence of a talented narrator affected the satisfaction of some visitors.

Using VR simulations is a tool for museums to promote their place as being a social venue to discover and explore culture as well as a place for technological innovations and enthusiastic discovery. It also seems that designing GPS suitable for multiplayer use is beneficial for visitors to create more powerful memories as they share their experiences with others.

7.3 Provocation

The results on the author's investigation of provocation are interesting as they show the effect of GPS on the ability to trigger curiosity. International visitors are more willing to pursue their learning and cultural experience once the experience is over.

The findings point out that provocation was more effective on the population that didn't know much about the culture or are more willing to learn. Locals and older visitors had less interest in visiting familiar places, and the experience acted more as a new perspective on the cultural heritage rather than provoking an interest.

The financial support of this experience on CH reveals a need and a willingness from visitors to pay for VR experiences. Viewed as a supplement for the existing exhibitions, VR experiences appear to be a new way for museums to provoke people's empathy via a new media.

As previous researches claimed, those gamified VR experiences are another solution for museums to make profit and to improve their image (Shehade and Stylianou-Lambert, 2020). It is also clear that the majority of kids wanted the experience free of charge, which could be interpreted as higher normative expectations from new generations.

GPS is an interesting way to provoke people's behaviour toward CH as it can not only push people to visit the actual venue where the experience took place, but also contribute to its finance.

Finally, the novelty of the content as well as VR as a new media triggered people to get involved in designing similar experiences that would be relevant for their local heritage. For locals, it is viewed as a relevant media to span and link generations. Further, by anticipating the digital way of sharing local stories about the heritage, VR designers can easily count on the voluntariness of communities to tell stories of yesterday through the technology of tomorrow.

7.4 Multiple perspectives

This experience confirms previous research made on the ability of VR to offer a new perspective of the historical heritage of Denmark and Sweden (Shehade and Stylianou-Lambert, 2020). However, for GPS, offering all perspectives in a single experience is not a real need for visitors as long as they offer a visual perception of the venue through architecture.

To distinguish between an ideal outcome for these types of GPS experiences and the reality of creating something useful has been difficult for the authors. Some audiences appreciated understanding the context and the reason for the situation as a whole but, there will always be room for improvement and increased sophistication.

One of the ways creators can do this is by providing different avatars for participants to “become”. Each avatar can have an unique objective correlated to their perspectives allowing visitors to see both sides of a conflict (for example).

8. Limitations

This has been an extensive thesis and inevitably, there were considerable limitations. Firstly there is the possibility of subjective bias since the collection of literature was conducted from the researchers' understanding of VR, CH and DH interpretation and the field is in itself quite divided.

More specifically, the framework by Rahaman and the 4 indicators used to measure outcome are comprehensive but not 100% complete. The researchers stayed broad on the topic and applied the first and unique theory about cultural heritage interpretation to the experience they created in parallel (Rahaman, 2018). It is clear that the research did not explore other indicators in depth and it could be argued that each indicator could be further explored. Further research should be done by focusing simply on one specific concept (or indicators) which can help finding relationships between demographic criterias and indicators' variables.

Technological limitations :
The use of digital technology has been widely used in this research, both in the designing of the experience and in the data collection.
In the experience design, the experience was only solo player as it was very complex to find and implement a second performing computer, which did not allow the research to compare the experience in a multiplayer mode versus one player mode.
The experience has to be run with wire-goggles connected to the computer, which must require one of the researchers to take care of the visitor. Then, the researcher gives external feedback to the visitor, and at some points, breaks the sense of presence. On the contrary, it was also a positive limitation as for many of the respondents, it was their first time using this media. Researchers also guide the visitors in their quest of the treasure, and overcome some problems of orientations and storytelling. The quest could have been biais as visitors were helped in their exploration, however none of the answers of the quizz has been revealed to any visitors at any moments.
It was also the first time for the researchers/designers to make a VR experience, which

include some limitations in the interactivity of the game as well as some computer bugs in the use of the plateforme.
Further, the experience was made in english, and some visitors of the younger generations couldn't read and understand some notes that would help them correct their mistakes, while all the adults spoke english. Finally, due to technicality issues, the precise location of the treasure has not been able to be reproduced but the whole storytelling as well as the information offered in the experience are accurate.

For the questionnaire, researchers faced a serious difference of responses between the Q2 that was made on site, and the 3rd that was sent by email two weeks later. First, a lot of emails could not be sent as they were either not written properly or did not exist. Analyzing visitors' answers a few weeks later after the experience seems to be a relevant approach in the interpretation analysis, however the way to conduct this final questionnaire should be rethought. Secondly, for a majority of kids visitors, they wrote their parents' address, and researchers had no visibility on the fact that kids really replied to the final questionnaire and not their parents.

The size of the sample has also been limited. First, because of Covid-19 and the restrictions on the allowance of people that can visit the venue at the same time. Secondly, because the experience was not at the entrance of the museum, and was located in the historical part of the museum, which is not the most crowded place of the museum. Finally, it was based on volunteering, meaning only the people that were willing to fulfill surveys and to play it on the moment.

All the emails were sent the same day, the 19th of July, 15 days after the last day at the museum conducting the research. Consequently, the time of responding is not equal for all respondents.

9. Conclusion

This master thesis set out to investigate the phenomenon of Gamified Past Simulation and its effect on Cultural Heritage interpretation. In order to find out the applicability and any possible improvement of the related current theories, the authors followed Rahaman's theoretical framework for Digital Heritage Interpretation as well as modern Edutaining theories to recreate the past.

"The 1677 Siege of Malmo" VR experience was designed and co-constructed from scratch in partnership with multiple stakeholders and hosted at the Museum of Malmo for 15 days for empirical data collection.

This approach not only allowed the authors to "put theory to the test", improving any areas found to be lacking, but also discover first-hand any practical challenges arising from this kind of entrepreneurial endeavor, disclosing them here in order to help developers, students and researchers alike.

In order to do this research a combination of qualitative and quantitative methods have proven to be highly effective. On one hand, authors took advantage of the large scale survey methodology to draw tendencies and get conclusions about learning through GPS for different age groups, as well as for people from different locales. Despite having a rate of replies for the last survey (Q3) of under 50%, the approach was interesting for researchers to analyze the effects of this experience. Indeed, replying to the two first questionnaires (Q1 and Q2) while being on site made the authors understand the effect while visitors still were on their trip, and two weeks later made it similar to post-trip feedback, when visitors rely on their memories. The qualitative methodology was based on comprehensive interviews and complemented the findings of the qualitative survey. This allowed the authors to find relevant comments and opinions which were unpredictable.

It has been the author's experience that to get the most positive effects from a GPS, the main educational purpose should be explained and clear objectives should be given to participants before starting the game. Any flimsy or unannounced educational goals are likely to be ignored by participants who are generally keen to play, discover and test the boundaries of the reality they find themselves in.

The evidence from this study suggests that the main goal of GPS should be to support and boost learning while focusing on exploring the virtual environment and its artefacts. Visuals are the main way of communicating on GPS and it represents a new and very welcomed tool for interpretation. However, combining audible explanations are also viewed as essentials by visitors who tend to feel more emotionally engaged when the experience is immersive and plausible.

Furthermore, it is clear that the simulation in itself does not suffice as the entertainment part of the Edutaining equation. Rather, once participants are inside the virtual world, all activities they undertake must be directly related to the educational content if creators want to make the most of this tool. In other words, playing has to be directly connected with the learning objectives.

GPS has the ability to be educational for all ages, but for kids, the learning aspect is even more promising as they show the ability to quickly adapt to the technology and are more willing to progress by correcting their mistakes

GPS motivates and engages people from all ages in their discovery of CH. Artefacts in general, but especially the ones visitors are familiar with, are great tools for maintaining entertainment, engagement and curiosity. Older generations tend to be less intuitive with the technology and do not enjoy the full educational resources offered in a GPS scenario.

GPS is a great marketing tool for museums, both via word of mouth and for social media marketing. It represents and offers a modern and exciting way of supporting their traditional exhibitions and creates enthusiasm and engagement.

GPS is an experience that provokes visitors, and especially internationals, as it incentivizes them to keep exploring the city and interacting with the culture once the experience is over.

Locals are willing to spend time with GPS's designers to share their knowledge and stories. The GPS experience also enhances their sense of belonging, deepens their cultural understanding and knowledge of their place through generations.

For service managers GPS also has the possibility to offer new forms of revenue for cultural heritage organizations. Indeed, people value GPS in a way that they are willing to pay for such an experience.

GPS can offer a multitude of perspectives in a single experience in terms of seeing different opinions, reproducing context and visualizing architecture.

GPS can also have negative effects on the cultural heritage interpretation. Uninteresting storytelling can lead to poor entertainment and failure in learning. Lack of meaningful activities in the virtual world can render the experience shallow.

It is self-evident that society is becoming more digital and technology is allowing humans to do things thought to be impossible a few decades ago. CH sites are part of this revolution and GPS offers the opportunity for museums to display their collection differently through new storytelling via the democratisation of this new media. This will allow them to emphasize a specific point of the heritage which would add value to visitors' trips, and also help organizations improve their image and boost their finances.

This work, which is a practical application of the first theory made by Rahaman on how digital heritage affects visitors' interpretation, has the intention to help digital heritage designers move toward experiences that are fun, educational and connected. It also proves that it is a viable business and has the potential to generate substantial revenue.

The approach has a lot of potential due to its ability to provide emotions and learning to all age groups, as well as offering internal and external tools for visitors to interpret in their own way the heritage they are exploring.

Being at its early days, gaming and digital heritage still have a lot of things to be questioned and discovered in order to propose various ways of educating visitors and also to expand to broader subjects that share similarities with heritage interpretation.

The contribution of this work is practical as well as theoretical. Authors believe this thesis can help designers to focus resources on creating virtual artifacts that have meaning as well as experiences that directly engage those artifacts with the learning goals, bringing value to CH sites.

The future of displaying cultural heritage includes the development of new theories and techniques in digitalization as it offers unique perspectives for interpretation. Similarly, this approach for education and VR also has space for investigation.

The authors of this thesis believe it will be interesting to do further research on specific topics that improve the overall experience and include more aspects of interpretation. It will be helpful for experienced designers to understand the big picture of CH interpretation by creating content that is appreciated by different demographic categories.

Problematics can be expressed further, and understanding how this tool can be used at a multiplayer perspective could be a key factor in the democratisation of VR.

It is the ultimate goal of cultural heritage interpretation to go through time via its own vision of the past with the ability to connect generations. Keep telling the story of the past, live and feel it in the present through futuristic vision and technology.

10. Annexes

Annexe 1 : First quantitative questionnaire

First name:

Email:

1- Are you:

a) Male

b) Female

c) Prefer not to say

2- What is your year of birth?

3- Where are you from?

a) Skane,

b)Sweden (not Skane),

c) International (where?_____)

Quizz 4 questions - Please mark the right answer.

4- Who was the King of Sweden in 1677?

a) Karl Gustav b) Cristian V

c) Charles XI d) I don't know

5- Who was trying to invade Malmo in the 17th century?

a) Germans b) Danish

c) Finish d) I don't know

6- When did the Skanian War begin?

a) 1677 b) 1676

c) 1777 d) I don't know

7- Which social class formed their own unit during the siege of Malmo?

a) Bourgeois b) Poor Citizens

c) Royal familly d) I don't know

Please answer **YES** or **NO** for the following question:

8- Have you ever tried VR in a Cultural Heritage setting?

a) Yes

b) No

Please choose one of the following answers for the question below:

9- On this experience I primarily expect to:

a) Have Fun/Play b) Learn about culture

c) Have fun and learn at equal measure d) Other

Annexe 2 : Second quantitative questionnaire

1- In your opinion what was the main theme of this experience?

a) The Siege of Malmo

b) The Treasure

c) A visit to see the architecture and feel of Malmo 1677

d) Other (which _____)

Please rate between highly agree to highly disagree

2- I am going to do further research about the Siege of Malmo?

3- I am now more likely to go into the old citadel of Malmo once I have finished visiting the museum?

Quizz 5 questions - Please mark the right answer.

4- Who was the King of Sweden in 1677?

a) Karl Gustav X

b) Cristian V

c) Charles XI

d) I don't know

5- Who was trying to invade Malmo?

a) Germans

b) Danish

c) Finish

d) I don't know

6- When did the Skanian War begin?

a) 1677

b) 1676

c) 1777

d) I don't know

7 - Which social class formed their own unit during the siege of Malmo?

a) Bourgeois

b) Poor Citizens

c) Royalty family

d) I don't know

8- How long did the Siege of Malmo last?

a) 1 week

b) 4 weeks

c) 3 months

d) I don't know

9- Considering that this is an additional exhibition at the museum, how should it be financially supported?

a) I would only attend if it were free

b) Donation base (tips)

c) I'd only go if it costs less than 50sek pear player

d) I'd be happy to pay between 50sek-100sek per player

e) I'd consider paying over 100Sek per player

Please give each of the following questions a 1 to 5 ratio according to your personal experience with 1 being the lowest score and 5 the highest.

Quizz - Please mark your grade

10- The experience offered a <u>good supplement</u> to the museum's exhibitions ?

11- The content was unique and informative.

12- The experience was <u>more motivating</u> than <u>the other experiences</u> in Museum?

13- The goal of finding the treasure <u>was interesting</u>?

14- I would prefer to have the experience with another person?

Please answer YES or NO

15- Do you think the experience gave you a new perspective of the history of Malmo?

16- Did you miss a Danish perspective during this experience?

Annexe 3 : Question for qualitative interview

Interview Semi-structured:

1- What was your favourite interactive artefact and why? (S)

2- Did the experience change your notion of how life in Malmo was in the 1600s? (MP)

3- What did you learn during the experience? (L)

4- This experience was co-created with locals who gave us ideas and feedback. If we were to do something similar where you live, how interested would you be to get involved? (P)

5- What other (if any) effects did the experience have on you?

Annexe 4 : Third quantitative questionnaire

Quizz 5 questions - Please mark the right answer.

1- Who was the King of Sweden in 1677?

a) Karl Gustav X

b) Cristian V

c) Charles XI

d) I don't know

2- Who was trying to invade Malmo?

a) Germans

b) Danish

c) Finish

d) I don't know

3- When did the Skanian War begin?

a) 1677

b) 1676

c) 1777

d) I don't know

4 - Which social class formed their own unit during the siege of Malmo?

a) Bourgeois

b) Poor Citizens

c) Royalty family

d) I don't know

5- How long did the Siege of Malmo last?

a) 1 week

b) 4 weeks

c) 3 months

d) I don't know

Rate the following questions between highly agree and highly disagree:

1) 3 weeks after, I consider the experience was a good supplement to the rest of my visit.

a) Highly agree

b) Agree

c) Neither agree or disagree

d) Disagree

e) Highly Disagree

Other interest :

a) **Did you share the experience on Social Media ?**

b) **Did you talk about this experience to your friends/family that were not here ?**

c) **Have you been doing further research on the topic ?**

d) **Have you been looking/asking for similar experiences in the cultural place that you visited ?**

e) **Do you think the experience gave you a new perspective of the history of Malmo?**

f) **Have you be into the old citadel of Malmo once the visit was finished to complete your cultural trip ?**

11. References

Adcock A., Van Eck R. (2012) Adaptive Game-Based Learning. In: Seel N.M. (eds) Encyclopedia of the Sciences of Learning. Springer, Boston, MA. https://doi.org/10.1007/978-1-4419-1428-6_4

Affleck, J. and Kvan, T. (2008). A Virtual Community as the Context for Discursive Interpretation: A Role in Cultural Heritage Engagement. *International Journal of Heritage Studies*, 14(3), pp.268–280.

Agyeman, K.H. (2020). *Top 10 Museum Trends You Should Know*. [online] Medium. Available at: https://medium.com/museum-tech-trends/top-10-museum-trends-in-2019-3c5582ed8253.

Aksakal, N. (2015). Theoretical View to The Approach of The Edutainment. *Procedia - Social and Behavioral Sciences*, 186, pp.1232–1239.

Alivizatou-Barakou, Kitsikidis, et al. Intangible Cultural Heritage and New Technologies: Challenges and Opportunities for Cultural Preservation and Development. *Mixed Reality and Gamification for Cultural Heritage*. by Marinos Ioannides, Magnenat-Thalmann, N., Papagiannakis, G. and SpringerlinkCham: Springer International Publishing, 2017

Anderson, E. F., McLoughlin, L., Liarokapis, F., Peters, C., Petridis, P., & de Freitas, S. (2010). Developing serious games for cultural heritage: A state-of-the-art Review. *Virtual Reality*, *14*(4), 255–275. https://doi.org/10.1007/s10055-010-0177-3

Bec, A., Moyle, B., Timms, K., Schaffer, V., Skavronskaya, L., & Little, C. (2019). Management of immersive heritage tourism experiencs: A conceptual model. *Tourism Management*, *72*(November 2018), 117–120. https://doi.org/10.1016/j.tourman.2018.10.033

Bekele, M.K. and Champion, E. (2019). A Comparison of Immersive Realities and Interaction Methods: Cultural Learning in Virtual Heritage. *Frontiers in Robotics and AI*, [online] 6. Available at: https://www.frontiersin.org/articles/10.3389/frobt.2019.00091/full [Accessed 15 Dec. 2019].

Beycan, C., & Edina, A. (2018). *Virtual Reality for Cultural Heritage Tourism*.

Bloom M V and Hanych D A (2002) Skeptics and true believers hash it out Community College Week 4, 14

Bonde, M. T., Makransky, G., Wandall, J., Larsen, M. V., Morsing, M., Jarmer, H., & Sommer, M. O. A. (2014). Improving biotech education through gamified laboratory simulations. *Nature Biotechnology*, *32*(7), 694–697. https://doi.org/10.1038/nbt.2955

Brinkmann, S. & Kvale, S. (2015). InterViews. Los Angeles, CA: Sage Publications.

Bryman, A. (2012). *Social Research Methods 4e.* 4th ed. [online] Oxford, Uk Oxford University Press. Available at: https://www.academia.edu/30520568/Social_Research_Methods_4th_Edition_by_Alan_Bryman_pdf.

Buckingham, D. & Scanlon, M. (2000). That is edutainment: Media, pedagogy and the market place. Paper presented to the International forum of researchers on young people and the media, Sydney.

Building Design + Construction. (2018.). *The future of museums: The ultimate visitor experience*. [online] Available at: https://www.bdcnetwork.com/blog/future-museums-ultimate-visitor-experience.

Champion, E. 2020. *Critical Gaming Interactive History and Virtual Heritage*. [S.l.]: TAYLOR & FRANCIS.

Champion, E. (2015b). Defining Cultural Agents for Virtual Heritage Environments. *Presence: Teleoperators and Virtual Environments*, 24(3), pp.179–186.

Champion, E. (2015a). Roleplaying and Rituals For Cultural. *DiGRA 2015: Diversity of Play*.

Champion, E. (2016). Entertaining the similarities and distinctions between serious games and virtual heritage projects. *Entertainment Computing*, 14, pp.67–74.

Chiu, L. K., Dzakiria, H., Kasim, A., & Scarlat, C. (2013). The Need To Understand Cultural Heritage Tourists Behaviour. *Advances in Business-Related Scientific Research Journal*, *4*(1), 85–98.

ComRes. (2016a). *Interest in experiencing tourism through virtual reality in Great Britain in 2016, by age*. *Statista*. Statista Inc.. Accessed: April 24, 2021. https://www-statista-com.ludwig.lub.lu.se/statistics/672446/interest-in-experiencing-tourism-through-virtual-reality-in-great-britain-by-age/

ComRes. (2016b). *Interest in experiencing cultures through virtual reality in Great Britain in 2016, by age*. *Statista*. Statista Inc.. Accessed: April 24, 2021. https://www-statista-com.ludwig.lub.lu.se/statistics/674380/virtual-reality-interest-in-experiencing-cultures-via-vr-great-britain-by-age/

Flick, U. (2019). *Introduction To Qualitative Research.* Sage.

Fossard, E.D. (2008). Using Edu-Tainment for Distance Education in Community Work, *Sage Publications,* 2008, pp. 19.

Gérard, M., Bartoli, P.-H. and Gautier, A. (2019). *L'accès à la culture et au patrimoine via le numérique - Quelles perceptions et attentes des Français vis-à-vis de l'accès à la culture et au patrimoine grâce aux outils numériques ?* [online] Fédération francais des télécoms. Available at: https://harris-interactive.fr/wp-content/uploads/sites/6/2019/09/Rapport-Harris-Lacces-a-la-culture-via-le-numerique-FFT.pdf.

Grandviewresearch.com. (2018). *Virtual Reality Market Size | Industry Growth Analysis Report, 2025*. [online] Available at: https://www.grandviewresearch.com/industry-analysis/virtual-reality-vr-market.

Guttentag, D. A. (2010). Virtual reality: Applications and implications for tourism. Tourism Management, 31(5), 637–651.

Harris Interactive. (2019). *Percentage of people interested in digital cultural activities in France in 2019, by type*. *Statista*. Statista Inc.. Accessed: April 24, 2021.

https://www-statista-com.ludwig.lub.lu.se/statistics/1059190/interest-in-digital-cultural-activities-by-type-france/

Hillier, L. (2018). *Econsultancy*. [online] Econsultancy. Available at: https://econsultancy.com/how-museums-are-using-immersive-digital-experiences/.

Huang, Y. C., Backman, K. F., Backman, S. J., & Chang, L. L. (2016). Exploring the implications of virtual reality technology in tourism marketing: An integrated research framework. International Journal of Tourism Research, 18, 116e128.

Iran-Nejad, A., Mckeachie, W. J., & Berliner, D. C. (1990). The Multisource Nature of Learning: An Introduction. Review of Educational Research, 60(4), 509–515. https://doi.org/10.3102/00346543060004509

Jacobson, J. and Holden, L., 2007. Virtual Heritage. *Techné: Research in Philosophy and Technology*, 10(3), pp.55-61.

Javaid, M. and Haleem, A. (2019). Virtual reality applications toward medical field. *Clinical Epidemiology and Global Health*.

Jerald, J. (2016). *The VR book : human-centered design for virtual reality*. New York: Association For Computing Machinery ; San Rafael, California.

Loiseau, M., Lavoué, É., Marty, J.-C. and George, S. (2014). A Multiplayer Learning Game based on Mixed Reality to Enhance Awareness on Archaeology. *EAI Endorsed Transactions on Game-Based Learning*, 1(3), p.e3.

https://www.minsar.app/post/a-brief-analysis-of-xr-technologies-in-cultural-heritage
www.minsar.app. (2021). *XR Technologies in Cultural Heritage*. [online] Available at: https://www.minsar.app/post/a-brief-analysis-of-xr-technologies-in-cultural-heritage

Makarius, E. E. (2017). Edutainment: Using Technology to Enhance the Management Learner Experience. *Management Teaching Review*, *2*(1), 17–25. https://doi.org/10.1177/2379298116680600

Marsh, T. (2016). Slow serious games, interactions and play: Designing for positive and serious experience and reflection. *Entertainment Computing*, 14, pp.45–53.

May, T. (2021). *SOCIAL RESEARCH : issues, methods and process.* S.L.: Open Univ Press.

Navarrete, T. (2019). Digital heritage tourism: innovations in museums. *World Leisure Journal*, 61(3), pp.200–214.

Nesta. (2020). *Which digital activities does your museum offer?*. *Statista*. Statista Inc.. Accessed: April 24, 2021. https://www-statista-com.ludwig.lub.lu.se/statistics/1202656/digital-activities-offered-by-museums-england/

O'Connor, Stuart, et al. "Fostering Engagement with Cultural Heritage through Immersive VR and Gamification." *Visual Computing for Cultural Heritage*, by Fotis Liarokapis et al., Springer Nature Switzerland, 2020, pp. 301–319, doi.org/10.1007/978-3-030-37191-3_16.

Okan, Z. (2003). Edutainment: Is learning at risk? *British Journal of Educational Technology*, *34*(3), 255–264. https://doi.org/10.1111/1467-8535.00325

Pagano, A., Palombini, A., Bozzelli, G., De Nino, M., Cerato, I. and Ricciardi, S. (2020). ArkaeVision VR Game: User Experience Research between Real and Virtual Paestum. *Applied Sciences*, 10(9), p.3182.

Perkins Coie. (2020). *Sectors expected to witness the most disruption by immersive technologies over the next 12 months according to XR/AR/VR/MR industry experts in the United States in 2020*. *Statista*. Statista Inc.. Accessed: May 16, 2021. https://www-statista-com.ludwig.lub.lu.se/statistics/1185060/sectors-disrupted-immersive-technology-xr-ar-vr-mr/

Qian, M., & Clark, K. R. (2016). Game-based Learning and 21st century skills: A review of recent research. *Computers in Human Behavior*, *63*, 50–58. https://doi.org/10.1016/j.chb.2016.05.023

Rahaman, H. (2012) 'A framework for digital heritage interpretation', Phd thesis, National University of Singapore, Singapore

Rahaman, H. (2018). Digital heritage interpretation: a conceptual framework. *Digital Creativity*, 29(2-3), pp.208–234.

Rahaman, H. and Kiang, T., 2017. Digital Heritage Interpretation: Learning from the Realm of Real-World. *Journal of Interpretation Research*, 22(2), pp.53-64.

Rahaman, H. and Kiang, T. (2011). Interpreting Digital Heritage: A Conceptual Model with End-Users' Perspective. *International Journal of Architectural Computing*, 9(1), pp.99–113.

Rubio-Tamayo, J. L., Barrio, M. G., & García, F. G. (2017). Immersive environments and virtual reality: Systematic review and advances in communication, interaction and simulation. Multimodal Technologies and Interaction, 1(4), 1–20. https://doi.org/10.3390/mti1040021

Seel, N.M. (2012). *Encyclopedia of the sciences of learning*. New York: Springer. (all the reference about edutainment)

Selmanović, E., Rizvic, S., Harvey, C., Boskovic, D., Hulusic, V., Chahin, M. and Sljivo, S., 2020. Improving Accessibility to Intangible Cultural Heritage Preservation Using Virtual Reality. *Journal on Computing and Cultural Heritage*, 13(2), pp.1-19.

Shehade, M. and Stylianou-Lambert, T. (2020). Virtual Reality in Museums: Exploring the Experiences of Museum Professionals. *Applied Sciences*, 10(11), p.4031.

Shin, D. (2018). Empathy and embodied experience in virtual environment: To what extent can virtual reality stimulate empathy and embodied experience? *Computers in Human Behavior*, 78, pp.64–73.

Smith, L. (2009). *Uses of heritage*. London ; New York: Routledge.

Soda PDF Blog. (2019). *5 Awesome and Cheap VR Headsets for Under $100*. [online] Available at: https://www.sodapdf.com/blog/best-vr-headset/ [Accessed 23 Mar. 2021].

Tilden, F. (1977). *Interpreting our heritage.* Chapel Hill: University Of North Carolina Press.

Timothy, Dallen J. Nyaupane, G. P. (2009). *Cultural heritage and tourism in the developing world : a regional perspective*. London: Routledge.

Triclot, M. (2011). *Philosophie des jeux vidéos*. Paris: Zones.

UNESCO: 2003, Convention for the safeguarding of the intangible cultural heritage. 32nd Session: The general conference of the United Nations Educational, Scientific and Cultural Organisation. Paris, UNESCO.

UNESCO (2014). *CULTURE FOR DEVELOPMENT INDICATORS - Methodology Manual*. UNESCO.

Uzzell, D. 1994, Heritage interpretation in Britain four decades after Tilden *in* R. Harrison (ed.) *Manual of Heritage Management*, Butterworth-Heinemann, Oxford, pp. 293–302. x

VentureBeat. (2018). *Museums are the best place to find innovation in AR*. [online] Available at: https://venturebeat.com/2018/03/27/museums-are-the-best-place-to-find-innovation-in-ar/

Vygotsky, L. S. (1978). In M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.), Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

www.malmo1692.se. (n.d.). *Malmö 1692*. [online] Available at: http://www.malmo1692.se/Sv/index.htm [Accessed 5 Apr. 2021].