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A game for the National Museum:
A case study into the design and evaluation of a mobile museum game for children

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Supervisor(s):
Henrik Schønau-Fog

Project group no.:
N/A

Members:

Alexander Kure Risvang

Daniel Herrero Ditlevsen

Aalborg University Copenhagen

Frederikskaj 12,

DK-2450 Copenhagen SV

Semester Coordinator:
Stefania Serafin

Secretary:
Lisbeth Nykjær

Abstract:
This thesis presents an investigation into the design process of an on site and online mobile game for children as a case study with the National Museum of Denmark.
Through five iterations, the design of the game was refined using the OA3 framework based on the field of engaging player experiences.
In total five iterations of the design were evaluated (including the final experiment). In total 24 children in the age group of 5 to 16 participated in the evaluations. Each test provided knowledge in regards to the limitations of the design and based on the feedback the design was iterated.
The experimental test sought to investigate how the desire to continue playing the game experience was affected across three levels: pre, during and post experience. No significant difference was found between the levels, but the desire to continue increased through the iterations. The test was conducted at the National Museum of Denmark and 16 children in the age group of 5 to 13 participated.
While participants played the game experience, measures of their player behaviour was recorded, in order to investigate their relation to engagement. Several interesting relationships were found and will be the focus for future studies.
Full abstract can be read in the thesis.

A game for the National Museum

A case study into the design and evaluation

of a mobile museum game for children

Alexander K. Risvang & Daniel H. Ditlevsen

1. Abstract

This thesis presents an investigation into the design process of an on site and online mobile game for children as a case study with the National Museum of Denmark.

Through five iterations, the design of the game was refined using the OA3 framework based on the field of engaging player experiences. The SGDA framework was used as a secondary design framework focusing on the purposive aspect of the game experience.

The game experience consisted of a mobile game in which the players have to locate characters and object in a medieval town. In addition, an augmented reality experience was developed in order to bridge the virtual and physical space of the museum.

In total five iterations of the design were evaluated (including the final experiment). In total 24 children in the age group of 5 to 16 participated in the evaluations. Each test provided knowledge in regards to the limitations of the design and based on the feedback the design was iterated.

The experimental test sought to investigate how the desire to continue playing the game experience was affected across three levels: pre, during and post experience. No significant difference was found between the levels, but the desire to continue increased through the iterations. The test was conducted at the National Museum of Denmark and 16 children in the age group of 5 to 13 participated.

While participants played the game experience, measures of their player behaviour was recorded, in order to investigate their relation to engagement. Several interesting relationships were found and will be the focus for future studies.

The Again-Again table and its relation to the player experience concept of engagement was investigated and no association was found.

Overall the participants enjoyed the game experience and this thesis shows that such games are viable in a museum setting and that the iterative design process can be beneficial to games at museums.

2. Preface

The following study is a master thesis in Medialogy at Aalborg University Copenhagen. The authors of the study are:

Alexander Kure Risvang
arisva13@student.aau.dk
alexanderkurerisvang@gmail.com

Daniel Herrero Ditlevsen
dditle13@student.aau.dk
danielhditlevsen@gmail.com

The study was made in collaboration with the National Museum of Denmark. The contact at the National Museum was Jacob Wang, contact info: Jacob.Wang@natmus.dk

The result and references are reported in APA format.

The hyperlinks work by pressing either the year of publication or the figure, table, chapter or section number.

The study developed an interactive application to use both on site (at the museum) and online (anywhere). The authors urge the readers to play the game before reading the thesis. Doing so will provide a better understanding of the content within.

The application consists of two parts, first a game for mobile devices and an AR game, playable only on Android devices. The .apk files for both games can be found in the Digital Appendix, see Applications Folder. The AR game needs targets in order to work, these targets are also included in the Digital Appendix, see AR Targets Folder. The targets need to be printed. The application used in the thesis experiment is also included in the Digital Appendix, see Experiment Applications Folder.

The thesis AV presentation is accessible via the following link: `https://www.youtube.com/watch?v=IQGygo0WejM`

2.1 Abbreviations

Continuation Desire = CD
Objectives, Activity, Accomplishment and Affect framework = OA3 framework
Virtual Reality = VR
Augmented Reality = AR
Player Engagement Process = PEP
Engagement Sampling Questionnaire = ESQ
Game Engagement Questionnaire = GEQ(2)
Game Experience Questionnaire = GEQ
Serious Game Design Assessment = SGDA
Evaluation-Driven Design = EDD

3. Motivation

The motivation for writing this thesis is twofold and consists of a personal and professional motivation, and an academic motivation.

3.1 Personal & Professional Motivation

The authors have worked within the field of games for museums throughout their master's degree. Utilizing several different technologies such as smartphones, tablets, immersive virtual reality and physical interfaces have provided the authors a perspective of what is possible when creating interactive experiences at museums.

In 2016 the authors collaborated with the Natural History Museum of Denmark, to develop a tablet game for the Zoological Museum, more precisely for their Evolution exhibition. The museum found the exhibition difficult for children to understand. The purpose of the study was to detect how a game could support social experiences for parents and children at the museum, and how parent mediation provides children a better understanding of complex subjects. The AV presentation for the project can be seen using the following link: `https://www.youtube.com/watch?v=ofRLSWNowWE`

During spring 2017, the authors developed an Immersive Virtual Reality experience for Trelleborg Museum, a museum associated with the National Museum. The experience sought to teach children about the intangible culture from the Viking age in Denmark. The AV presentation for the project can be seen using the following link: `https://www.youtube.com/watch?v=5J1boK6OEMU&t=3s`

The authors spent their internship semester (autumn 2017) working for the National Museum of Denmark, Copenhagen. We developed a game for the for the Peoples of the Earth exhibition. The game tells the story of a Greenlandic shaman who takes a spiritual journey to see the Mother of the Sea. The story is a traditional tale from Greenlandic Inuit culture. The game is exhibited at the museum and the AV presentation for the internship project can be seen using the following link: `https://www.youtube.com/watch?v=UL169-D35Pw`

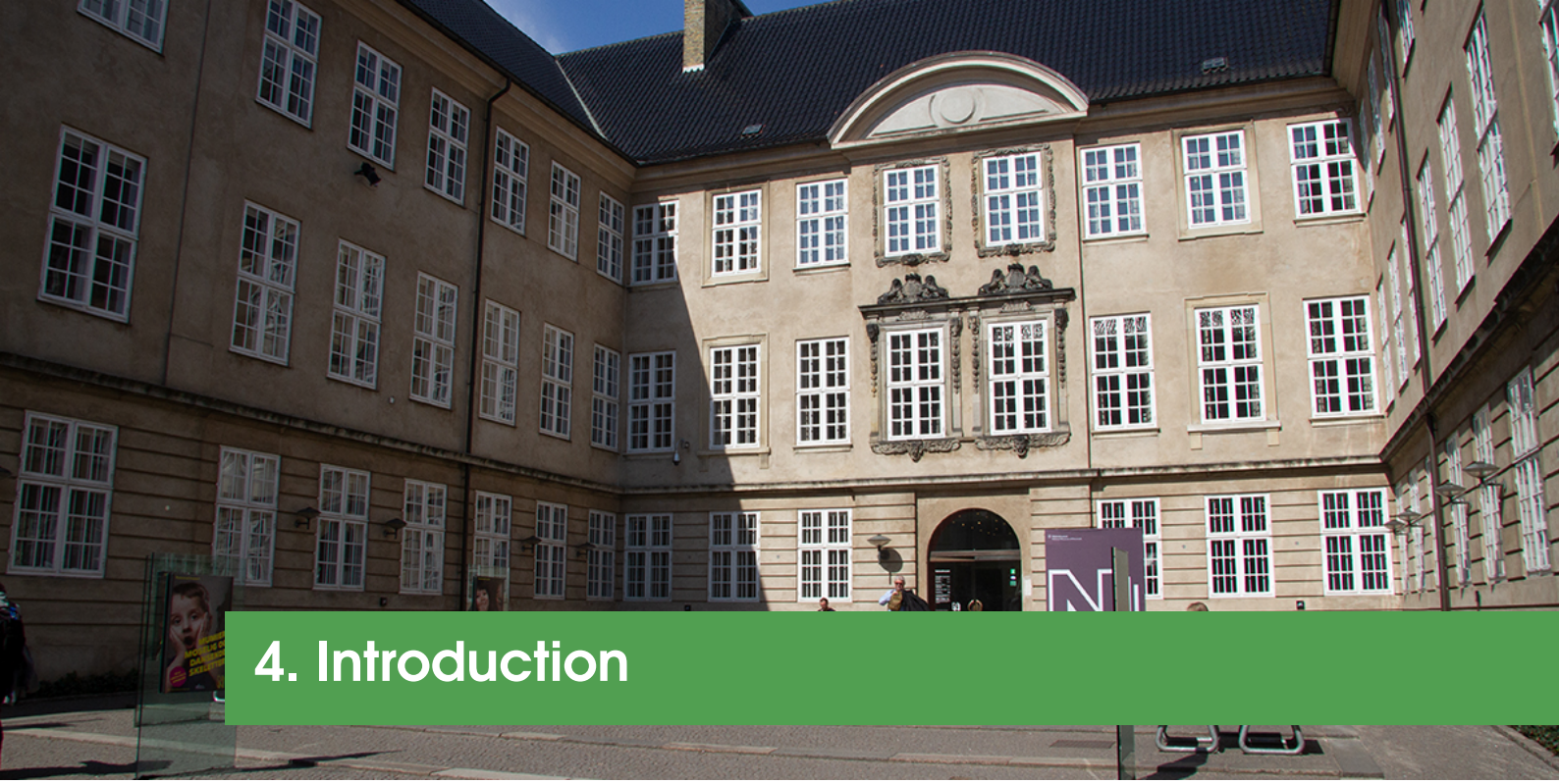
For this present thesis, the authors got in contact with the National Museum's digital coordinator, through their previous contacts with the museum. The idea for this thesis is to provide the authors with an insight into the design process of a game which can be played both at home and at the museum, linking the physical location of the museum with online experiences. The authors want to push the limits of what people expect from museums in regards to digital content, in order to expand the museums' target population. The authors want people to think of the museum as facilitators of culture, which are not dependent on the physical location. The museum should be able to facilitate culture on all platforms including mobile games, streaming services, and long reads. This thesis will take the first steps for the authors into researching how creating such application can be achieved.

3.2 Academic Motivation

Serious games and games for museums have become increasingly interesting for museums to provide their visitors with a more interactive and diverse experience. Together with the increased interest for such games in the industry, studies into how these games provide the visitors with an interesting experience, and how such games should be designed has been carried out at various institutions around the world. The authors have used several different design frameworks in previous game development processes and found that many of them lack depth in regards to how an interesting player experience is designed. Research into the field of player experience has been steadily increasing and the field has been able to categorize the components of such experiences, together with in-depth frameworks for how to design them. The authors want to expand the depth of the current design frameworks for serious games, with design methodology from the research of player experiences.

Contents

IV Evaluation



4. Introduction

In recent years museums have sought to create meaningful and interesting museum experiences for their visitors. Interaction has become a central element, changing the traditional museum experience from a passive experience to an experience where visitors engage and interact with the museum and its exhibitions. The design of these experiences has changed to a user-centric approach, where the visitor's interests and desires are catered to. These new experiences fall within the field of engaging museum experiences, which can curate the museum's exhibitions in a playful manner (Mortara et al., 2014) and sustain learning while being entertaining (Danks et al., 2007; Wyman et al., 2011).

Research within the field of museum experiences show that interactive mediums, such as digital games, increase the visitor's engagement (Danks et al., 2007; Falk and Dierking, 2012; Haywood and Cairns, 2006; Ioannidis et al., 2013; Meecham and Stylianou, 2012; Othman, Petrie, and Power, 2011; Radeta et al., 2017; Waltl, 2006; Yiannoutsou and Avouris, 2012). Several studies propose methods to measure engagement within the field of museum experiences and games at museums, such as Haywood and Cairns (2006) comparing the museum game experience to experiences such as watching tv or reading, and the Again-Again table is used to measure engagement as the desire to repeat an activity (Radeta et al., 2017; Van Dijk, Lingnau, and Kockelkorn, 2012).

None of these use engagement evaluation methods used within the fields of game and player experiences, where the Game Experience Questionnaire (GEQ) (K. Poels, de Kort, and W.A. IJsselsteijn, 2007), Game Engagement Questionnaire (GEQ(2)) (Brockmyer et al., 2009), and Continuation Desire (CD) (Schoenau-Fog, 2011b) have been used. It could be interesting to utilize an engagement measurement tool from the field of digital games and player experiences within the field of museum experiences.

As digital games become a larger part of museums, it is necessary to methodically design the player experiences. Several studies have researched and evaluated games at museums, but few of these approach the subject from a game design perspective, with the player experience in focus, and specifically the game design process in focus.

The concept of CD by Schoenau-Fog (2011b) describes the player's desire to continue playing a digital game and is used as a measurement of player engagement. Furthermore CD has been used in related fields within applied game research such as purposive game development and narrative engagement (Schoenau-Fog, 2011a; Schoenau-Fog, Louchart, et al., 2013), but not within the field of museum experiences. By applying the theory of CD in the field of museums, it could be explored how and if museum games can be evaluated according to CD.

Schoenau-Fog, Birke, and Reng (2012) propose that games can be designed using the Objectives, Activity, Accomplishment and Affect (OA3) framework from CD, which describes the player engagement process (PEP) (Schoenau-Fog, 2011a), and they used it as an iterative design tool to develop a game (Schoenau-Fog, Birke, and Reng, 2012). It could prove interesting to apply this iterative design method to the development of a museum game, as none of the studies within museum experiences present a design framework. Serious games could be a field that bridges the two fields, with design frameworks such as the Serious Game Design Assessment (SGDA) framework (Mitgutsch and Alvarado, 2012) and the Evaluation-Driven Design (EDD) framework (Emmerich and Bockholt, 2016). Using CD and the two serious game frameworks to develop a museum game could shed light on how the different fields relate and how museum games can be designed.

This thesis seeks to research how a game for a museum can be designed by merging design tools from the field of game development with the field of museum experiences. The goal is to create an engaging game experience at a museum. The authors approached the National Museum of Denmark to use them as a case for the thesis.

The National Museum has since 1819 been an organization under the Ministry of Culture with three main tasks: dissemination, conservation of cultural heritage, and research (Nationalmuseet, 2016) and they have the responsibility of making their collections public on a local, national, and international level (Nationalmuseet, 2017b).

The museum strives to have relevant exhibitions that appeal to a wide audience. They want to renew their dissemination strategies and exhibitions, especially through digitalization (Nationalmuseet, 2016; Nationalmuseet, 2017b; Nationalmuseet, 2018c). In a Non-User Survey carried out by the museum itself they found that the museum is a "one-time show", meaning that most visitors do not return after their first visit (Nationalmuseet, 2017a) and that is something the museum seeks to change. They want to provide reasons for the public to visit, with products that engage and maintain visitors (Nationalmuseet, 2017a).

Recently, the museum has launched a strategy where they focus on children (Nationalmuseet, 2018c). Through their Children First initiative, and what they call The Surprising Museum, they will begin development of digital interactive mediums such as games, that can bridge on site and online experiences, that utilizes the physical and virtual space, through the use of interactive narratives (Nationalmuseet, 2018c).

This is an area where this thesis can support the National Museum's new strategy, by developing a game that follows the strategy. It can then be evaluated if such a game can help change the visitor's desires to return, so that the museum is no longer a "one-time show".

In an interview with the coordinator for the digital initiative at the museum, Jacob Wang, we learned that they see the general experience their visitors have as being one-dimensional and

homogeneous. Instead the museum wants to "disrupt the uniformity" and create diverse experiences. He explained that through the use of casual digital games they want to instill a sense of "magic" and "wonder" within the visitors.

The National Museum has very few implemented digital games in their exhibitions. In the exhibition 'Cosplayer! Manga Youth' the visitor's can play one installment of the Legend of Zelda series: Skyward Sword (Nintendo, 2011) on the Nintendo Wii system. The game includes a lot of content and it can be argued that it requires several days of playing it to complete it. It is impossible for a museum visitor to get the full game experience.

The authors of this thesis developed a digital game for the 'Peoples of the Earth' exhibition called 'The Journey to the Mother of the Sea' which went live in April 2018. Here visitors experience a traditional Greenlandic Inuit story, where players drum on a physical drum to progress through the story. It is evident that digital games are underrepresented compared to other content at the museum, and that the implementation of more games could prove beneficial.

The museum has developed an experience to spearhead their Children's Initiative and The Surprising Museum strategies. It is called The Boredom Button, and it launched during Easter 2018 (Nationalmuseet, 2018a). The visitor count during the Easter increased by 40 %, indicating that the new initiative and The Boredom Button are successful in attracting more visitors (Stockmann, 2018).

Other museums around the globe have experimented with digital games, such as the Science Museum, in the UK (ScienceMuseum, 2018a). They have made several successful games over the years, i.e. Rugged Rovers and LaunchBall (amongst others), of which the latter is reported to have over 10 million uses (ScienceMuseum, 2018d).

From an academic perspective, the thesis seeks to research the efficiency of using a design framework from the field of applied game research in the field of museum experiences to develop an engaging game at a museum.

We want to evaluate how engaging the game is for visitors, and how it can affect the visitor's museum experience, by confirming if the game can affect their desire to continue playing, indicating engagement, and if it can have an effect on the desire to return to the museum.

This is a study we have not encountered in the literature and studies within the fields of museum experiences and applied game research.

The thesis will present an analysis of museum experiences and player experiences, and how the theory of CD can be applied to the museum context. State of the art museum games and commercial games will be analyzed to allocate strengths and weaknesses in designs made by other developers. The iterative design method used in the development of the game for this thesis will be presented, as well as the process of implementing the design.

A description of the experimental design method is described, with the purpose of evaluating on the game's and this thesis' purpose. Results from the various tests are then reported and discussed.

A future development plan for the game is also presented, as the authors and the museum are working on fully developing the game and implementing it in the National Museum's various exhibitions and museums.

To summarize, we have the following initial problem statement for the academic work in this thesis:

How can we design and evaluate an engaging museum game for the National Museum of Denmark.

We will use a game design approach, and look at how a museum visitor experience and a digital game player experience relate, to create a holistic design merging theories from both fields. This is

something lacking in the academic research into games at museums. We found that CD can be used to evaluate a digital game, but it has not been used in the context of museums, something we find interesting and will attempt to do.

I Background

5. The Museum Experience

The National Museum aims to be more relevant and novel to its visitors, and to attract more visitors (Nationalmuseet, 2018c). As presented in the previous Introduction chapter 4, the aim of this thesis is to provide the museum with a prototype of a digital game that is in line with their new strategy. To create a holistic design for the prototype, we cannot ignore the museum visitor experience as the game in its nature will be a museum game. Therefore this following chapter will present an analysis of the museum visitor experience, the museum visitor types, and how these relate to the National Museum and its new strategy. We will look at how interactive experiences at museums have been evaluated previously to allocate measurement instruments that could prove useful to evaluate the prototype, and we will research how the desire to return to a museum can be measured.

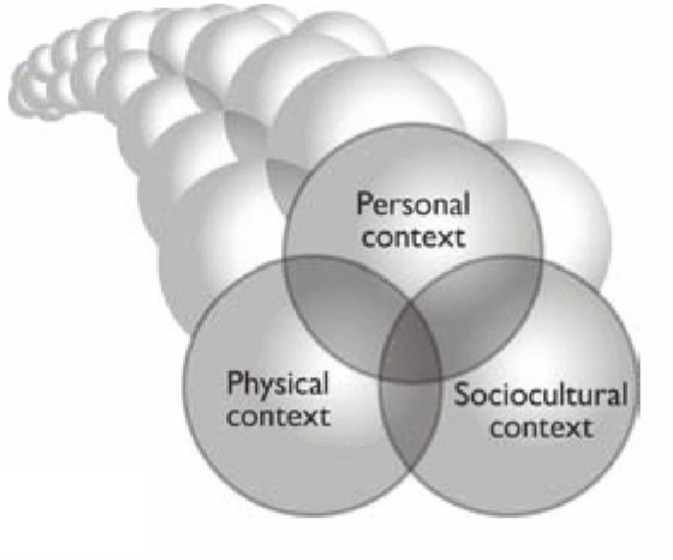
We will analyze from a designer and developer perspective, in an attempt to establish design guidelines for the prototype, which follow current research, and are relevant to the National Museum. In the next chapter we will look at player experiences, and attempt to set it in context with the presented research in this chapter.

5.1 The Three Museum Contexts

Falk and Dierking (2012) use the Contextual Model of Learning to understand what a museum experience is. In the mentioned model, three contexts are presented; the personal, the sociocultural, and the physical context (Falk and Dierking, 2012). These can be applied to all facets of the museum experience, and they overlap constituting the complete museum experience (Falk and Dierking, 2012). Figure 5.1 shows the three contexts. Note that the model includes time, as the three contexts evolve over time. Later in this section we will present examples of how the National Museum's future strategies fit within the Contextual Model of Learning.

The personal context is the opinions, prior knowledge, beliefs, interests, etc. that a museum visitor brings to the museum. Everything the visitor experiences at the museum will be affected by their personal context, e.g. a person with interest in history might engage with the exhibition and enjoy the visit, while a person with no interest in history might be bored and not feel any enjoyment. When present at the museum the physical context plays a large role on the visitor's experience. The

Figure 5.1: The Contextual Model of Learning (Falk and Dierking, 2012).



architecture of the museum, its exhibitions, facilities, exhibits, the way information is presented to the visitor, and so on, is the setting for the visit which can have an effect on the whole museum experience. The sociocultural context deals with the social encounters at the museum, such as sharing the museum space with other visitors, interacting with museum employees e.g. information desks, guards, tour guides, and so on. Furthermore the sociocultural context extends to how society views the museum. Does the museum have a positive or negative reputation? Are there any social conceptions about who a specific museum is for? All of these questions can influence the personal context of a visitor before they visit the museum. Over time, these contexts influence each other as they change. The personal context of a visitor can be vastly different between the first time visiting a museum, to the second time visiting a museum, due to the effects from the physical and sociocultural contexts from the first visit.

As museums increasingly utilize digital mediums such as websites, podcasts, TV broadcasts, articles, etc. which are not bound to a physical location, it can be argued that the model lacks one additional context, which the authors define as the virtual context. This fourth context is not limited to a single medium, as the content can be transmedial by utilizing a combination of modern technology such as mobile phones, televisions, and computers.

The virtual context can be relevant before the museum visits begin, as visitors might plan their trip by visiting the museum's website Falk and Dierking (2012). It can be assumed that this fourth context also affects the overall museum experience. An example of this is how a visitor that has seen *"Historien om Danmark"*, a danish TV documentary series produced by DR (Danmarks Radio), the National Museum, and the Agency for Culture and Palaces (DR, 2018), might have a different personal context when arriving at the museum than a visitor who has not seen the documentary series. It should be noted that examples of scenarios where visitors have not encountered the virtual context at all can still be speculated, but with the increased use of social media, web services, and available technology, such a case could prove to be rare.

By Falk and Dierking's model, the virtual context could be placed within the sociocultural context, as this context includes the museum's societal role, and how a museum is regarded across cultural differences. Through social media, the personal context of one visitor can influence that of another visitor. The reception of a product such as *"Historien om Danmark"* can influence how certain social groups regard the National Museum. To specify, the virtual context, works on an individual basis, and not on how e.g. *"Historien om Danmark"* is presented in the news or social media. An individual watching the documentaries will create their own opinions about the museum preceding the actual visit, thus influencing their personal context, which in turn can either affect or be affected by the museum's sociocultural and physical contexts. We will throughout the following section analyze the National Museum's new strategy, and set it in relation to the Contextual Model of Learning.

5.2 The National Museum: Children First

Museums have for the past decade had an increased focus on children and how digital mediums can facilitate cultural heritage to children (Pold, 2007; Radeta et al., 2017; Van Dijk, Lingnau, and Kockelkorn, 2012). This year, the National Museum has begun an effort to cater more to children, through their "Children First" initiative (Nationalmuseet, 2018a). This entails a change in their sociocultural context, as they seek to shift the public's perception of the museum to be a relevant site for children. The physical context is also changing to accommodate the new initiative through new on site museum experiences which cater more to children.

In an expert interview with Jacob Wang, the coordinator for the digital initiative at the National Museum, he explained that the recent strategies of the museum are based on dividing the museum into three pillars, as can be seen on tables 5.1, 5.2, and 5.3. The expert interview methodology and procedure can be read in section 10.2.1. Additionally we were provided with a currently-in-development pitch document for the three pillars (Nationalmuseet, 2018c).

5.2.1 The Media House

Table 5.1: First pillar (Nationalmuseet, 2018c)

The Media House
Relevant news with a historical perspective
On demand media: Podcasts Videos Long reads
Content marketing

The Media House pillar operates within Falk and Dierking's sociocultural context and our virtual context. It is supposed to engage the public as a news outlet and place to learn. The Media House can change the public's perception of the museum, influencing different social groups and cultures by providing historical insight and perspectives on modern topics and discussions. The products developed by the Media House place themselves in our virtual and the sociocultural context, as users can engage in the content regardless of their physical location. This is what we call *online*, as it is not bound to the physical context of the museum, and it is available for consumption via online means.

The media house also extends to the physical context, as videos, brochures, etc. can be present at the museum.

5.2.2 The Surprising Museum

Table 5.2: Second pillar (Nationalmuseet, 2018c)

The Surprising Museum
Emphasis on children
Interactive narratives: Games Gamification
Bridging on site and online
Bridging the physical and virtual space: Augmented Reality Virtual Reality

It is this pillar that develops experiences for the Children First initiative (not exclusively). This pillar falls within several of Falk & Dierking's contexts, as it can be present on site and online. In the physical context, the latest project for children is The Boredom Button (*Kedsomhedsknappen*) (Nationalmuseet, 2018a). The idea is that throughout the physical museum in the exhibitions they have placed electronic buttons. When the visitors press the buttons, extraordinary events happen, ranging from a museum employee dressed up as a historical figure telling a story, to 3D animations projected on walls.

This project invites social interaction in the sociocultural context. The children interact with the employees, and each other depending on the result of pressing a button. This product is exclusively on site, while they through an extensive marketing strategy have made the public aware of these buttons. This marketing strategy works within the sociocultural context, as it can be argued that it has changed parents' and children's perception of the museum. The museum saw an increase of 40 % in visitor numbers during the week that The Boredom Button was launched (Stockmann, 2018).

The museum's efforts with The Surprising Museum seek to create experiences where children learn about cultural heritage through play, something which interactive technology can facilitate. By letting the visitors (children included) be active participants, they become more engaged and immersed in the experience (Danks et al., 2007; Falk and Dierking, 2012; Haywood and Cairns, 2006; Ioannidis et al., 2013; Meecham and Stylianou, 2012; Othman, Petrie, and Power, 2011; Radeta et al., 2017; Waltl, 2006; Yiannoutsou and Avouris, 2012). This finding proves that interactive mediums such as digital games can have a great effect on the visitors, improving their museum experience. It should be noted, the above cited papers vary with their definition (or lack one) of immersion, engagement, and motivation.

Digital games *are* part of The Surprising Museum. In the pitch, the museum mentions that they will develop digital games and interactive narratives, that they want to connect the physical and virtual space, and that the games should work on site and online (Nationalmuseet, 2018c).

This thesis will focus on working within this pillar, as an attempt to support the museum's efforts in catering more to children. With this thesis, we will contribute to the children's initiative through the use of interactive digital games, as these can help the visitor's become more engaged with the museum. By developing a game targeted towards children, we accommodate the first two points

within *The Surprising Museum*, as can be seen on table 5.2.

The remaining two points are; *Bridging on site and online* and *Bridging the physical and virtual space*. To support these points our prototype should be designed to be applicable both on site and online. This indicates that the physical context of the museum cannot be a limiting factor in the design, if the prototype is to be consumed online away from the museum and on site at the museum. In relation to our addition to the Contextual Model for Learning, it can be stated that our prototype has to work in both the physical context and in the virtual context. To clarify, we see the physical context as the on site part, while the virtual context is what constitutes the online part. From here on, we will refer to these parts as on site and online, to match the terminology used by the museum in their pitch.

Lastly, it should bridge the physical and virtual space. They suggest Augmented Reality (AR) or Virtual Reality (VR). Location-based mobile games that utilize AR have proven to facilitate children's engagement (Xhembulla et al., 2014). Mobile games could prove to support the ability to play the prototype on site and online, as the device is mobile, and has become standard technology in society today. VR on the other hand requires a Head Mounted Display (HMD) as an additional device, a limiting factor as these are not as common as mobile devices. Furthermore, social interactions between museum visitors can be difficult to facilitate if the player is wearing the HMD while playing the VR experience, with headphones on. AR does not suffer from these limitations. It should be noted that VR can be viable at museums, depending on the desired experience.

The points raised within *The Surprising Museum* pillar provide initial guidelines for the design of the prototype.

5.2.3 Facilitation of Free Knowledge

Table 5.3: Third pillar (Nationalmuseet, 2018c)

Facilitation of Free Knowledge
Sharing knowledge: Digital collections
Crowdsourcing knowledge: Open dialogue with the public
Makerspaces and creative meetups
Working with other museums

The third pillar, Facilitation of Free Knowledge, works in the sociocultural context by activating amateurs and passionate people to engage in knowledge sharing. The museum also works on expanding their digital collection of 750.000 pictures of 1 million objects from the museum's collection (Nationalmuseet, 2018c). This digital collection operates online, which in turn can affect the sociocultural context.

5.2.4 Initial Design Guidelines

This analysis has provided us with a initial guidelines for our design. To narrow down the target group, we have looked at some of the museum's current projects for children (Nationalmuseet, 2018b):

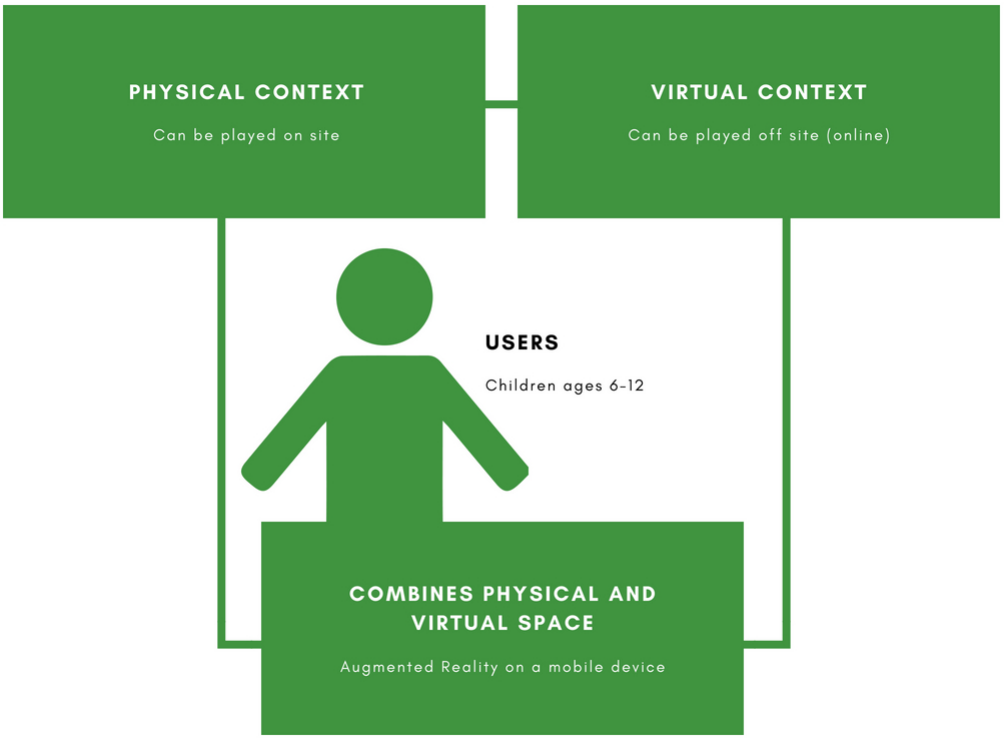
- The Boredom Button (6-12 years old).
- Guided children tours (6-12 years old).
- The children's museum (under 6 years old).

It appears that the museum has an emphasis on the age group 6 to 12 year olds, which we assume to be part of the focus of the Children's Initiative. An age group which we will also focus

on for this thesis.

Figure 5.2 shows an overview of the current design, based on the guidelines derived from the conducted analysis.

Figure 5.2: Initial design guidelines.



5.3 The Museum Visitor Experience of a Child

The following section in this subchapter will present a more thorough analysis of how children interact with museums, and how that might shape their visitor experience.

Here we will look at how our target group falls within Falk's museum visitor types (Falk, 2013; Falk and Dierking, 2012) to better understand in which personal and sociocultural contexts they visit the museum and their goals with the museum visit.

5.3.1 Children as guests

Falk and Dierking have established five identity-related categories for museums guests (Falk, 2013; Falk and Dierking, 2012). In 2013 the Agency for Culture and Palaces of Denmark carried out a User Survey which utilizes the museum visitor types, including a sixth type which they have added to the list (Lundgaard and Jensen, 2014). The target group of this thesis can fall within several of the visitor types.

The User Survey (Lundgaard and Jensen, 2014) does not include ages below 14, which is outside the target group age range of this thesis. For the purposes of categorizing the target group, we will look at the youngest age range of the study (14-29) despite there being large behavioral differences between ages 6-12 and 14-29. It should be noted that 5 % of the visitors in the 14-29 age range are between 14 and 19 years old. This present study will not derive important assumptions as the difference in age ranges (6-12 y/o versus 14-29 y/o) is large. We will instead use it to gain an

overview of the youngest visitor segment reported in the User Survey (Lundgaard and Jensen, 2014).

The expanded museum visitor type list is presented below, with explanations and descriptions.

- Explorers: Curiosity-driven visitors with a generic interest in the content of the museum (Falk, 2013).
  - 14 % are 14-29 y/o (Lundgaard and Jensen, 2014).
  - *"I am curious and interested, and I am visiting the museum to gain new knowledge and inspiration"* (Lundgaard and Jensen, 2014).
- Facilitators: Visitors who are socially motivated. They enable the experience and learning of their accompanying social group (Falk, 2013).
  - 10 % are 14-29 y/o (Lundgaard and Jensen, 2014).
  - *"I am here to create a good experience for the people who are with me. The most important thing is that the people who are with me find the museum interesting"* (Lundgaard and Jensen, 2014).
- Professionals/Hobbyists: Typically motivated by a desire to satisfy a specific content-related objective. They feel a close tie between the content of the museum and their professional or hobbyist passions (Falk, 2013).
  - 23 % are 14-29 y/o (Lundgaard and Jensen, 2014).
  - *"I am here today because of a specific professional interest. I assess the exhibition and the professional communication critically"* (Lundgaard and Jensen, 2014).
- Experience seekers: They perceive the museum as an important destination. Their satisfaction derives from the fact of having 'been there and done that' (Falk, 2013).
  - 15 % are 14-29 y/o (Lundgaard and Jensen, 2014).
  - *"I am here to experience and concentrate on whatever is most eye-catching. I do not need to see everything to get to know the place"* (Lundgaard and Jensen, 2014).
- Rechargers: They seek to have a contemplative, spiritual and/or restorative experience. They use the museum as a refuge from the work-a-day world (Falk, 2013).
  - 11 % are 14-29 y/o (Lundgaard and Jensen, 2014).
  - *"I am here today to recharge my batteries and to find peace and time for contemplation. I am looking for aesthetic experiences in the exhibition, architecture and surroundings"* (Lundgaard and Jensen, 2014).
- Tag-along: Young citizens with a lower or upper secondary school background. They visit the museum because others bring them along, in e.g. a school trip (Falk, 2013).
  - 33 % are 14-29 y/o (Lundgaard and Jensen, 2014).
  - *"I am here today because I am with others who wanted to visit this place today"* (Lundgaard and Jensen, 2014).

The different visitor types tell us about the visitor's motivation, and/or reason to visit the museum. They do not tell us about how the individual visitor interacts with the content of the museum, which activities increase their engagement, or how their personal contexts affect their visit.

Falk and Dierking state that each visitor's motivation is highly identity-related (Falk, 2013; Falk and Dierking, 2012). The reason for going to the museum comes from a personal need or goal, which can change from day to day for the individual visitor (Falk, 2013). A child visiting in a school context (a tag-along) might not have the same level of motivation to visit as a child visiting as an experience seeker. The tag along is forced to go, while the experience seeker wants to try out novel experiences (e.g. The Boredom Button) which yield a high motivation to visit the museum.

Our take away from these findings is that the reason for going to the museum is important and that it affects the visitor's motivation. We are interested in the interplay between a visitor's motivation

and the activities they participate in. Here, the process stretches from before the museum visit, to a possible second visit to the museum.

We have allocated visitor types and reasons for going to a museum, therefore we will now present an analysis of how interactive experiences can affect the museum visit itself and/or provide increased motivation to visit a museum in the first place. We will look at how previous research measures the effects of interactive experiences on children's museum experiences.

5.4 Evaluating Interaction at Museums

Mihaly Csikszentmihalyi and Hermanson (1995) utilize the flow theory to describe intrinsic motivation that can happen at museums. Interest, involvement, and engagement work together to create a state of flow, where the museum experience becomes intrinsically rewarding for the visitor, and they become motivated to explore (Mihaly Csikszentmihalyi and Hermanson, 1995). Wood and Wolf (2008) comment on Csikszentmihalyi's early work on motivation (Mihaly Csikszentmihalyi, 1990) and on Falk and Dierking's contextual model (Falk and Dierking, 2012), stating that these alone cannot serve as the definition for engagement.

They proceed to mention Haywood and Cairns (2006), whom define engagement according to three categories (Haywood and Cairns, 2006), as seen on table 5.4.

Table 5.4: Three categories of engagement (Haywood and Cairns, 2006).

Participation
Playful process during which information is made personal by children becoming part of the experience.
Narration
The formation of stories and accounts of events. Conceptualised in terms of linear structure and fantasy.
Co-Presence
Co-presence of others is based on the concepts of reassurance and feedback, distractions, attracting attention and communication. Not necessarily collaboration.

The third category Co-Presence, is further explained to have both positive and negative effects on engagement. A finding which Cairns already found within the field of games (E. Brown and Cairns, 2004).

Haywood and Cairns (2006) used a grounded-theory approach (Corbin, Strauss, et al., 2008) where they through semi-structured interviews gathered qualitative data from 10 to 13 year old children, evaluating on their engagement with a game utilizing embodied interaction. They asked about engagement by having the children compare their experience to watching TV or reading.

Wood and Wolf (2008) emphasize that visitor engagement at a museum depends on the museum itself. They find that the actions by visitors at each exhibit range from express participation with an exhibit interactive, to various aspects of problem solving, to conversations or dialogue that serve to enhance the experience (Wood and Wolf, 2008). Their focus lies on families and learning at museums.

In a study on using Quick Response (QR) codes to increase user engagement in museum-like spaces, three variables for engagement were found, described on table 5.5 with the corresponding data collection measure (Pérez-Sanagustın et al., 2016).

Table 5.5: Three variables for engagement (Pérez-Sanagustın et al., 2016).

Variables	Data collection
Content consumption: The amount of information consumed at each exhibit.	[Q1] How much of the video did you watch? [Q2] How much of the text did you read?
Time: The average amount of time visitors spend at the exhibit	Observed time spent at the exhibit.
Visitor's perceived quality of the experience: Rated interest of the content and general opinion of the experience.	[Q3] Please, tick the boxes that best describe the information you just saw. Options: Interesting, Too basic, Too detailed, Entertaining and Not for me/us. [Q4] What would you say to other visitors regarding this kind of exhibit? Options: Don't bother, Didn't like it, Just Fine, Really Good, The Best.

The study was not focused on games, but evaluating according to the three variables for engagement could prove useful for this thesis.

Read, MacFarlane, and Casey (2002) present a toolkit to measure children's fun aged between 5 and 10. The toolkit consists of three tools: Smileyometer, Fun-Sorter, and Again-Again table (Read, MacFarlane, and Casey, 2002). The authors define fun as having three dimensions: expectations, engagement, and endurability (Read, MacFarlane, and Casey, 2002).

The toolkit is used by Van Dijk, Lingnau, and Kockelkorn (2012) to evaluate a museum game. They utilize the Smileyometer, Again-Again table, and an adapted Intrinsic Motivation Inventory (IMI) scale to measure enjoyment of children aged between 10 and 12 while playing a multi-touch table game at a museum (Van Dijk, Lingnau, and Kockelkorn, 2012). The Smileyometer is a 5-item Likert scale using smileys instead of numbers, as seen on figure 5.3.

Figure 5.3: Smileyometer scale (Read, MacFarlane, and Casey, 2002).

For the Again-Again table, they asked the children if they wanted to do the activity again ("*Do you want to do it again?*"), with three possible answers: *yes, maybe*, and *no*. Read, MacFarlane, and Casey (2002) establish the Again-Again table as a measurement for Endurability, which they describe as being two things:

- The likelihood to remember things that we have enjoyed (*Remembrance*).
- The desire to do again an activity that has been fun (*Returnance*).

The second statement, which they also describe as 'returnance', could be interesting for this thesis. It could be utilized to detect if the activity of playing our prototype has an effect on the children's desire to return to the museum. Van Dijk, Lingnau, and Kockelkorn (2012) use the Again-Again table as a measurement for engagement, as they argue that fun can facilitate engagement, and that people like to repeat fun activities (Van Dijk, Lingnau, and Kockelkorn, 2012).

Additionally, Van Dijk, Lingnau, and Kockelkorn (2012) use the Children IMI interest/enjoyment scale, derived from the IMI, with the following two statements:

- I thought this was an exciting activity.
- This activity held my attention very well.

Here they applied the Smileyometer technique by having children answer on a 5-item Likert scale, with the smiley visual representation ranging from *totally agree* to *totally disagree*.

Radeta et al. (2017) also use the Smileyometer and Again-Again table to evaluate between a game experience and a storytelling experience for children aged 9 to 10 at a museum.

The game experience consists of a location-based mobile game based on a treasure hunt design, where children had to find certain tags throughout a exhibition which rewarded them with points. The storytelling experience was similar to the game experience with less focus on points and more focus on bridging narratives between exhibits.

They use the Smileyometer to measure enjoyment and the Again-Again table to measure engagement. They utilize skin conductance as a psychophysiological measurement to measure arousal, pre and post test quizzes to compare what the children learned from the experience, and as Van Dijk, Lingnau, and Kockelkorn (2012), they used the IMI to measure intrinsic motivation (Radeta et al., 2017). Radeta et al. (2017) found that the game experience was rated more positively than the storytelling experience, and they learned that the treasure hunt design had the possibility to engage, entertain and scaffold the children's learning through museum contexts. In general, they found that children are easy to engage in treasure hunt tasks. This could prove interesting for the design of the prototype in this thesis.

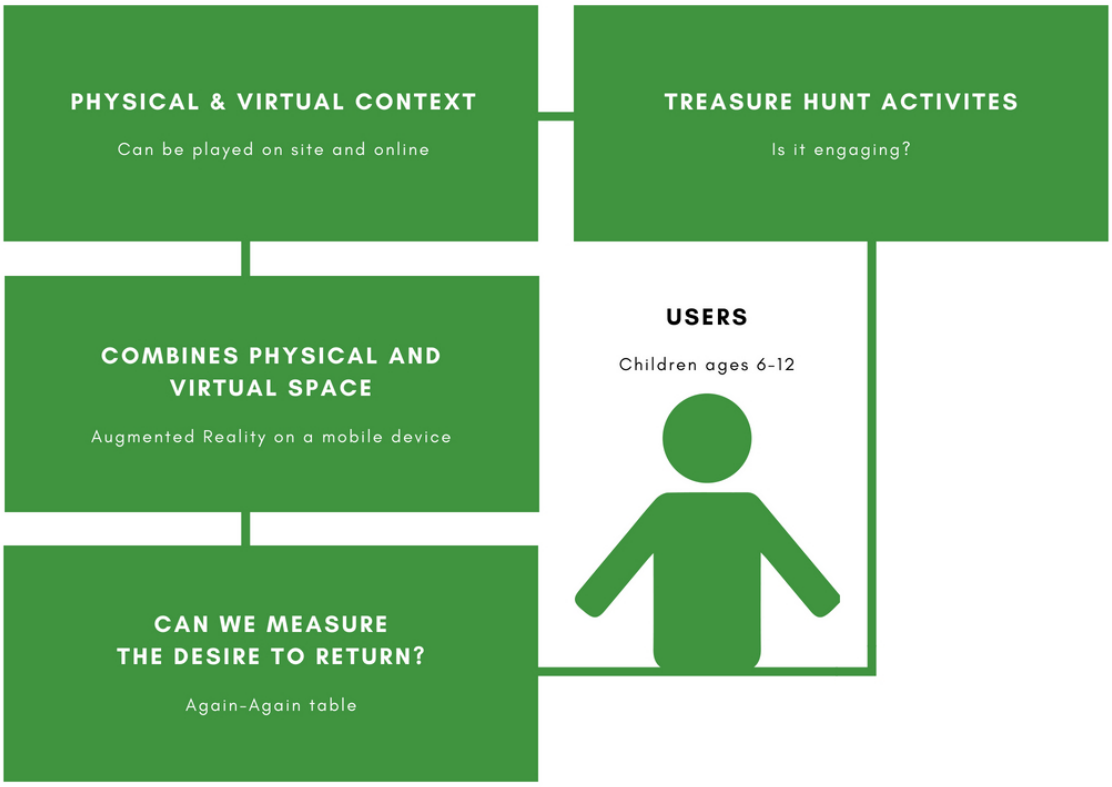
The Smileyometer, Again-Again table, and adapted IMI measurement tools are interesting as they are partially targeted towards the same age group as ours. All three tools could prove interesting for our thesis. Specifically, the Again-Again table is interesting, as it could be used to measure the desire to return to a museum and it has been used to measure engagement. Both Van Dijk, Lingnau, and Kockelkorn (2012) and Radeta et al. (2017) measure engagement with the Again-Again table, which we find interesting as Read, MacFarlane, and Casey (2002) who propose the Again-Again table, use observations to measure engagement, and not the Again-Again table. It could prove interesting to compare measurements from the Again-Again table with a different measurement for engagement.

The above presented research revolves around measuring the museum visitor experience. The majority evaluate the experience of an interactive digital game in museum contexts, but none focus on evaluating the digital games from a game design perspective. There is not much focus in the research on the types of activities that facilitate engagement for museum visitors.

To summarize the presented analysis, we found the Again-Again table interesting, as it can be used as a measure for visitor's desire to return to a museum and it has been used to measure engagement. We found that treasure hunt activities facilitate engagement within children at museums, this can be used for our design.

Furthermore we analyzed the National Museum and their strategies, allocating several design guidelines which we can use. To maintain a game design approach, we will in the following chapter analyse the player experience, and set it in context with the research within the field of museum experiences. Figure 5.4 shows an overview of the current design guidelines we have found based on the presented analysis.

Figure 5.4: Current design guidelines.



6. The Player Experience

The following chapter will present an analysis of player experiences within the field of digital games. We look at what constitutes a player experience, and how previous research has measured the player experience (e.g. the GEQ, GEQ(2), and CD). We present how we choose to focus on CD, as it is a tool to design and evaluate games, and how it relates to the Again-Again table presented in the previous chapter. The OA3 framework from CD is analyzed, and how it measures engagement is described. Finally we set CD in context with museum experiences and the National Museum's new strategy.

All game designers strive to create an engaging player experience. In order to do so one must know what an engaging player experience consists of. Several studies have gone into describing the multifaceted realm of player experiences. Karolien Poels, Yvonne De Kort, and Ijsselsteijn (2007) argue that the experience of playing a digital game is multidimensional and multi-layered. Karolien Poels, Yvonne De Kort, and Ijsselsteijn (2007) present a comprehensive categorization of the game experience. Their categorization includes frequently mentioned concepts of game experiences related to an engaging player experience, such as the concept of player's feeling like they are part of the game world, known as Presence (Lombard and Ditton, 1997; Tamborini and Skalski, 2006).

Players can reach a state of mind where playing games becomes an intrinsically rewarding activity, based on the challenges posed by the game and the player's ability to complete these challenges. This is known as the Flow Theory by Csikszentmihalyi (Abuhamdeh, Nakamura, and Csikszentmihalyi, 2005; Mihaly Csikszentmihalyi, 1990; Sweetser and Wyeth, 2005).

Immersion is a state of mind players feel when attention to the real world diminishes as they focus on the game world, forgetting time and place. They are drawn in to the game experience, and an hour long play session can feel like only five minutes (E. Brown and Cairns, 2004; Ermi and Mäyrä, 2005; Jennett et al., 2008; McMahan, 2003).

The reason for players even beginning the game can have a large effect on the player experience, a concept known as Motivation (Przybylski, C. S. Rigby, and Ryan, 2010; S. Rigby and Ryan, 2011; Yee, 2006).

Playing can result in many different feelings for the player, one of these being enjoyment, leading to the players feeling a positive affect (WA IJsselsteijn, YAW De Kort, and Karolien Poels, 2008; Klimmt, 2003; K. Poels, de Kort, and W.A. IJsselsteijn, 2007). These findings were used by K. Poels, de Kort, and W.A. IJsselsteijn (2007) to design the GEQ.

The GEQ is a self-report measurement that aims to characterize the multifaceted experience of playing digital games, based on the following seven components: Sensory and Imaginative Immersion, Tension, Competence, Flow, Negative affect, Positive affect, and Challenge (K. Poels, de Kort, and W.A. IJsselsteijn, 2007). These components are meant to be evaluated immediately after a game experience, with 42 Likert-scale items. A shorter version was developed to be used intrusively, during a play session. This is the In-game Game Experience Questionnaire (iGEQ), and it consists of 14 Likert-scale items, two for each of the seven components. The GEQ (and the iGEQ) could prove interesting to evaluate on the game experience for this thesis. A focus of this thesis is to design a museum game according to a framework which can be evaluated, and the GEQ does not present such a framework. Furthermore the GEQ is not focused on measuring engagement, but rather on the whole game experience. Other measurement tools focus more on engagement, such as the Game Engagement Questionnaire (GEQ(2)) by Brockmyer et al. (2009).

It is developed according to other studies and how they measure the game experience concepts listed above (e.g. *Presence, Flow, Immersion, etc.*). It uses 19 Likert-items to measure engagement, and as with the GEQ, the GEQ(2) does not present a framework which can be used to both design and evaluate a game experience.

Among the concepts related to an engaging player experience is the desire to continue. The desire to continue in context to play is explained by S. Brown and Vaughan (2009), who argue that play provides continuation desire and that the pleasure of the experience makes us keep doing it. Schoenau-Fog (2011b) sets the desire to continue in context with player engagement. In his article Schoenau-Fog explains which characteristics of player engagement makes one want to continue playing (Schoenau-Fog, 2011b).

As mentioned in the previous section Evaluating Interaction in Museums (see section 5.4), the Again-Again table for measuring the visitor's desire to return to an museum exhibit, together with the Smileyometer, are validated solutions for measuring the concepts of returnance and enjoyment in children (Radeta et al., 2017; Read, MacFarlane, and Casey, 2002; Van Dijk, Lingnau, and Kockelkorn, 2012). The simplicity of the Again-Again table is very similar to how Continuation Desire has been used to measure player engagement through the Engagement Sampling Questionnaire (ESQ) (Schoenau-Fog, 2011a; Schoenau-Fog, 2011b; Schoenau-Fog, 2012; Schoenau-Fog, Birke, and Reng, 2012).

Both measurements can be collected by repeating an easy understandable statement for participants to answer *"I want to continue playing"* from CD and *"Would you like to do this activity again?"* from the Again-Again table. The two concepts are alike as they both try to describe if players are engaged in an experience and if they want to continue or redo the experience. The two approaches are different in that CD explains if and why players keep playing, and the Again-Again table describes the player's willingness to relive the same experience after it has ended.

The following section will describe and investigate the concept of CD and the OA3 framework (Schoenau-Fog, 2011b). The focus of the investigation will be to analyze CD and the OA3 framework, in order to use CD as a tool to evaluate a museum game experience and to design our prototype according to an iterative design process.

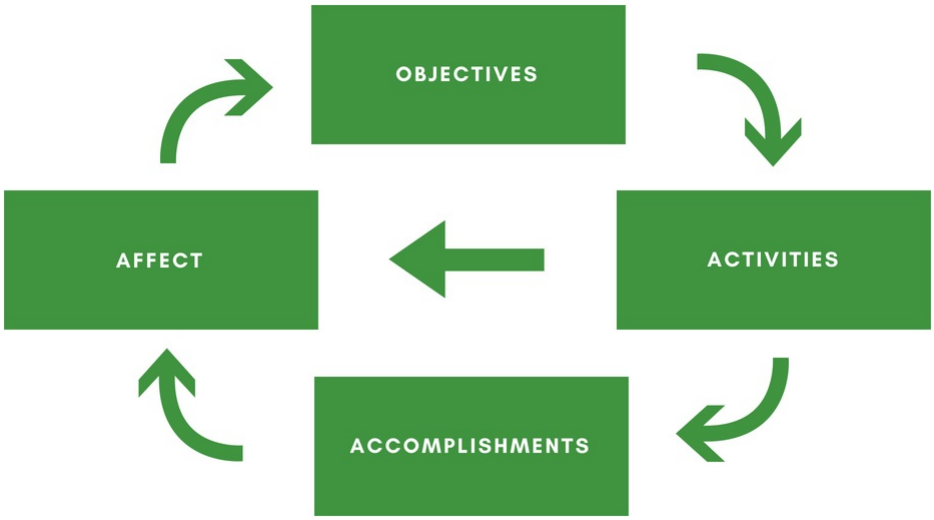
We focus on CD (namely the ESQ) as it is a measurement which uses a simple, easy to understand question to measure engagement. Other measurement scales such as the GEQ and GEQ(2) use many items to measure the game experience and player engagement, and with a target group of children, it is preferable to use short measures. Furthermore, CD (namely the OA3 framework) can be used to design and evaluate a game iteratively (Schoenau-Fog, Birke, and Reng, 2012), a functionality we find useful and beneficial.

6.1 Continuation Desire

In his article Schoenau-Fog (2011b) distinguishes between motivation and player engagement. He states that motivation is related to the reasons for starting to play and defines player engagement as being the reasons for wanting to keep playing. He explains it as *"what it is that "hooks" players so much that they want to keep playing"* (Schoenau-Fog, 2011b). He further argues that player engagement begins with the motivation to start playing and is then driven by the motivation to continue. The reason for the distinguishment is that in some situations a player can start playing a game, without being engaged (e.g. boredom or school assignments). Schoenau-Fog further defines player engagement as the level of continuation desire experienced, while or after playing (Schoenau-Fog, 2011b).

Through a ground theory approach, Schoenau-Fog allocated different factors which make up the player engagement process (PEP), which became the categories presented in the OA3 framework (Schoenau-Fog, 2011b). Through questionnaires he gathered opinions on the following questions: *"What in a game motivates you to play?", "What in a game makes you want to continue playing?"*, and *"What in a game makes you want to come back to play?"*. The survey was carried out with 41 participants, and resulted in 205 answers related to the posed questions (Schoenau-Fog, 2011b). Through various coding techniques the answers could be categorized into the four components of the OA3 framework, which will be presented below. Furthermore Schoenau-Fog rank-ordered the components and categories of the OA3 framework, by ranking the answers to "What in a game makes you want to continue playing?" according to the frequency of each answer (Schoenau-Fog, 2011b).

Figure 6.1: The OA3 Framework.



Schoenau-Fog's findings narrowed down the concept of player engagement into four main components: Objectives, Activities, Accomplishment and Affect Schoenau-Fog (2011b). With

each component presenting multiple triggers for engagement, along with multiple disengagement triggers. Schoenau-Fog proposes that player engagement can be described as a process. The PEP explains the chronologically ordered characteristics and connections between the four main components.

Schoenau-Fog visualises the PEP through the OA3 framework, shown on Figure 6.1. The framework consist of two loops explaining the chronological relationship between the components in a full loop (e.g. Objectives -> Activities -> Accomplishment -> Affect -> ...) and a short loop (e.g. Objectives -> Activities -> Affect -> ...).

Before entering the loop the player is motivated to play due to intrinsic (e.g. wanting to learn about a subject or to socialize) and/or extrinsic (e.g. commercials, suggestions by friends) reasons. When entering the loop most games set an objective for the player. The objective set by the game is defined as an extrinsic objective (e.g. save the princes, collect points, complete the quest). These are objectives set by an extrinsic entity (i.e. the game). The objectives can also be set by the players themselves, this is defined by Schoenau-Fog (2011b) as an Intrinsic objective (e.g. talking to every NPC, building the tallest tower, collect all items in a game). A game normally sets up an amount of extrinsic objectives and the players themselves often set up various intrinsic objectives. These objectives can change as the game progresses.

Table 6.1: Activities ranked by their impact on the desire to continue (descending).

Activity	**Description**
Experiencing the story	Completing objectives which develop or progress the story of the game
Socializing	Sharing the experience with others, includes social game experiences such as competition, collaboration and co-creation
Sensing	Experiencing the audio-visual and haptic part of the game aesthetics. E.g. games which have sensory feedback, or a compelling audio-visual design
Exploration	Engage with the environment of the game. Seeking the boundaries of the game world. Investigating combinations and so on
Experiencing the characters	Experience the characters evolve or explore how they are affected by the game or the players actions
Solving	Completing and engaging in intellectual challenges and puzzles. Experiences where the player is mentally challenged
Experimentation	Customization of characters, game world and game rules
Interfacing	Experiencing a innovative or challenging control scheme
Destruction	The demolition of structures and the killing of NPCs and opponents
Creation	Creating and adding to the game world or rules

As the objective is set, the player then engages in activities to accomplish the objectives. Schoenau-Fog categorized and ranked the activities derived from his evaluation based on their impact on the desire to continue playing, see Table 6.1. The activities which ranked highest in their impact on continuation desire are: experiencing the story, socializing, and sensing. Even though experiencing the story was frequently mentioned as an engagement trigger, for some it could also be a disengagement trigger (e.g. too much story, too complex story), and this is the case for all the activities. Schoenau-Fog (2011b) argues that the triggers and activities can be further expanded and investigated as their impact on the desire to continue can vary depending on several aspects such as player preferences, demographics and setting. His research does not include demographics such as children. Further categorization of activities which engage and disengage children in particular could be useful to allocate, when designing for games for museums.

Depending on the loop the player experiences either accomplishment or affect after completing an activity. The short loop describes the possibility to experience affect without accomplishment as long as the objective is not completed (e.g. meditative game experiences, where the activity itself provides *relaxation* and the player therefore continues playing without accomplishing the objective, as described by Mihaly Csikszentmihalyi (1990) in the theory of Flow). The full loop describes the experience when the execution of an activity has resulted in objective completion and therefore leads to Accomplishment.

Schoenau-Fog argues that Accomplishment consists of several components: Achievements, Completion, and Progression. Achievements have to do with the player's continuous desire to unlock content such as new levels, items, customization possibilities for characters and so on. Some players become disengaged if there is no possibility for achievements.

A player also becomes engaged in games because of the desire to complete tasks, quests, bosses, levels and so on. Some players have to complete all the quests in a game, collect all the coins, or collect all items, read every book, and so on (Schoenau-Fog, 2011b). This completion desire is defined by Schoenau-Fog (2011b) as the desire for Completion.

Progression is defined as the players desire to continue if they have the possibility to progress in experience points, character levels, weapon damage, better spells, faster weapons, harder enemies and so on. The desire to progress also entails bettering of the player's physical and mental skills, such as mastering and manipulating the controls or rules of games. Completion was the component of Accomplishment which had the largest impact on the player's desire to continue playing, whereas Achievements has the lowest impact on continuation desire.

As the result of an accomplishment or an activity, the players experience some emotional affect. Schoenau-Fog (2011b) argues that the affects players seek can be categorized into: Positive affect, Negative affect, and Absorption. The Positive affect entails players who wish to continue playing if the experience leads them to feel positive emotions such as enjoyment, success, excitement and so on. The positive effect could also be of physical nature, such as relaxation, adrenalin rush or empathetic reactions for characters. The Negative affect relates to the emotions produced by disengagement triggers, such as frustration and boredom. A negative affect can also lead to the continuation of the loop, e.g. if the frustration of a difficult control scheme leads to players becoming better and therefore satisfied once they master it. Absorption relates to the players experience of concepts such as flow, presence and immersion. It has to do with players experiencing an altered perception of time or that they are feeling present in the game world. If the players feel that the affect of the accomplishment or activity is engaging, the loop can continue.

6.2 Measuring Engagement as a Construct of the desire to continue

In order to measure the desire to continue for participants playing games, Schoenau-Fog (2011a) proposes the ESQ. The method is based on the work of Mihaly Csikszentmihalyi (1997), namely the Experience Sampling Method (ESM) (Mihaly Csikszentmihalyi, 1997) and the PEP.

The ESQ is proposed as an intrusive method. The objective of the method is to gather the level of engagement (desire to continue) before, during, and after a playthrough. The ESQ not only seeks to allocate the level of engagement, but also its triggers, therefore the questionnaire is also directed at providing information about the four components of the PEP and OA3 framework (Objectives, Activities, Accomplishment, Affect). The ESQ proposed by Schoenau-Fog (2011a) consists of 18 questions. A short version of the questionnaire containing only the questions related to the overall measure of continuation desire, called the Basic Game ESQ, is presented in Table 6.2 (Schoenau-Fog, Birke, and Reng, 2012).

Table 6.2: The basic Game ESQ (Schoenau-Fog, Birke, and Reng, 2012).

Before the playthrough
Please indicate below the extent to which you agree or disagree with this sentence: “I want to begin the experience” (to quantify the users Continuation Desire (CD)) - 7 point likert scale - 1 being Disagree strongly and 7 being Agree strongly.
“What makes you want/not want to begin?” (to identify the user’s CD and objective) - Text answer
During the playthrough
Please indicate the extent to which you agree or disagree with this sentence: “I want to continue the experience now!” - 7 point likert scale - 1 being Disagree strongly and 7 being Agree strongly.
“What makes you want/not want to continue?” (to identify the source of the user’s CD and objective) - Text answer
After the playthrough
Please indicate the extent to which you agree or disagree with this sentence: “I want to try again!” - 7 point likert scale - 1 being Disagree strongly and 7 being Agree strongly.
“What makes you want/not want to try again (in the application / experience)?” - Text answer

The remaining questions in the ESQ have to do with, demographics, general comments and further allocating the triggers within the four components (e.g. *"What do you want to do next?"* (Activites), *"What do you feel now?"* (Affect)). The ESQ can be combined with other methods such as observations, questionnaires (e.g. the GEQ or GEQ(2)), runtime user behaviour (game data logs of the player’s actions), or psychophysiological measures (Bateman and Nacke, 2010; Mandryk, Atkins, and Inkpen, 2006).

The Basic Game ESQ was used by Schoenau-Fog, Birke, and Reng (2012) to evaluate design iterations in the development period of the game Space Bug’z. The reasoning for the iterative

evaluation of the design was to allocate design components which decreased or increased the participant's desire to continue. This was done in order to keep, change or exclude components in the next iteration, as it also leads to the possibility of reverting back to an earlier iteration if needed. Schoenau-Fog, Birke, and Reng (2012) evaluated on five design iterations using the Basic Game ESQ as an intrusive method. They conclude that the method was useful as a template for assessing continuation desire in games and that additional questions could be implemented to further investigate the engagement triggers (or disengagement triggers) of the game. They also argue that it could have been beneficial to have the same group of participants throughout evaluation of the iterations, this could have provided a convergent view of the participants' desire to continue, as many factors which vary based on each individual, could influence the findings (e.g. player types and previous knowledge of games).

Designing our game according to the OA3 framework, and using CD to evaluate over several iterations could prove useful for this thesis. By using the OA3 framework as a design tool, we can establish the whole PEP. We can define an objective, activities to solve the objective, accomplishments when solving the objective, and then evaluate how these elements contribute to the player's affect and engagement process. As argued by Schoenau-Fog, Birke, and Reng (2012), the iterative design evaluations should be conducted with the same participants in order to isolate player preference variables over time.

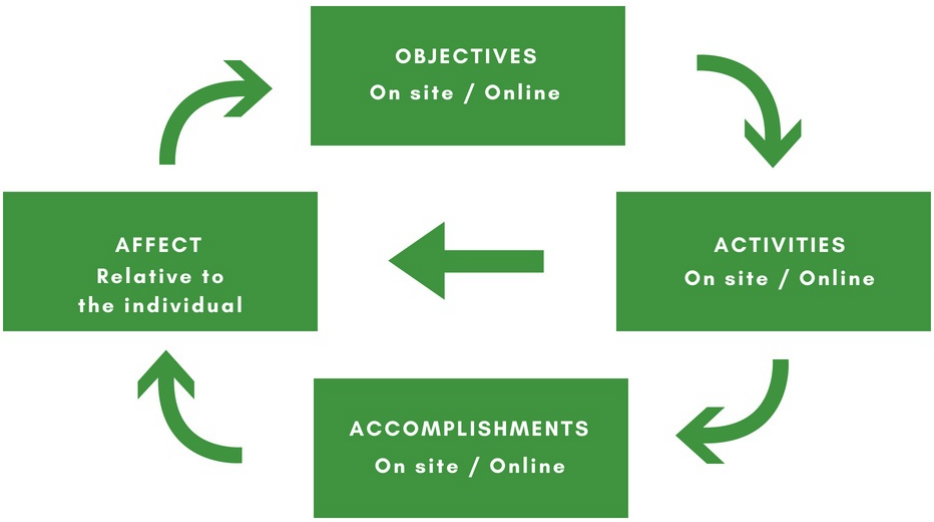
6.3 Continuation Desire in a Museum Context

As one of the objective of this thesis is to create an engaging experience for children, the measurement methods have to accommodate the target group. The Basic Game ESQ is very similar to both the Again-Again table and the Smileyometer is its design. The Basic Game ESQ and the Again-Again table have similarities in the construct of what they have been used to measure. Schoenau-Fog, Birke, and Reng (2012) used the Likert scale item *"I want to do this again"* after their playthrough (see Table 6.2), which is very similar to *"Do you want to do it again?"* from the Again-Again table. It could also be argued that the concepts of returnance and the desire to continue have some coherence in their nature as they both seek to describe an individual's opinion on returning to an experience. The Basic Game ESQ with its simplicity and similarities to other measures appropriate for children (e.g. Again-Again table, Smileyometer, Children IMI interest/enjoyment scale) should in comparison to the methods such as the GEQ and GEQ(2) be easier to understand and therefore has the possibility to be a tool for measuring the level of engagement experienced by children.

This thesis will use both of the measures (Basic Game ESQ and Again-Again table) in order to validate the ESQ as a measurement for engagement in museum game experiences, as a measurement of engagement in children, and to further investigate comparability between the Basic Game ESQ and the Again-Again table.

When taking into account the online part (virtual context) explained in section 5.1, The Contextual Model of Learning, and the National Museum's wishes to develop experiences that bridge on site and online experiences, the way we can use the Player Engagement Process changes. As the online part is not limited to be experienced at the museum (on site), the new location (wherever the game is played) adds a second dimension to at least three of the four main components, as presented on Figure 6.2. An objective can now be presented to the player either on site or online. The activity related to that objective can also be experienced either on site or online. The objective can be given online, while the activity needed to complete that objective can be carried out online and/or on site (e.g. Objective: Solve the puzzle -> Activity: Connect items in the exhibition) and vice versa.

Figure 6.2: The adapted OA3 Framework (On site / Online).



As an activity is carried out and the objective is completed, the achievement can now be provided on site and/or online (e.g. unlocking new content in the game or getting free access to an exhibition which then provides the player with more activities to do).

Solving a puzzle online can result in new objectives and activities unlocking at the museum and so on. The affect stays relative to the individual but can also be experienced both on site and online. It will be interesting to see the effect of a changing setting (on site vs. online) when experiencing the game, it will also be interesting to further investigate which objectives, activities and achievements result in an increased desire to continue playing and desire to return at the museum.

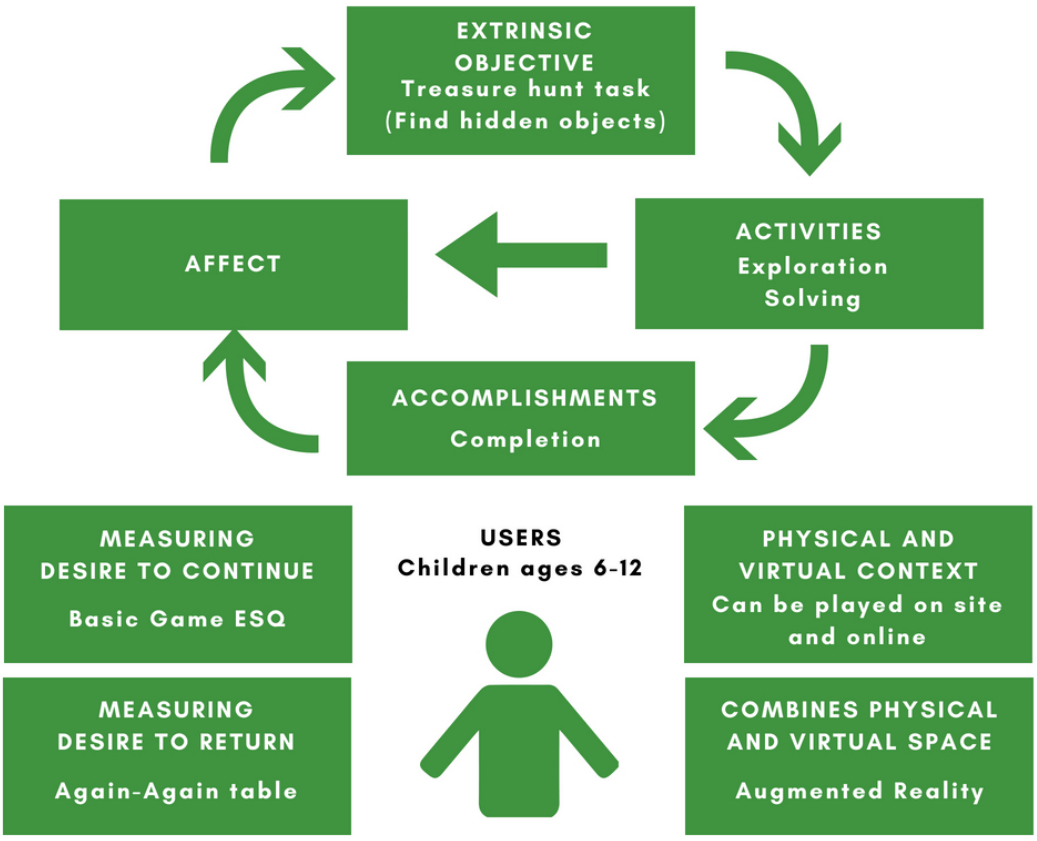
To research which on site and online objectives, activities, and accomplishments we can utilize in the design for the game in this thesis, we should analyze state of the art museum games and commercial games. By setting them in context with the OA3 framework, and allocating which parts are carried out on site or online, we can begin to design a game that is based on the OA3 framework and that is in accordance with the museum's new strategy.

As found in the previous chapter, treasure hunt tasks facilitate engagement in children at museums. This task in context with the OA3 framework would be an Extrinsic objective stating that certain hidden objects have to be found, and the activities related to completing the objective would be Exploration and Solving (if there are puzzle elements or riddles hinting at the location of the treasure which can be solved). Accomplishments would then be in the form of Completion. In the state of the art analysis of museum games we attempt to detect if any of the successful games utilize these components in the OA3 framework, to validate if we should use these or not.

Furthermore we found that using the Basic Game ESQ and Again-Again table could prove useful to measure to which effect the game we will develop can influence the desire to continue and the desire to return to the museum. We also found that CD can be used to iteratively evaluate our design, something we should do with participants over several design iterations.

Figure 6.3 shows the design guidelines we should use, with the OA3 framework inserted.

Figure 6.3: Updated design guidelines.



II State of the Art Games Analysis

7. Museum Games

This chapter will present the results of a state of the art analysis of museum games for children. The games included in the analysis are developed by/for international museums and danish museums. The games included are produced for museums of various types, such as natural history, cultural history, science, and art museums. As this study explores the possibilities of games on mobile devices, all included games play either partly or solely on mobile devices (smartphones and tablets). In total 16 games were included in this analysis.

The games included were analysed with a focus on exposing popular objectives and activities (i.e. as in the OA3 framework), target groups preferences, latest technologies and how the games bridge the physical and virtual space of the museum. We look at if and how the games can be played either on site or online.

Furthermore the analysis has the purpose of allocating trends and conducts within the industry, and to provide guidelines for the development of the our prototype.

The included games are of various ages. LaunchBall is one of the older games, as it launched in 2007 (Preloaded, 2018a). The game was one of the pioneers in the genre of games for/by museums. Whereas Treasure Hunters which launched March 2018, is one of the newest games (ScienceMuseum, 2018d).

The analysis of the included games proposes four sections of interest. The first being how the games connect to their appropriate museums. Is the game only playable when the visitor is present in the exhibition (i.e. on site) or can the game can be played anywhere (i.e. online)? The second category has to do with technology, namely AR. The technology is used for various purposes at museums and has various applications. We look at AR as opposed to VR, as it can be used on a mobile device without additional devices. The third category has to do with the community surrounding the games. Communities keep the game alive over a longer period and was mentioned in a focus group with the museum's employees as important to the National Museum's new strategy for interactive media. The method and results for the focus group will be presented in the Design chapter, section 11.1.8.

The last category is popular activities, and is included to provide an overview of the design of these games and why they are made. In short, we present their purpose. The most prominent titles will be investigated further and set in context with the OA3 framework in order to provide guidelines for designing the game.

7.1 Connection to the Museum

As the National Museum wishes to bridge the on site experiences (e.g. at the museum, in exhibitions) with the online experiences (e.g. website, mobile games) we decided to look into how other games have catered to those experiences. The analysis will be divided into three categories: games which can be played both on site and online, games which exclusively can be played online, and games which exclusively can be played on site.

7.1.1 Games which can be played both on site and online

Out of the 16 games analyzed only four were playable both on site and online. The four titles are Rugged Rovers (Preloaded, 2018c), LaunchBall (Preloaded, 2018a), Treasure Hunters (ScienceMuseum, 2018d), and Tate Trumps (TateGallery, 2012b).

Rugged Rovers

Rugged Rovers is a competitive multiplayer game (Preloaded, 2018c). The game was originally designed as an installation (it was later released for mobile devices, available on Google Play and App Store) for the Science Museum (UK) for their "Engineer the Future" exhibition (ScienceMuseum, 2018b). It is mostly an interactive exhibition including other games such as Futureville (ScienceMuseum, 2018c). The exhibition has the purpose of motivating children in the age group of 11 to 15 to learn about engineering and the possibilities a job in engineering can provide.

Rugged Rovers tries to explain the iterative design process of robotics using the case of building a Mars rover. The general objective of the game is to design a rover that can travel the furthest (see fig. 7.2). The player experience of the game in context with the OA3 framework is presented in Figure 7.1. The gameplay experience can be described as following:

- The players are provided with the objective of designing and building their own rover with the focus of designing the rover which can travel the furthest.
- The players then carry out the activity of building and designing their rover.
- When finished with the design, the player then launch their rovers into a rugged landscape (resembling an alien planet).
- From here on the game takes over and based on the quality of the rover design the rover then travels a certain distance before stopping and crashing.
- The rover which traveled the farthest wins and in addition the leader of the day is displayed for everyone to see and beat.

As for the challenge of designing a game which is present both on site and online, Rugged Rovers has ported the game to mobile devices. The gameplay on site and online does not reinforce each other in any way. The players on site can challenge the leader of the day and the other players participating in the same playthrough, while the players online challenge an online highscore table. There is the chance that players are being motivated to visit the museum after playing the game online, as they might desire to beat the leader of the day at the museum after practicing at home.

Figure 7.1: Rugged rovers in context with the OA3 framework.

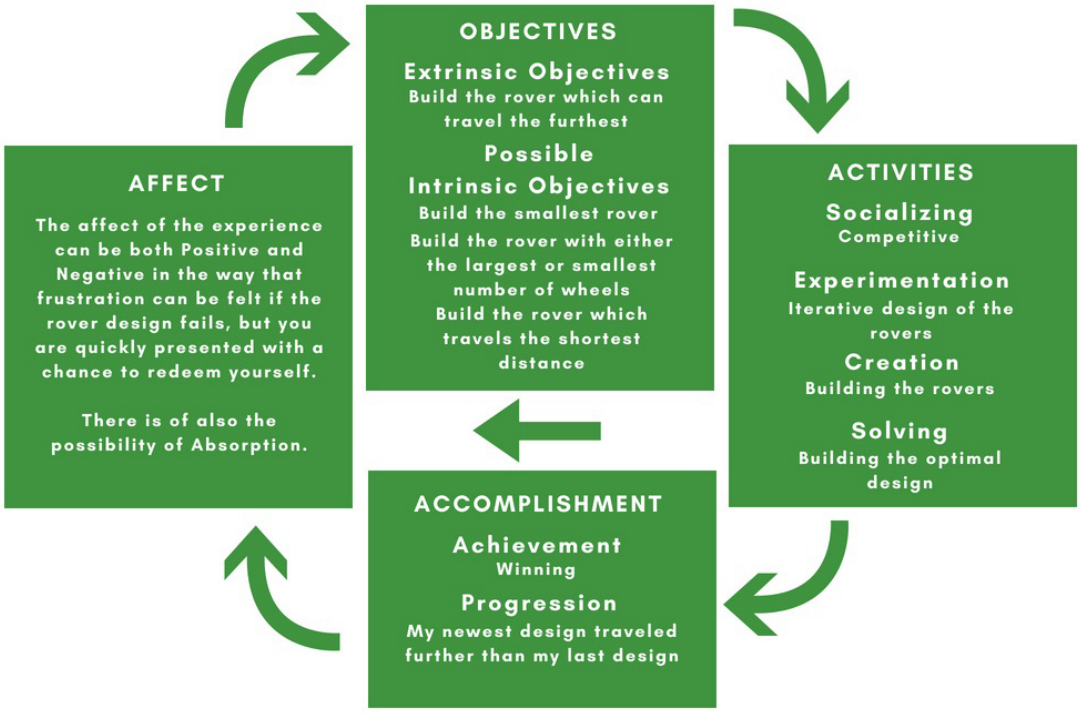
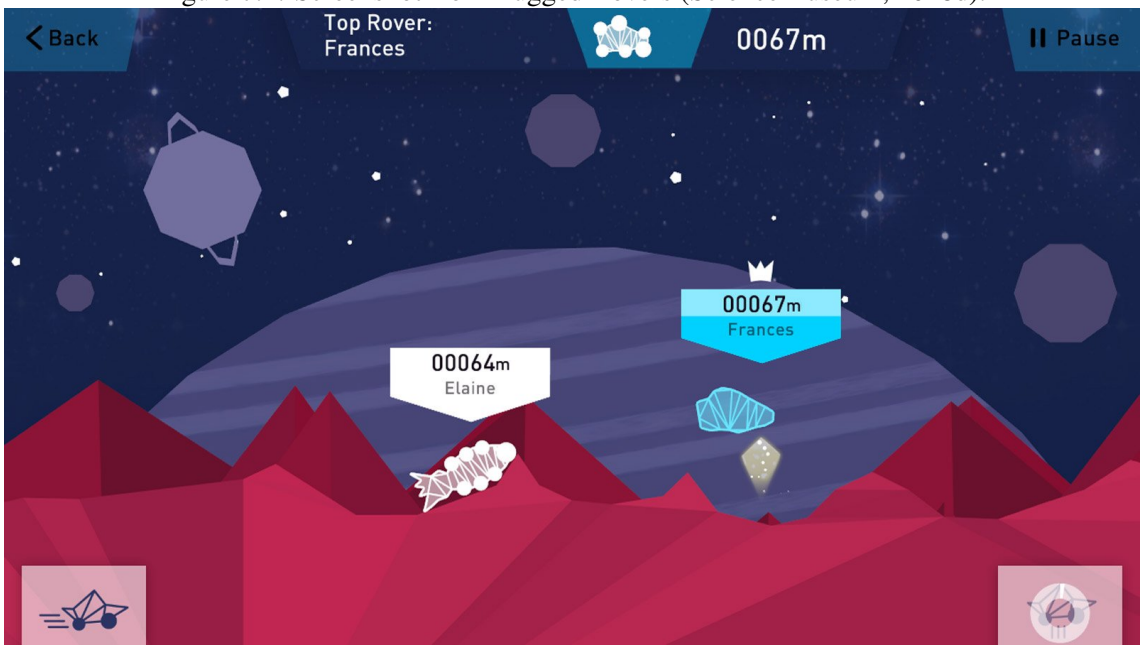


Figure 7.2: Screenshot from Rugged Rovers (ScienceMuseum, 2018d).



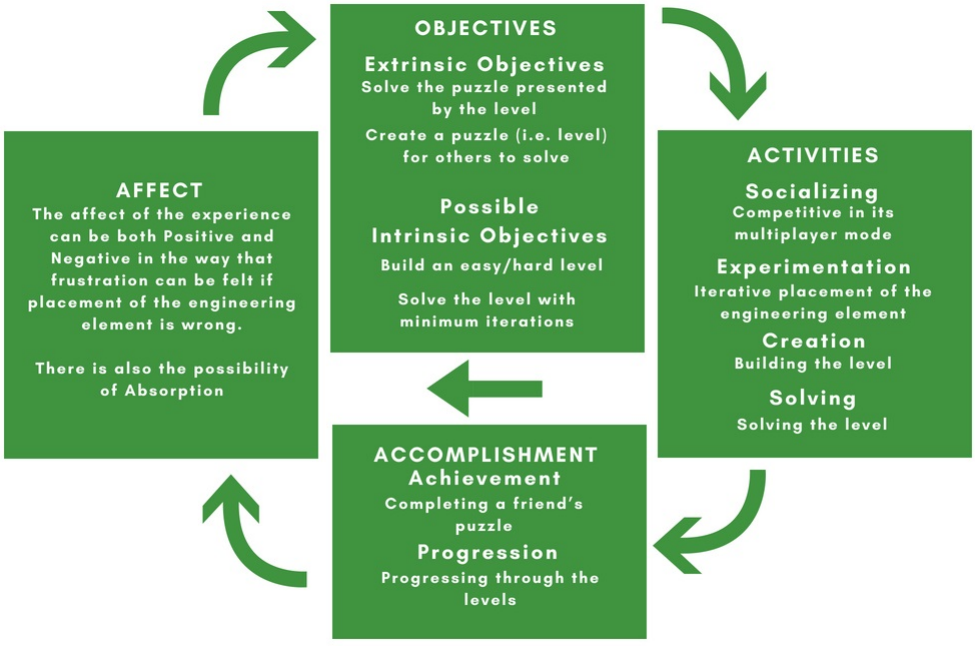
LaunchBall

Another game which was originally designed for the exhibition and later ported to mobile devices (and a website) is the sandbox puzzle game LaunchBall (Preloaded, 2018a). The game was originally developed for an exhibition at the Science Museum, UK, and has won several awards in both the game and museum industry. The game targets children in the age group of 7 to 14, with the purpose of educating them about the basic elements of physics (e.g. force, attraction, motion, energy). The main objective in the game is to make a ball travel from a start point to a goal by placing different elements of engineering such as turbines and magnets, which then affect the ball's trajectory. The game functions as both a single and multiplayer experience, separated into two gameplay modes. The single player mode presents the player with an objective created by the developers, whereas the multiplayer mode presents the player with an objective created by another player. The player experience of the game is very similar to the player experience of Rugged Rovers, as it also has an initial stage (i.e. designing a rover and placing the engineering element) and after that launching the game. The player experience in context with the OA3 framework is presented in Figure 7.3. The full gameplay experience can be described as following:

- The game or another player presents an objective (i.e. puzzle in the form of a level) to the player.
- The players then engage in the activity of placing the engineering elements, in order to affect the ball's trajectory or path through the level.
- The players then launch and the games then takes over. The player perceives the effect of the engineering element's placement.
- The ball then reaches its goal or stops on the way. Dependent on success the player then progresses to a new level or tries the level again.

When developed, LaunchBall could only be played on site at the museum on a device (we assume on a PC) and players could take turns playing the game. Once it was ported to mobile devices, the game could be played online and thus anywhere. There was never any interplay between the on site and online parts, and today the on site part is no longer available.

Figure 7.3: LaunchBall in context with the OA3 framework.



Treasure Hunters

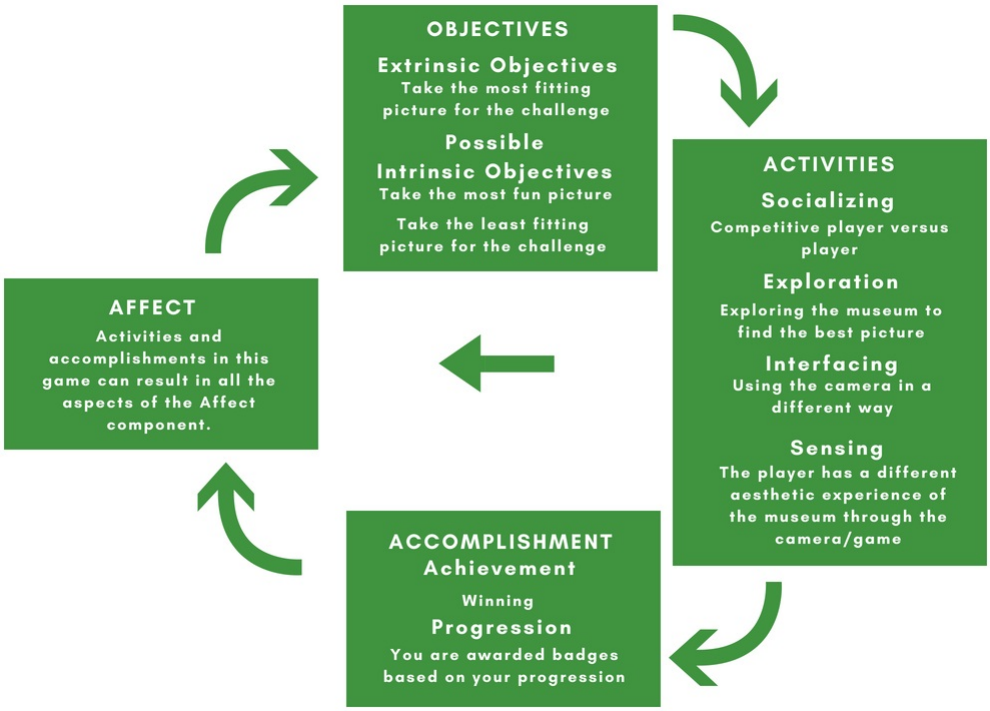
Treasure Hunters is the newest of the three games from the Science Museum, UK (released March 2018) (ScienceMuseum, 2018d). It is a turn based photo challenge game, with objectives and activities resembling board games such as Cards Against Humanity (CardsAgainstHumanity, 2011) and Dixit (Libellud, 2008). The game is meant for people to play at the museum (or any of the museums belonging to the Science Museum) and at home. The objective of the game is to take the best picture based on a description/challenge presented in the game (e.g. *"Can you find a piece of wood?"*). Players then search their surroundings, and take pictures to solve the objective. They are awarded points depending on how well their photo match the objective. Players can play against each other or team up.

The game has a less serious purpose than the previous games developed for the Science Museum, UK, as the purpose is to start discussion between players and provide a social experience at the museum. Treasure Hunters does not follow the same gameplay experience as the two previous games. The experience is set in context with the OA3 framework presented on Figure 7.4.

The gameplay experience can be described as following:

- The game provides the players with an objective in text form (e.g. "Take a photo of the largest artifact in the museum").
- The players then take turns to go around in the museum to photograph what they feel matches the challenge.
- After the players have taken their photos the players then vote on which pictures are the best match for the challenge and the player with the highest amount of votes wins.

Figure 7.4: Treasure Hunters in context with the OA3 framework.



On site, the game can encourage social interaction between visitors, and the challenges posed by the game change depending on which on site location the game is played. The online part presents a set of random challenges without any special ties to a location. It should be noted that the challenges which are posed on site can be accessed even without being present at the exhibition,

but it does not make much sense as the challenges are based on the exhibits at each museum under the Science Museum, UK.

Tate Trumps

Tate Gallery has a game called Tate Trumps (TateGallery, 2012b). The gameplay is indicated by the title, as it is a game of trump. The idea is that each artwork at the gallery has been awarded a set of stats (*Exhilaration, Menace,* and *Absurdity*), so that artworks can be compared based on those values. Players search the gallery for artworks they think have a certain set of stats, collect them by using a code written on each artwork label, and then players can fight by comparing the stats of the artwork that each player found. The purpose of the game is to engage players with the artworks, and having them think about which stats each artwork might have. The game was originally exclusive to being on site at the gallery, but it has since been adapted to work online as well (all the artworks in the gallery can be found within the game, instead of having to look through the exhibition). Figure 7.5 shows Tate Trumps set in context with the OA3 framework.

Figure 7.5: Tate Trumps in context with the OA3 framework.

We did not find any games which have their on site or online aspects directly reinforce each other, meaning that the two parts work independently of each other.

To bridge the on site and online parts, this thesis should seek to create a more dynamic behavior between the two parts. This is something not done by the analyzed games, and it could be interesting to study if it can increase engagement and result in an increase in the desire to return to the museum.

All the games in this category include social activities and many of them rely on competitive multiplayer gameplay. That means that all the games in this category were designed in order to relate to the sociocultural context explained by Falk and Dierking (2012). It is worth mentioning that three of the games also include a singleplayer mode (i.e. LaunchBall, Treasure Hunters, and Rugged Rovers).

7.1.2 Games which exclusively can be played online

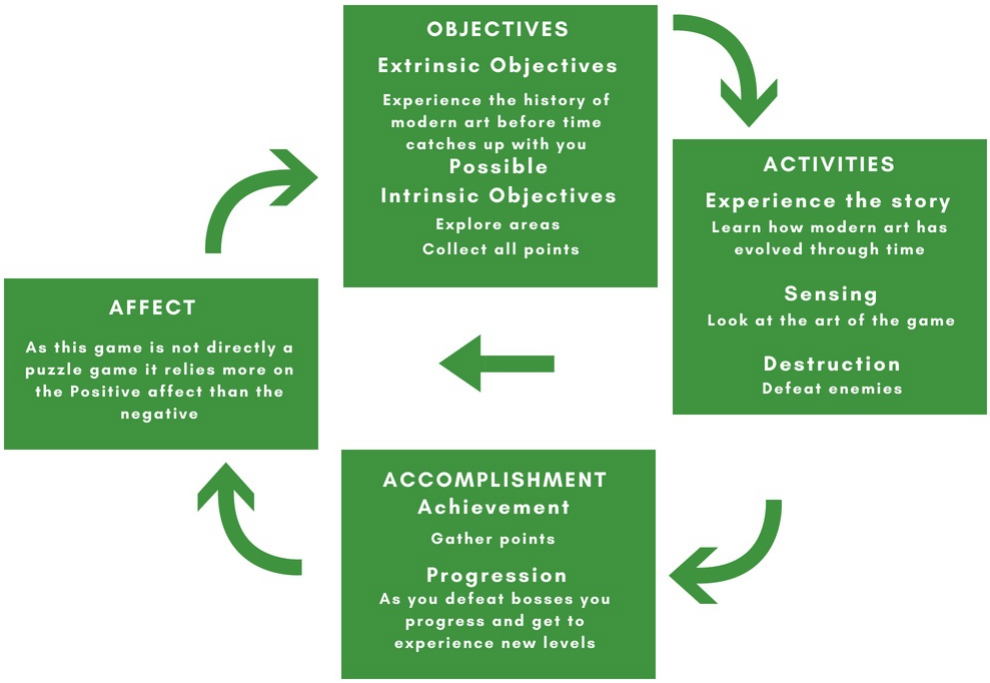
The games included in this analysis are not part of an exhibition, but they may connect to an exhibition through a narrative or learning purpose. LaunchBall could be included in this section as well, as the installation is not present in the museum anymore. Out of the 16 included in the state of the art analysis, seven of them can exclusively be played online. The seven titles are:

- Transmission (Science Museum, UK) (ScienceMuseum, 2018d)
- Race Against Time (Tate Gallery, UK) (TateGallery, 2012a)
- Aquation: The Freshwater Access Game (Smithsonian, USA)(Smithsonian, 2017a)
- Morphy (Smithsonian, USA) (Smithsonian, 2015)
- Disaster Detector (Smithsonian, USA) (Smithsonian, 2017b)
- Kampen om de Syv Have (Experimentarium, DK) (Experimentarium, 2017b)
- Mobilhund (Experimentarium, DK) (Experimentarium, 2017c)

Race Against Time

Race Against Time is a 2D platformer developed for the Tate Gallery (TateGallery, 2012a). The games takes you through the history of modern art, starting back in time at the beginning of modern art. The purpose of the game is to inform how modern art has evolved and to motivate players to learn more about art. It is rated as being for ages 4 and up. The game only connects to the museum in the aspect of overall narrative (i.e. modern art), but not to a specific exhibition or exhibit. The game has a deeper narrative than the previous described games. In the game you play as a chameleon collecting chromo colors (i.e. points). As you progress through the levels you encounter bosses and jumping puzzles. The game provides a very different player experience than the previously mentioned games, as it does not include a social activity (collaborative or competitive). The player experience in context with the OA3 framework is presented on Figure 7.6.

Figure 7.6: Race Against Time in context with the OA3 framework.

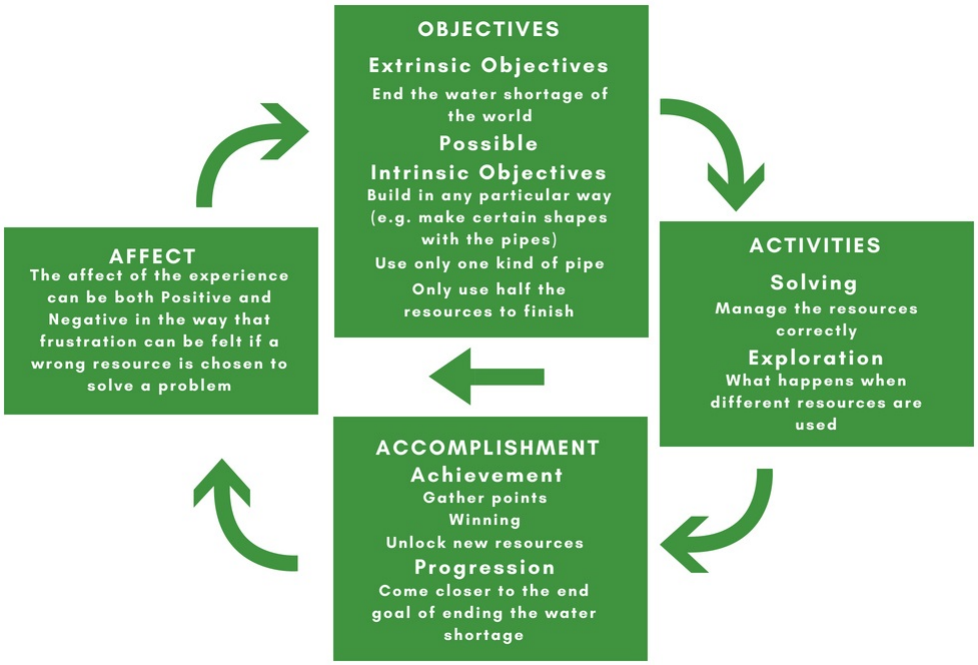


Games from the Smithsonian

There are several similarities between the games developed for the Smithsonian Institute (i.e. Aquation, Morphy and Disaster Detector). Two of them, Aquation: The Freshwater Access Game (Smithsonian, 2017a) and Disaster Detector (Smithsonian, 2017b), seek to inform children about societal and natural problems, in this case water shortage and the possibility for natural disasters. Whereas Morphy (Smithsonian, 2015) has the purpose to teach that animals have evolved in order to survive. Aquation: The Freshwater Access Game and Disaster Detector do not only inform, they also attempt to teach what can be done to prevent these problems in future. We will present Aquation: The Freshwater Access Game as an example of how the Smithsonian approaches games.

Aquation: The Freshwater Access Game is a strategy game. The balance of water provision in the world is skewed and the player must use the resources of rich nations to build pipelines in order to provide water to the parts of the world which have none. The player experience of Aquation in context with the OA3 framework is presented on Figure 7.7.

Figure 7.7: Aquation: The Freshwater Access Game in context with the OA3 framework.



Science Museum games

The last games in the analysis are all science museum games (Science Museum, UK, and Experimentarium, DK). As games from the Science Museum, UK, have previously been covered we will provide a short description of the additional games from the Science Museum, UK, and their gameplay. Transmission (ScienceMuseum, 2018d) is a puzzle game with the purpose of teaching the science behind communication (e.g. signal waves, radio waves). The objective of the game is to solve puzzles and progress through the stages.

Kampem om de Syv Have is a resource management game for the Experimentarium, DK (Experimentarium, 2017b). The narrative of the game is that you play as a captain on a cargo ship. As a player your objective is to deliver the correct goods to the correct location. The game functions both as multiplayer and singleplayer versus the game. Mobilhund is similar to the 1990's Tamagotchi toys. As a player you have to take care of a dog by feeding it, walking it (using GPS location) and so on. The objective of the game is to make the dog as happy as possible.

Almost all the games in this category are single player game experiences, except Kampen om de Syv Have (both single and multiplayer). This could be a result of the games being designed to be played at home and not at the museum, meaning that the sociocultural context of being at a museum is not present.

7.1.3 Games which exclusively can be played on site

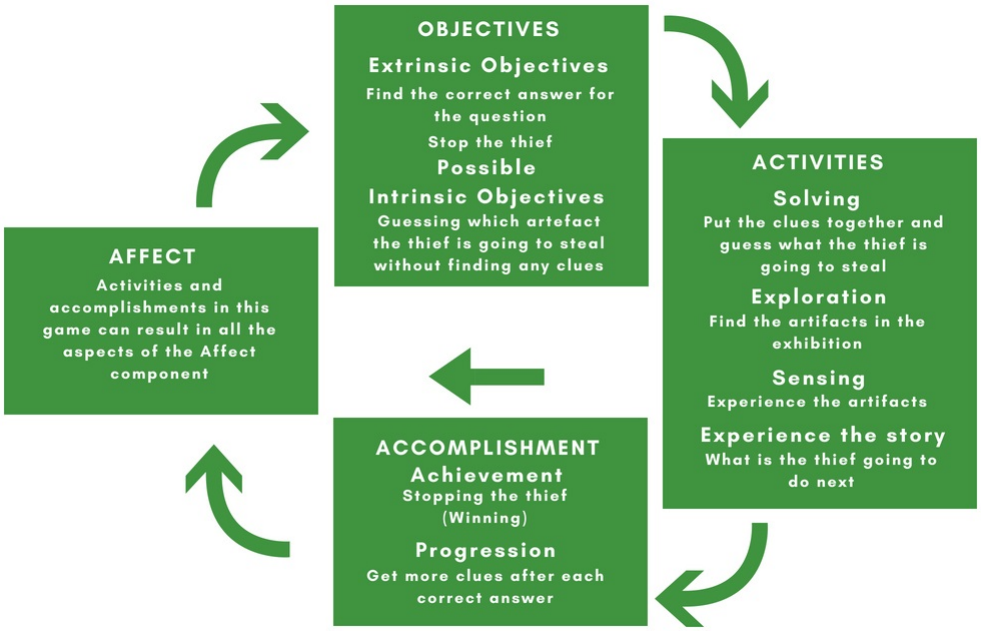
Out of the 16 games which were analyzed, five of them are directly tied to at least one exhibition, and are not playable outside the exhibitions. The five games are:

- The Museum Mystery (Multiple danish museums, including Christiansborg slot, DK) (Monkey, 2016a)
- Futureville (Science Museum, UK) (ScienceMuseum, 2018c)
- Micro Rangers (American Museum of Natural History, USA) (AMNH, 2016)
- Nature Quest (Several locations in the danish nature, DK) (Monkey, 2016b)
- Energi-Agent (Experimentarium, DK) (Experimentarium, 2017a)

The Museum Mystery

The Museum Mystery game (Monkey, 2016a) is produced for several danish museums including Christiansborg Slot, Fredensborg Slot and Roskilde Museum. The game is available through the Useeum mobile app (Useeum, 2018), which is an collection of apps related to museums. The games utilize all the museum exhibitions in order create an experience reminiscent of a treasure hunt. In the narrative, the player plays as themselves and have to help to catch a thief who is about to steal an artifact from the given museum. The thief offers the player a way to catch him, by providing clues as to which object he is going to steal. To get a clue, the player has to find certain artifacts and answer a question related to the artifact (e.g. "How many necklaces is the woman on the painting wearing?"), if the players answer correctly, they get a clue. The purpose (besides entertainment) of the game is to get the players to explore the exhibitions. The player experience is presented in context with the OA3 framework on Figure 7.8.

Figure 7.8: Museum Mystery in context with the OA3 framework.



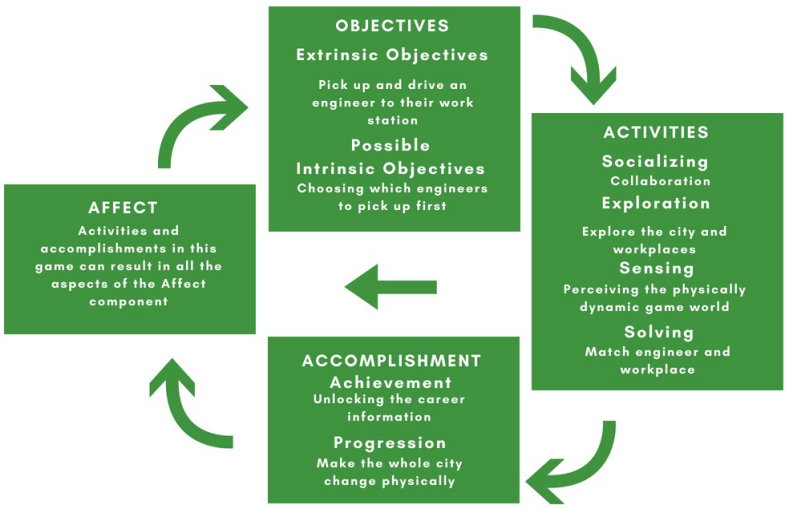
Nature Quest

The game Nature Quest is also available through the Useeum app, and is produced by the same developer as the The Mystery Museum (Monkey, 2016b). The game takes place in nature, as players have to find specific locations in nature which then progresses the story. The narrative in revolves around either saving or destroying nature. A character named Akiko tries to save nature, whereas a character named Polle wants to destroy it. You can choose who you want to help and then the story will unfold.

Futureville

Futureville is a multiplayer (up to five players) game made for the Science Museum, UK (ScienceMuseum, 2018c). The game is developed by Nexus Interactive, lead by BAFTA winning animator/director Jim Le Fevre. The game is projected on a customized installation at the museum, which physically changes as the game progresses. The game has the purpose of informing children in the age group of 11 - 15 about the possibilities a career in engineering provides. As a player you drive around Futureville to pick up engineers and drive them to work. As you drop of the engineer at the appropriate workplace, the installation physically changes, and you get information in regards to the career of the engineer you just dropped of via projections on the reformed installation. The player experience is presented in context with the OA3 framework on Figure 7.9.

Figure 7.9: Futureville in context with the OA3 framework.



Micro Rangers and Energi-Agent

The last two games in this category are Micro Rangers (AMNH, 2016) and Energi-Agent (Experimentarium, 2017a). Micro Rangers is an Augmented Reality single player experience and will be described further in the AR category below. Energi-Agent is a multiplayer game which is connected to the energy related hands-on activities available at the Experimentarium, DK. The game provides the players with objectives with the purpose of motivating them to explore the activities.

In conclusion a vast variety of games have been produced for museums. Out of the 16 games included in this analysis, nine of them connected with at least one exhibition (on site) and seven of the games were exclusively meant to be played anywhere on a mobile device (online). Many of the games which were directly connected to an exhibition included socializing as an activity, either competitive or collaborative.

7.2 Augmented Reality

AR is a technology which has the possibility to add a virtual layer to the reality we perceive. AR through mobile devices has become very popular at museums of various backgrounds around the world. Many art museums are beginning the see the possibility of AR to bring life their static exhibitions (e.g. paintings, sculptures) to life. The William Kentridge exhibition (Kentridge, 2017) at Louisiana, Museum of Modern Art, DK, used AR to bring life to works of other artists. Before or while visiting the exhibition the visitors acquired the AN ART application which allowed them to point their camera at the artworks. The artworks then became alive (as animations) as an augmented layer was added to the works.

Many museums have used the technology to add an alternate informal experience to an artifact or exhibition. The Smithsonian Museum of Natural History, USA, has developed an AR application called Skin and Bones (Smithsonian, 2014). The application adds a virtual layer to their thirty year old exhibition called The Bone Hall. The exhibition features complete skeletons from animals various anatomical forms. The AR application then adds virtual skin to the bones, providing the visitor with insight into how the animals looked when they were alive.

The authors found it difficult to locate museum games which are implemented at a museum while utilizing AR in an interactive fashion.

Micro Rangers

Micro Rangers is a single player augmented reality game experience developed for the American Museum of Natural History, USA (AMNH, 2016). The narrative of the game asks the player to join the Micro Rangers and help them protect the microbiome which surrounds us from threats such as pollution. The purpose of the game is to educate the visitor (mainly children) about the problems and challenges of microbiotic world.

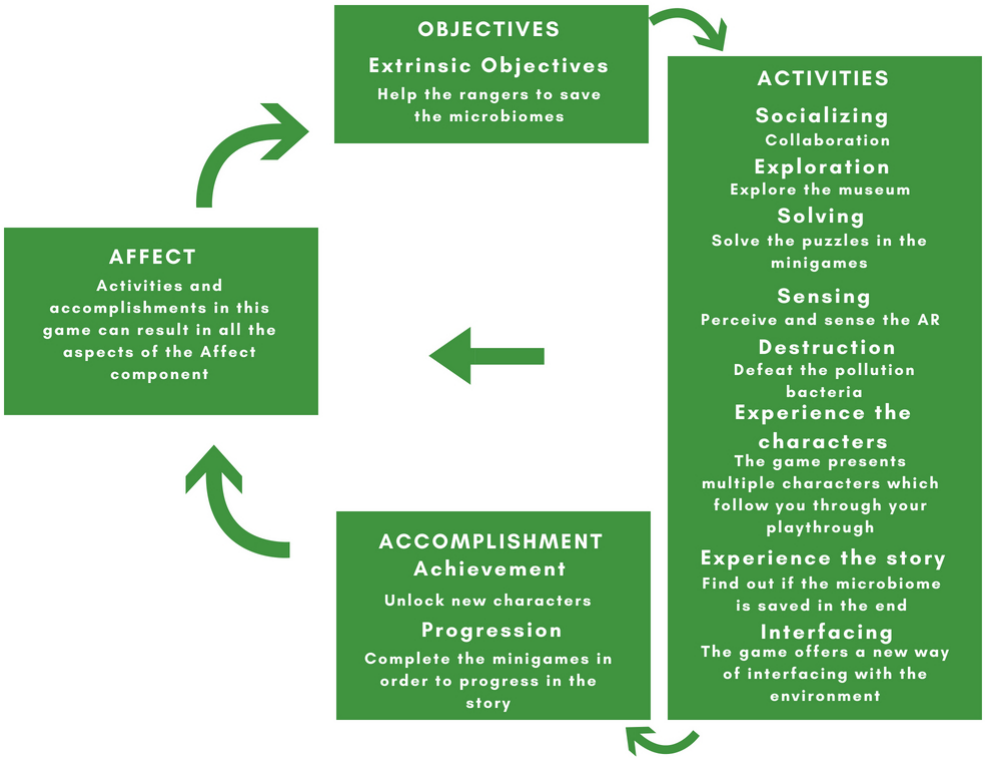
The game connects to most of the museum's exhibitions providing nine different objectives spread across the exhibitions. In order to play the game you need the Micro Rangers mobile app and a communicator coin (reminiscent of a poker chip). The gameplay experience can be described as following:

- The player points the phone at the communicator coin and a Micro Ranger appears standing on the coin.
- The Micro Ranger then provides you with an objective in the form of "Walk to the Hall of Ocean life and find the Coral reef diorama".
- The player then explores the musuem in order to find the location.
- When the right location is found the player then points the phone at the communicator coin and the Micro Ranger appears again and provide context to the following minigame.
- The minigame is in the form of an interactive AR experience, an example is that the player needs to swipe pollution bacteria away from microbes in the game in order to free them. The minigames throughout the game vary in format.
- After the minigame, the player has to point the camera at the communicator coin again and the ranger provides them with a new objective.

The game utilizes the AR technology well in order to provide a diverse experience throughout the museum visit.

The player experience is presented in context with the OA3 framework on Figure 7.10.

Figure 7.10: Micro Rangers in context with the OA3 framework.



As the use of AR is new to the museums, there are some limitations which are beneficial to take into account when designing and developing an AR experience. Ding (2017) proposes five elements which should be considered when making an AR experience:

- **The museum's ability:** The technology utilizes image processing technology in order to track the targets (e.g. the communicator coin in Micro Rangers). Many of these databases are only available online, which create the limitation that the mobile devices need to be online if the app is to be used, preferably connected to WiFi as the data being sent back and forth between the online service and the device can be large.
- **Visitor needs:** The museum should collect information on visitor preferences and behaviours in order to best suit their application for their audience.
- **The exhibition:** Does the exhibition need an AR experience and which exhibition would benefit from the experience. Ding argues that the experience should be designed for exhibitions which are difficult to curate, with traditional curation methods such as text panels and audio (Ding, 2017).
- **Evaluate on the experience:** Use appropriate evaluation method in order to determine the limitations of the experience and update the experience accordingly.
- **Create awareness:** As the experience only works if the relative game app is downloaded, it is important to advertise for the experience so the visitors are aware of its existence.

Using AR as an on site feature in the present study could lead to an engaging experience, as it caters to the National Museum's strategy of bridging the physical space and the virtual space. Furthermore as presented in the previous chapter 5, The Museum Experience, location-based AR mobile games can facilitate children's engagement (Xhembulla et al., 2014). The technology shows great promise and is easily accessible as it works on mobile devices.

7.3 Popular Activities

The games included in this analysis were analyzed and categorized using the OA3 framework. Each game was provided with tags (e.g. socializing, sensing) related to the activities which can be experienced in the game. A game can only be tagged with a specific activity once.

This section will present an overview of the activities present in the games. As the categorization is made on the basis of the author's interpretation and information provided by the museums' and games' websites, there will be the possibility for the presence of undiscovered activities. Figure 7.11 presents the frequency of the activities in the analyzed games.

Figure 7.11: Histogram of popular activities for all the games.

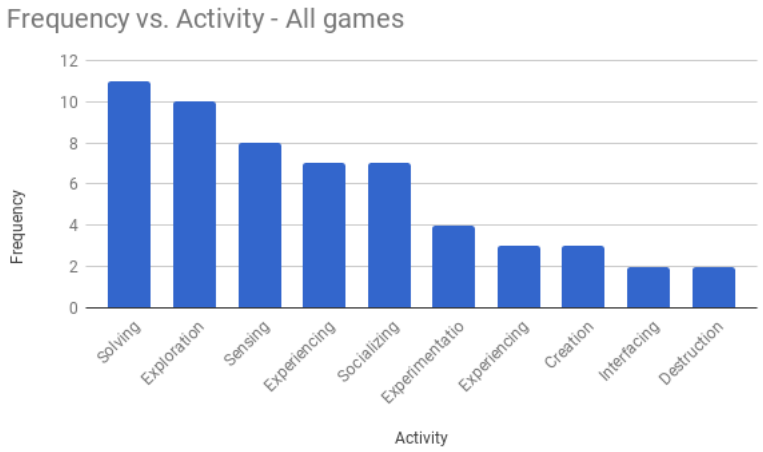


Figure 7.11 shows that the most frequent activities among the included games are: Solving, Exploration and Sensing, whereas the less frequent activities are Experiencing the Character, Creation, Interfacing, and Destruction.

Many of the games have the purpose to educate or inform about a subject (e.g. engineering, water shortages, etc.), which in the case of this analysis results in a high frequency of the Solving activity. The high frequency of the Solving activity can also be the result of the sample (the included games) which includes many games from the museums with a science background (e.g. Science Museum, UK, Smithsonian, Experimentarium, American Museum of Natural History, USA). Among the games included in the analysis 12 (out of 16) of them come from a science museum and 10 out of those 12 games include the Solving activity. Preloaded (Preloaded, 2018b) which are the developers behind Rugged Rovers and LaunchBall state the following:

> *"Learning is a consequence of play, with mastery of the content enabling mastery of the game itself."* (Preloaded, 2018b)

The second and third most frequent activities are Exploration and Sensing. The two activities are both common for a museum experience, as a visitor walks around the museum (Exploration) and takes in both information and the aesthetics of the place and artifacts (Sensing). The least frequent activity is Destruction, as only 2 out of the 16 games include the activity. The sample of games could have an influence on this result as none of the included games are developed for a museum with a war or violence background.

Figure 7.12: Histogram of popular activities for the online games.

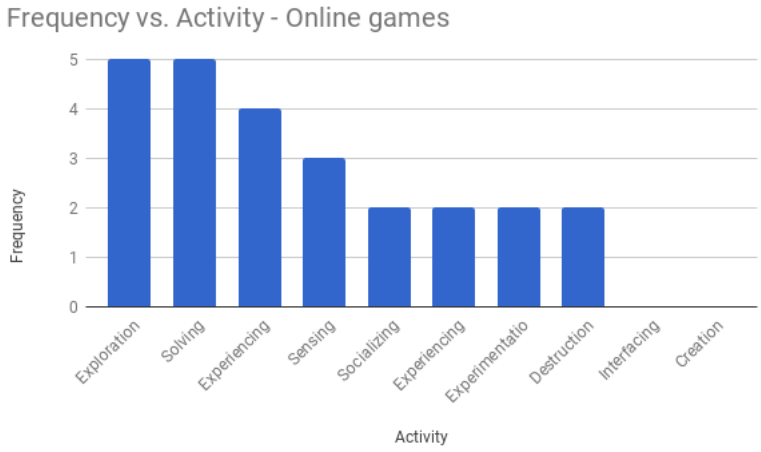


Figure 7.13: Histogram of popular activities for the on site games.

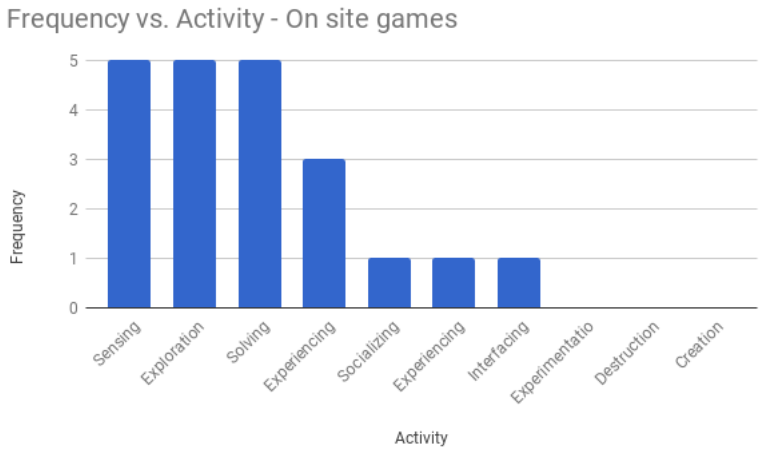
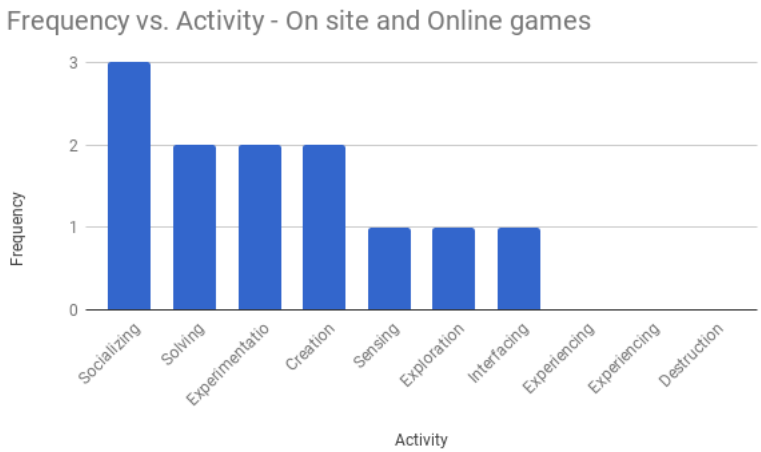


Figure 7.14: Histogram of popular activities for the online and on site games.



Figures 7.12, 7.13 and 7.14 present the frequency of activities categorized by the game's connection to the museums. The three figures show the difference in activities between the different categories. The most frequent activities among the online games are Exploration and Solving. This is also the case for the On site category. The difference between the two is that Sensing is among the frequent activities in the On site category, which can relate to the museum visitor experience as mentioned earlier. As for the On site and Online category the most frequent activity is the Socializing activity. As the current study attempts to develop an on site and online game, the activities Exploring, Sensing, Solving and Socializing should be included in the design or researched further to allocate their effect on children's engagement.

7.4 Community and keeping the game alive

This section of the analysis will present the included game's approaches towards community creation and how they prolong the lifetime of their games. The goal of establishing a community around the future games for the National Museum was also mentioned as important in the focus group with the museum employees carried out in the present study, which is explained in detail in the Design chapter, section 11.1.8. Two of the analyzed games include specific features in their design, which can prolong the lifetime of their games.

When Rugged Rovers ported their game for mobile devices, they added the feature of online competition. As described earlier, the online multiplayer mode of Rugged Rovers allows the players to create rovers and have them race each other. This feature has resulted in 1.000.000+ rovers (Preloaded, 2018c) created within the first three months since its launch, and and averaging 80.000+ play sessions each month. The feature of an online highscore table also allows for players to race not just their friends, but people from all over the world.

LaunchBall had from the beginning included the feature of player driven level creation, and in its first few months over 10 million levels had been created (Preloaded, 2018a). The level creation feature provides a stream of new content for the players, which then results in a prolonged lifetime. In order to further prolong the lifetime of the game, the museum chose to port the game to mobile devices making the game easily accessible for all.

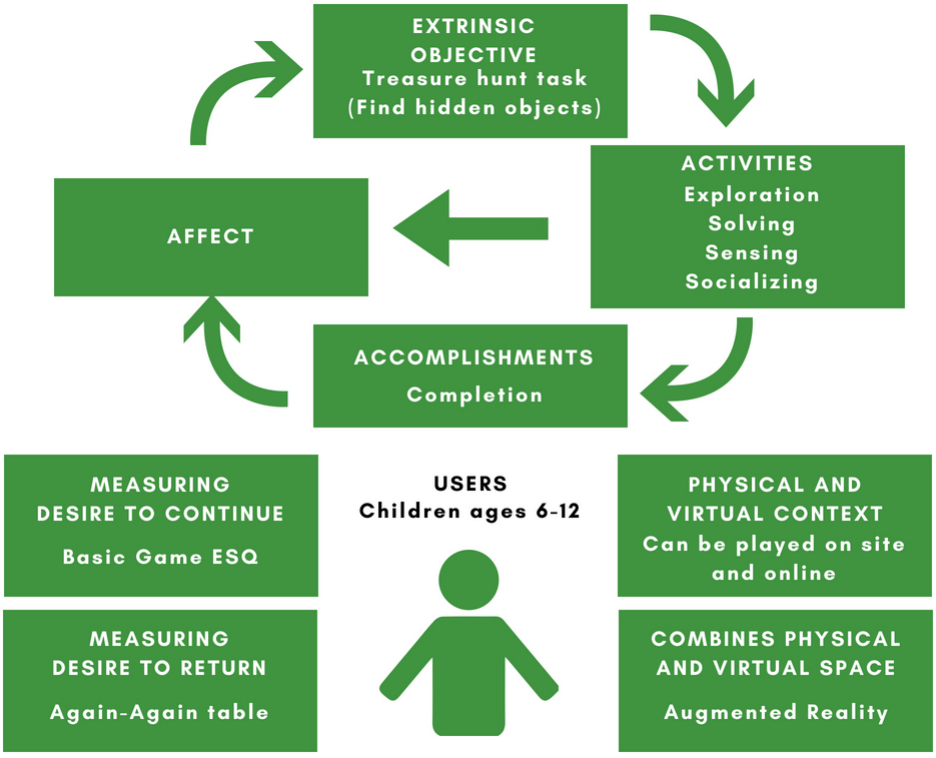
The two games take advantage of the Creation and Socializing activities. The Creation activity is designed in a way that allows the players to create content for the game, resulting in an amount of content in their game, not possible for the company to develop themselves. It also creates diversity among the content as the difficulty of the level will depend on the players experience with the game. The Socializing activity then turns the created content into a competitive feature. How this dynamic behaviour between the Creation and Socializing activities work could be investigated further to see if the relationship can influence desire to return to a museum among children.

To summarize this chapter, we have analyzed 16 museum games, and allocated the four most frequent activities within these 16 games. The design for our prototype should be based on the three activities: Exploring, Sensing, Solving and Socializing. In the previous Museum Experiences chapter, the design guideline that the prototype should use some form of treasure hunt fits well with the finding of the four activities. Treasure hunts include exploring an environment and solving puzzles or riddles, and they do not exclude the possibility of sensing or socializing.

Furthermore we found that our prototype should use location-based AR for its on site part.

Figure 7.15 shows the design guidelines derived so far in this study.

Figure 7.15: Updated design guidelines.



8. Commercial Games

The following chapter will present an analysis of a series of state of the art commercial mobile games. The purpose is to allocate current trends within the mobile gaming industry, which could provide design guidelines for the prototype which is to be developed for this thesis.

As we are attempting to detect trends, many games will be analysed and a few select will be analysed more in depth. These games are chosen based on their reception and relevance to the present study. These games will be set in context to the OA3 framework, and we will see how popular activities compare to the previously presented popular activities within museum games. We will only focus on games that are successful in the west and on the mobile platform.

We will present the top charts for games on the AppStore and Google Play Store in Denmark as reported by App Annie, a company dealing with statistics about the mobile app market (AppAnnie, 2018a). These charts will present a quantitative analysis of the mobile gaming market.

We will analyse a set of games in depth, functioning as qualitative analysis. These games will be chosen based on popularity, awards, and relevance to the National Museum.

8.1 Top Charts

AppAnnie pulls data from both the AppStore and the Google Play store every hour (AppAnnie, 2018b), updating their charts according to the following three categories: free (games that have no download fee, but can include in-app purchases), paid (games with an initial purchase fee), and grossing (games that have made money through in-app purchases).

The top 10 games in each category, for both iPhone and iPad on the Appstore, and for the Google Play Store, are shown in the Digital Appendix, folder SOTA.

The charts change continuously, and these charts were analyzed on the 21st of february 2018. For a quick overview, we have reported the developer, genre, and age rating.

8.1.1 Genres and Ratings

A summary of the top chart lists will now be presented. Two or more occurrences of the same game are not counted twice, even across the two app stores. We do this, as the product we are to develop would not be focused on either of the two stores, but rather targeted towards the mobile gaming market as a whole.

Games which appear on both iPhone and iPad charts will not be counted twice either as the Google Play Store charts are based on all Android-devices, meaning both smartphones and tablets. Figures 8.1 and 8.2 show frequency distributions of genres and of the ratings for each genre.

Figure 8.1: Histogram over genre frequency.

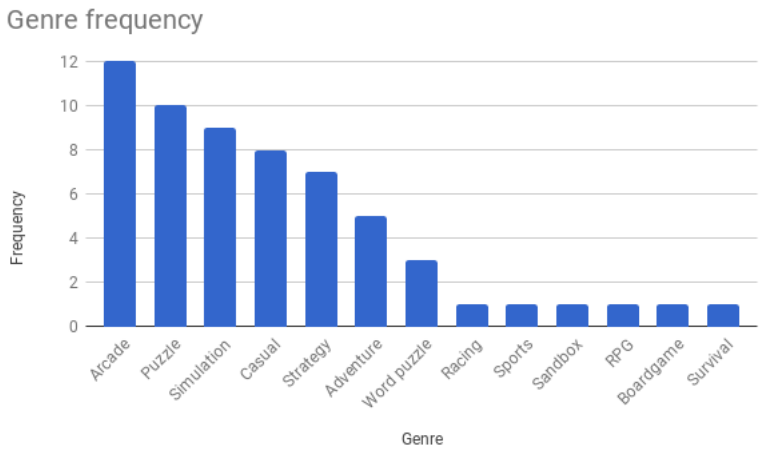
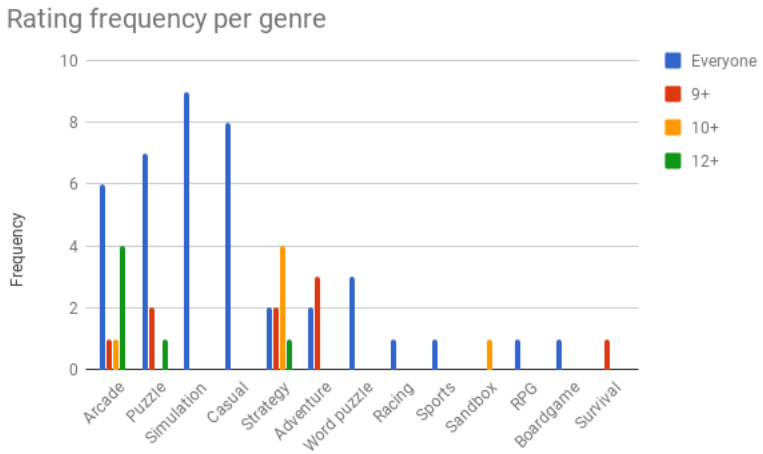


Figure 8.2: Histogram over rating per genre frequency.

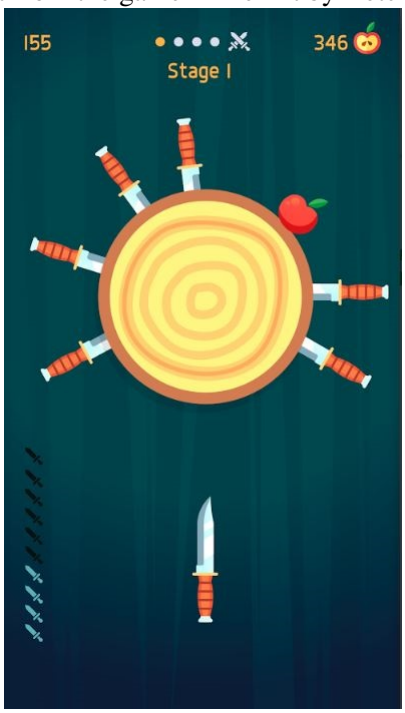


Arcade Genre

Here we can see that the most common genre is the Arcade genre. It is also one of the broadest genres, with sub genres such as clicker games, rhythmic games, and endless runner games. The games in the genre are defined by their very simple control scheme. The games are about beating high scores, and thus they have a high replayability. They are often composed of a series of smaller levels, allowing for short play sessions and low commitment from the player. An example of the simple control scheme can be seen on Figure 8.3, a screenshot from the game Knife Hit by

Ketchapp Studios (Katchapp, 2018). In this game the only interaction is to tap the screen to throw a knife (it does not matter where on the screen you tap), and the goal is to throw a certain amount of knives without hitting any of the other already thrown knives, as the target rotates. These arcade games are purely meant as entertainment, and they have close to no didactic elements.

Figure 8.3: Screenshot from the game Knife Hit by Ketchapp (Katchapp, 2018).



The rating for this genre is spread out, as there's a high frequency of games rated for everyone and as well as for 12+.

In relation to the OA3 model, the arcade genre relies on extrinsic objectives, due to the focus around high scores. The player is constantly presented with the score, often in comparison to friends' scores or top charts. This extrinsic objective pushes the player to keep playing, as there's no finish appart from beating your own or others' scores. Often the activities are Interfacing, as the controls are usually about hitting the right timing, Destruction, as with Knife Hit where the goal is to destroy fruit to achieve a high score, and Socializing, as scores can be shared between friends, and leaderboards are displayed. The Accomplishments in this genre are beating high scores, reaching certain levels, gaining achievements, and so on. This is a combination of Achievements and Progression. Affect can vary, and the experience often results in a Negative affect while attempting to beat a high score.

Even though it is one of the most popular genres, we will assume that the National Museum would demand a more didactic goal from their games than what the arcade games we have experienced provide. What can be learned from the popularity of the genre, is that people do play easy to approach games that require a low level of commitment to play.

Puzzle Genre

Next is the puzzle genre. This genre does not require the player to be paying constant attention and maintaining interaction, but instead provides the players with riddles and puzzles, so that the players can take their time to solve each level. These games are less about the high scores, and more about mental exercise. This genre seems more appropriate for the National Museum, as it

allows the players to reflect over the content of the game due to the general pacing of the genre. Museums also facilitate and promote social interactions, which the puzzle genre has room for: two players can discuss a solution to a puzzle on the same device.

The majority of the games are rated for everyone, this is also in compliance with our target group. The difficulty of the puzzles can vary, and when making puzzles for children caution should be had in regards to difficulty.

An example of a game in this genre which could be appropriate for the National Museum is The House of Da Vinci by Blue Brain (BlueBrainGames, 2017), shown on Figure 8.4. It is based on a historical figure with elements of fiction layered on top. Such games could provide players with a didactic and entertaining outcome.

Figure 8.4: Screenshot from the game The House of Da Vinci by Blue Brain Games (BlueBrainGames, 2017).

The puzzle genre also relies on extrinsic objectives, as the genre is about solving puzzles posed by the game itself. Activities are Solving, Exploring, and Experimenting, namely activities that make the players' reflect on their actions. Accomplishments come in the form of Progression, as solving a puzzle can unlock the next puzzle. The Affect a player feels depends on the puzzles themselves. If the puzzle is too difficult or too easy (thus breaking with the flow theory), player's will often feel a Negative affect. The puzzle genre relies on a fine balance between challenge difficulty and player skill, and with a well implemented learning curve a Positive affect can be achieved.

Simulation Genre

The third most frequent genre is the simulation genre. As the name suggests, games in the simulation genre attempt to simulate real life. The game Farming Simulator 18 is a game about farming (GiantsSoftware, 2017). There is no overall story arch, or simple objective. Instead the player goes through the process of maintaining a farm, such as cultivating fields, driving farm vehicles, and so on.

It is a genre that in some cases can merge with other genres, as the activities done by the player can occur in other genres. For instance, a game about driving Formula 1 cars on a racing track

could either be a simulation game or a racing game.

Here the difference lies in the game's objective. In the racing genre, the objective is competitive, to beat the other racers, while in the simulation genre it is more about driving the car itself. The genre attempts to simulate reality. This genre could also be appropriate for the National Museum, as certain time periods could be simulated.

The simulation genre, as opposed to the previous two genres, does not require a strong extrinsic objective. Often intrinsic objectives drive the gameplay forward, as the activities are Sensing, Interfacing, Exploration, Experimentation, and even Destruction or Creation. As the genre exclusively is rated for everyone, we assume that Creation is more common than Destruction. The activities depend on what the game simulates, and the Accomplishments are more hidden than with the other genres. The game might reward the player with new skins for, e.g. the Formula 1 cars, but there's seldomly a high score to beat, or a progression in experience points. The affect the players feel often rely on Absorption in this genre. The concept of simulation is to make the player feel like they are part of the game world, e.g. sitting inside the Formula 1 car.

8.1.2 Top Charts Summary

A wide range of genres appear on the top charts, providing us with many options. We will have to find the balance between a popular game genre, and one that is more in line with the National Museum. In the previous state of the art museum games analysis we found that Exploring, Sensing, Solving and Socializing. The puzzle genre could support these activities.

One game from the top charts that we will mention is BioSpil, made by BioSpil (BioSpil, 2013). It is a game which can only be played at Kino cinemas in Denmark, before movies begin. It allows the cinema guests to battle against each other in various arcade games, with the chance of winning real life prices.

It is interesting to see how popular it is despite it being bound by a location, as it can only be played at the cinema before a movie starts. This could prove that people are willing to download games at public spaces, something that could be useful for the museum.

The most important takeaway from the top charts analysis that there's many different game genres present, with many different types of activities. We will now present a more in depth analysis of a few select games.

8.2 Apple's Games of the Year 2017

The games shown on Table 8.1 are Apple's Games of the Year 2017 (Apple, 2017). Apple does not explain the criteria for being on the Games of the Year list, and they do not report the amount of downloads for each game. We believe they are chosen based on a balance between amount of downloads, income, reviews and awards.

We will based on this list choose a game to analyse more in depth, and we will attempt to set it in context with the National Museum and the OA3 framework.

Table 8.1: Apple's Games of the Year 2017 (Apple, 2017)

Art of War: Red Tides
(Game of the Year on iPad: China) Hero Entertainment Co., Ltd. Genre: Real-Time Strategy Target group: 12+
Framed
(Game of the Year on Apple TV: Australia, Canada, Japan, New Zealand, USA) Loveshack Genre: Puzzle game Target group: 12+
Hidden Folks
(Game of the Year on iPad: Denmark, Norway, Sweden, and over 60 other countries) Adriaan de Jongh and Sylvain Tegroeg Genre: Puzzle, exploration Target group: 4+
Micropolis!
(Game of the Year on Apple Watch: Australia, Canada, New Zealand, USA) Everywear Games Inc. Genre: Strategy Target group: 4+
Old Man's Journey
(Game of the Year on iPad: Brunei, Cambodia, Canada, India, Indonesia, Laos, Malaysia, Philippines, Singapore, South Korea, Sri Lanka, Thailand, Turkey, Vietnam) Broken Rules Genre: Puzzle game Target group: 4+
Splitter Critters
(Game of the Year on iPad: Denmark, Norway, Sweden, and over 80 other countries) RAC7 Games Genre: Puzzle Target group: 4+
The Witness
(Game of the Year on iPad: USA and many others) Thekla, Inc. Genre: Puzzle, Exploration Target group: 12+
Most common genre
Puzzle games
Most common age rating
4+

8.2.1 Hidden Folks

The game Hidden Folks (Jongh, 2017), by Adriaan de Jongh (game design) and Sylvain Tegroeg (art) is chosen as Game of the Year on iPad in Denmark, along with the game Splitter Critters by RAC7 games. We have chosen to analyse Hidden Folks, as its simple activities (Exploration and Solving, explained below) can be fitted very well to many different types of stories and settings, something the National Museum should seek to do due to their broad spectrum of themes and topics, and they coincide with some of the popular activities allocated within museum games. It could be argued that its genre is a mix between the popular genres: Arcade and Puzzle.

Hidden Folks has had success with reviewers and awards, winning the following prizes (Jongh, 2017):

- Winner 2017: App Store iPad Game of the Year (in Denmark amongst others)
- Winner 2016: BIG Indie Pitch San Francisco: Best Game
- Winner 2017: Anifilm: Best Game for Kids and Teenagers

It was also nominated for Best Mobile Game at The Game Awards 2017 (TheGameAwards, 2017).

The genre of Hidden Folks is difficult to define, as it is composed of exploratory elements and puzzle elements. It can be compared to Where's Wally books (known as Waldo in the US), where readers have to find Wally and his friends in large detailed environments (Handford, 1997).

The game is described as:

"Search for hidden folks in hand-drawn, interactive, miniature landscapes. Unfurl tent flaps, cut through bushes, slam doors, and poke some crocodiles! A strip of targets shows you what to look for. Tap a target for a hint, and find enough to unlock the next area." (Jongh, 2017)

To elaborate: The players explore environments to complete the goal of the game which is to find certain objects and characters (targets) hidden throughout these environments. They can be behind other objects, partially covered or fully covered, and they can be hidden in plain sight amongst many other elements. By clicking on elements in the environment, the environment shifts slightly revealing hidden objects and characters. An example is that to find a banana, the player must first press on a cluster of bananas, resulting in a single banana falling out, as can be seen on Figure 8.5.

This feature facilitates Exploration, as the players have to reflect on the environment and search every corner of it by clicking and observing. Additionally, many elements which are not part of the game's objectives react to the player's taps, by playing sounds or small animations. This feature facilitates Sensing and partially Experiencing the characters, from the OA3 framework. This gives the player even more incentive to explore the environment, even after they find the required objects. This type of genre and gameplay, would lend itself very well for didactic purposes and targets children very well. The environments could be based on historical time periods, and small factual elements could be hidden and discovered when playing the game.

The visuals are hand-drawn with ink on paper, which are then scanned and made into digital art pieces. They are cartoonish and visually interesting, while maintaining simplicity as the drawings are monochromatic (black and white). By the combination of simple details, and simple colors, the environments can be very populated with many elements, without straining the player's eyes. Had the drawings been very detailed with many different colors, the player's might get lost and confused. The audio side follows this same concept. All the sounds are recordings of the developer's making noises with their mouths. This gives the audio a simplicity, which is equivalent of drawings made by hand. Together it creates a holistic aesthetic, which is very pleasing. This facilitates the Sensing activity.

Figure 8.5: Screenshot from the game Hidden Folks by Adriaan de Jongh (Jongh, 2017).

The hints provided to find the targets and complete the game's objectives can resemble puzzle elements (thereof our partial definition of its genre being the puzzle genre). The hints come in text, giving the players vague information about the target's location. The hints feel very similar to riddles, and they allow for the Solving activity.

Hidden Folks poses the Extrinsic objective of finding all the characters and objects, providing a Completion Accomplishment. The game has several different levels, and Progression Accomplishments drive the player forward by unlocking new levels. At the same time, the game supports Intrinsic objectives such as pressing on all the windows to open them, which results in a Completion Accomplishment.

Negative affect can be had if the targets (characters and objects to find) are too difficult to find. Here, Hidden Folks presents more targets than is required to progress to a new level, meaning that you as a player can skip the hardest objectives if you feel too much Negative affect. Due to its aesthetics, and through the Sensing activity, Absorption can be felt.

Figure 8.6 shows how Hidden Folks fits within the OA3 framework.

Figure 8.6: Hidden Folks in context with the OA3 framework.

We find this game format very appealing, as it can support the museum's strategy within The Surprising Museum, as can be seen on Table 8.2.

Table 8.2: Possibilites with Hidden Folks in regards to the museum's The Surprising Museum.

The Surprising Museum	**Possibilities**
Emphasis on children	The game's puzzles are very simple, and the game is easy to approach.
Interactive narratives: - Games - Gamification	The game supports many different story worlds (locations), which can support different narratives. This is similar to how a museum is divided in several narratives across exhibitions.
Bridging on site and online	The activity of exploring and looking for characters is very similar to the activity a museum visitor does when sensing and exploring the exhibits. By applying the game's activities to the exhibition itself, an on site game could be made where the visitors have to find certain exhibits, while a part of the game could be just as Hidden Folks, something that can be played from home (online). If elements could cross over between the two parts, a bridge is made between on site and online.
Bridging the physical and virtual space: - Augmented Reality - Virtual Reality	By implementing the above mentioned on site part, AR could be used to detect the exhibits the visitors have to find. The exhibits could be brought to life virtually, and then be placed in context with the rest of the game, thus bridging the physical and virtual space.

To summarize, Hidden Folks is a game which has many quality elements useful for the National Museum. It's simple mechanic can easily be layered on top of any kind of historical setting or topic. Here we want to emphasize the possibilities, as the exhibitions and museums under the National Museum themselves appear as small individual narratives, it would be possible mirror those in the levels in Hidden Folks. This would be a step towards bridging the on site and online, as players would be experiencing a narrative based on an exhibition, and it could bridge the physical and virtual space by incorporating the exhibits and artefacts in the game.

Furthermore the gameplay, which could be compared to treasure hunts, fits within our design guidelines. We find Hidden Folks very interesting as a starting point for the design of our prototype.

8.3 Danish Press

The following section will present an overview of some of the best games from 2017 chosen by various danish press sites (DR (table 8.3), Jyllands-Posten (table 8.3), and Berlingke (table 8.4)). These games should provide insight into what type of games are well received within the danish press, something the National Museum should be interested in. We will based on relevance, analyse some of these games in depth.

Table 8.3: DR's best 5 mobile games of 2017 (DR, 2017) and Jyllands-Posten best mobile games of 2017 (unranked) (Jyllands-Posten, 2017)

DR	**Jyllands-Posten**
1: INSIDE	**Amazing Katamari Damacy**
Playdead Genre: Puzzle platformer Rating: 12+	Bandai Namco Genre: Arcade Rating: Everyone
2: Game Dev Tycoon	**INSIDE**
Greenheart Games Genre: Simulation Rating: Everyone	Playdead Genre: Puzzle platformer Rating: 12+
3: FEZ: Pocket Edition	**Gorogoa**
Polytron Inc. Genre: Puzzle platformer Rating: 9+	Buried Signal Genre: Puzzle Rating: Everyone
4: Monument Valley 2	**Old Man's Journey**
ustwo Games Genre: Puzzle Rating: Everyone	Broken Rules Genre: Puzzle Rating: Everyone
5: Stranger Things: The Game	**Reigns**
BonusXP, Inc. Genre: Adventure Rating: 12+	Nerial & Devolver Digital Genre: Strategy (Cards) Rating: 12+

Table 8.4: Berlingske 10 reviewed games (Berlingske, 2016).

Berlingske	
Super Mario Run	**Disney Crossy Road**
Nintendo Genre: Arcade / Action Rating: Everyone	Disney Interactive Studios Genre: Action / Adventure Rating: Everyone
Lost in Harmony	**Reigns**
Dixiart Entertainment Genre: Arcade / Music Rating: Everyone	Nerial & Devolver Digital Genre: Strategy (Cards) Rating: 12+
Dungelot: Shattered Lands	**Sorcery 4**
Red Winter Software Genre: Adventure Rating: 7+	inkle Genre: RPG Rating: 7+
SteamWorld Heist	**Gear.Club**
Image & Form Genre: Strategy Rating: 9+	Eden Games Mobile Genre: Racing Rating: Everyone
Solitairica	**Severed**
Righteous Hammer Games Genre: Strategy (cards) Rating: 7+	DrinkBox Studios Genre: Adventure Rating: 12+

8.3.1 Reigns

The game Reigns, by Nerial (Nerial, 2017) is a strategic game based on cards. Berlingske awards the game with a rating of 4 out of 5, and it appears on Jyllands-Posten's best games from 2017. The developers describe it as the following:

"Sit on the throne as a benevolent (or malevolent) medieval monarch of the modern age and swipe your royal fingers either left or right to impose your will upon the kingdom. Survive the seemingly never-ending gauntlet of requests from your advisors, peasants, allies, and enemies while maintaining balance between the influential factions of your kingdom. But beware; each decision you make might have implications and unfortunate consequences down the road that could put your reign and family's dynasty at risk!" (Nerial, 2017).

As stated in the description, the players are presented with a series of questions, events, and situations, to which they have to choose between two answers by swiping right or left, see Figure 8.7. It is a very basic mechanic, that encourages the player to think about each choice. The events and characters in the game are fictional and procedurally generated, but we see a didactic possibility in that the characters and events could be based on history. An example could be playing as different danish kings, where you are faced with the same situations as they were, but you can choose the same or a different outcome.

Figure 8.7: Screenshot from the game Reigns by Nerial (Nerial, 2017).

The game adds a strategic layer by showing four different attributes to the player: *religion, the people, the army,* and *wealth*. Each choice affects the balance between the four attributes, and if you gain too much or loose to much in one of them you lose the game. An example is that if you have no wealth left, your kingdom becomes an oligarchy ruled by merchants and you lose the throne. If your military becomes too powerful, they might do a coup d'etat and take the throne from you. This gameplay appears to be a mixture of the Solving and Experimentation activities, as players have to think about how they answer a given problem.

Aesthetically the game is very simple, with minimalistic stylized drawings and voices. The characters have few details, and they mumble, leaving most to the player's imagination. Despite the simple style, Sensing is an activity players might do, as the aesthetics are homogeneous and pleasing.

The Extrinsic objective the game proposes is to attempt to rule your kingdom for as long as possible. Players can explore what different options do to the kingdom, experience how characters change opinion about you depending on your answers, and players can be solving to find out which choices avoid your kingdom from falling. The game also relies on Intrinsic objectives, as it encourages the players to think about what type of king they want to be. Players might want to be a kind and benevolent king, or a malicious tyrant.

The game is not easy, as most choices have large consequences and the problems you face are often vague and it is difficult to reason which answer leads to the best outcome. This leads to feeling a Negative affect, which in some cases can result in determination to do better in the next playthrough, but it can also frustrate as it is difficult to understand the underlying rules of the game in regards to solving problems.

Figure 8.8 shows Reigns in context with the OA3 framework:

Figure 8.8: Reigns in context with the OA3 framework.

It is definitely a game which the National Museum can take inspiration from, as the strategic elements are appropriate for didactic purposes. The game is not targeted towards small children, as the questions posed are often intricate and they attempt to subterfuge the player.

8.3.2 Monument Valley 2

Developed by ustwo Games, Monument Valley 2 is a surrealistic 3D geometric puzzle game (ustwoGames, 2017). It's predecessor Monument Valley was successful, with critical acclaim and over 30 million downloads (ustwoGames, 2017), and DR lists the second installment on their best games of 2017 list (DR, 2017).

The goal of the game is to get to the exit door in each level, by moving a character around. To get the character to the exit door, the player must change the environment by rotating and moving pieces around. The style is minimalistic and surrealistic, using few colors and details, and a lot of symmetry. Figure 8.9 shows the artstyle and how the environment changes.

Figure 8.9: Screenshot from the game Monument Valley 2 by ustwo Games (ustwoGames, 2017).

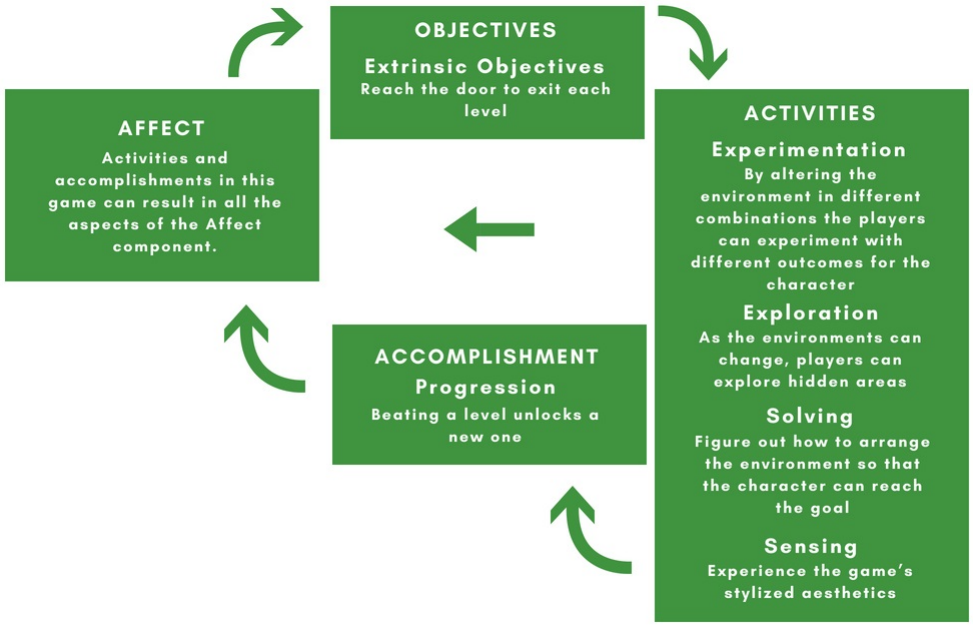
We have chosen to mention this game more in depth, as it also encourages thoughtful gameplay, through Solving, Exploration, and Experimentation.

The game has several levels with different puzzles and themes, again something the National Museum can utilize. Each level could be a certain century from human history, and thus players can get insight into many different historical periods.

In Monument Valley 2, the Extrinsic objective of the game is to have the player solve the puzzle of reaching the end of each level. Accomplishments come in the form of Progression through levels, and due to the pleasing aesthetics, players might feel Absorption.

Figure 8.10 shows Monument Valley 2 in context with the OA3 framework.

Figure 8.10: Monument Valley 2 in context with the OA3 framework.



8.3.3 Gorogoa

Another game we will analyze is Gorogoa, by Buried Signal (BuriedSignal, 2017), which appears on Jyllands-Posten's list (Jyllands-Posten, 2017). The game is about shifting drawings (comic panels) around to create different sequences, much like the Framed games by Loveshack Entertainment, which also gained critical acclaim (LoveshackEntertainment, 2017).

The developers describe Gorogoa as:

"Gorogoa is an elegant evolution of the puzzle genre, told through a beautifully hand-drawn story designed and illustrated by Jason Roberts.

(...)

The gameplay of Gorogoa is wholly original, comprised of lavishly illustrated panels that players arrange and combine in imaginative ways to solve puzzles. Impeccably simple, yet satisfyingly complex." (BuriedSignal, 2017)

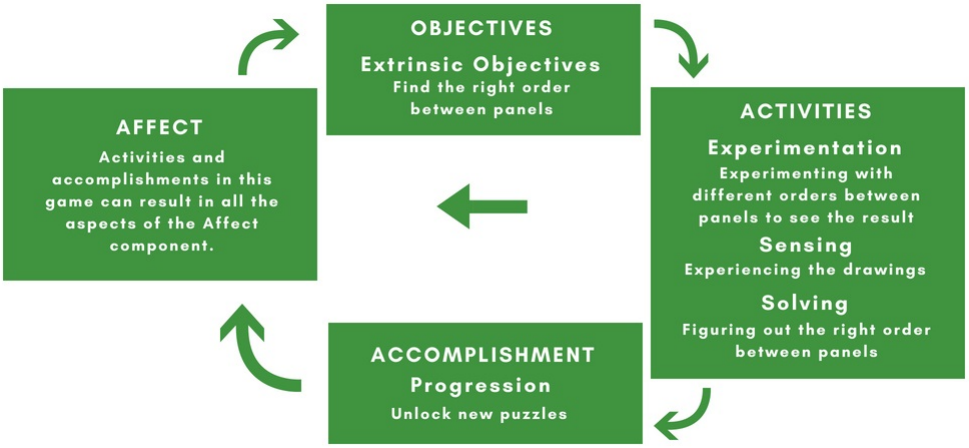
As in Hidden Folks and Monument Valley 2, Gorogoa allows for Exploration and thoughtful gameplay. The game revolves around Solving, as players have to find the correct combination of

panels, and it allows for Experimentation as different combinations results in different animations being played. It can also encompass many different settings and situations, as with Hidden Folks. The players could be recreating the story of the norwegian hero, Tordenskjold through these comic panels, by placing them in the right order. Gorogoa is another game which can provide inspiration to the National Museum.

The game relies on Sensing as one of the main activities, as the drawings are well drawn and the sounds are pleasing. Progression is the main Accomplishments, as new puzzles with new panels are unlocked once a puzzle is completed.

Figure 8.11 shows Gorogoa in context with the OA3 framework.

Figure 8.11: Gorogoa in context with the OA3 framework.



8.4 Commercial Games Summary

We have presented an analysis of some state of the art commercial mobile games, and chosen a few games to analyze. We found that the game Hidden Folks possesses many of the qualities that the museum is looking for, and it is in accordance with our previously derived design guidelines. We will strive to utilize the same genre, with its objectives, activities, and accomplishments. We do not include the Progression accomplishment, as we for this present study will focus on developing a single level.

9. Final Problem Statement

We have now presented an analysis of the two types of experiences we seek to combine: museum experiences and player experiences. We found that by measuring the visitor's desire to play (and continue playing) our game, and their desire to return to the museum (i.e. CD and the Again-Again table), we can evaluate our game design and if such a design can affect the visitor's desire to return.

We found that we can utilize the OA3 framework as a design tool by designing according to its categories, and CD, namely the basic version of the ESQ, can be used to evaluate the design iteratively.

The initial problem statement presented in the Introduction chapter 4, can now be expanded to a final problem statement for this thesis, as presented below:

How can Continuation Desire be used as an iterative design method to develop an engaging mobile game for children at the National Museum of Denmark, and to which extent does the game have an effect on the children's desire to continue playing and their desire to return to the museum in the future?

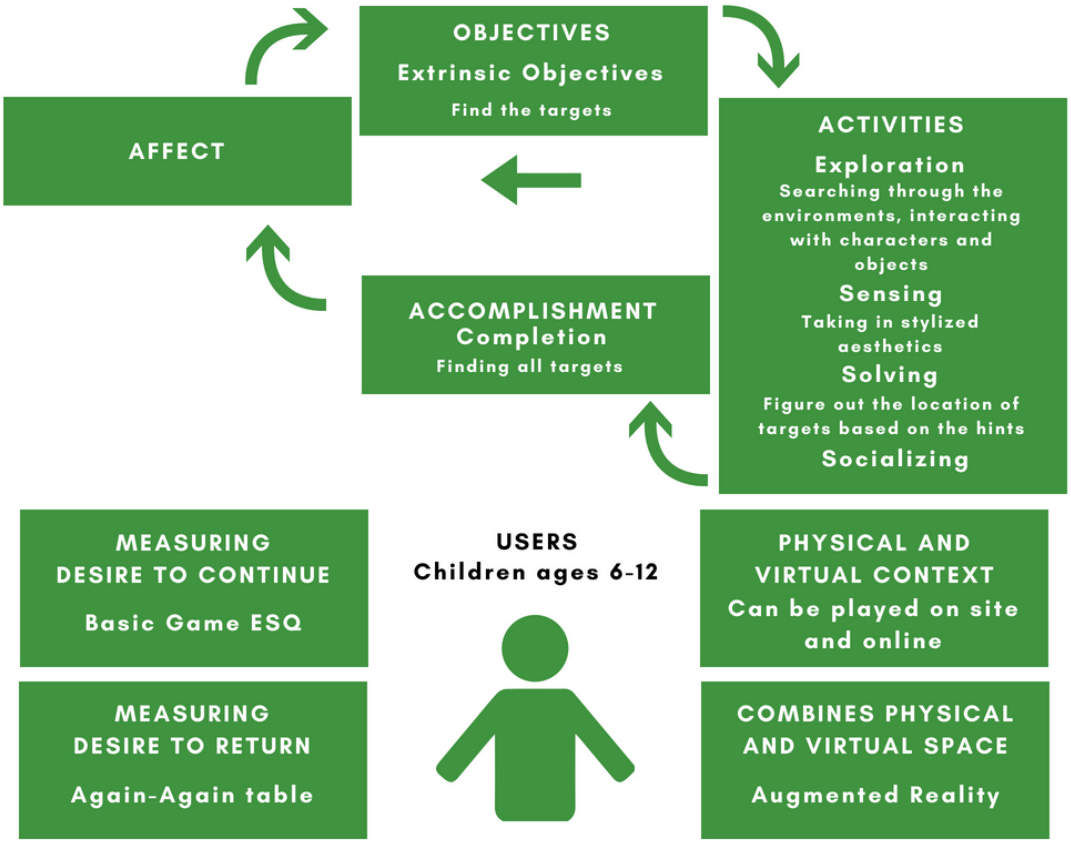
The final problem statement is three fold, as it first poses the exploratory problem of how to design an engaging game using CD, then it poses the problem of how the experience of playing such a game relates to the desire to continue playing, and lastly if the experience also relates to the desire to return to the museum.

Through an analysis of state of the art museum games, we discovered that the most frequent activities present in those games are: Solving, Exploring, Sensing, and Socializing, and that using AR technology could cater to the museum's wishes of bridging the physical and virtual space. We analyzed state of the art commercial mobile games, and found that the game Hidden Folks follows most of the activities found in museum games. Furthermore the design for Hidden Folks caters well to accommodate the museum's new strategy.

For this thesis we will base the design of our prototype on Hidden Folks, which can then be further developed in the future.

Based on all of the above findings we present a set of design guidelines as a design frame, which will guide the design of the game and evaluation of the final problem statement. The design guidelines can be seen on Figure 9.1.

Figure 9.1: Current design guidelines.



III

Iterative Design

10. Design Methodology

The development of digital games is a process where designers and developers utilize several different tools, frameworks, tests and techniques to achieve a satisfying design. It is important for designers and developers to establish a structure and plan the development process.

The following chapter will present our strategy to design and develop the game. We present an iterative design method, based on the previously presented OA3 framework and on two frameworks for the development of serious games; The Evaluation-Driven Design (EDD) and Serious Game Design Assessment (SGDA) framework, both of which will be presented in the following section.

The iterative design process will also be based on the collaboration with the museum, through expert interviews and focus groups.

We will present how we plan the iterative process for the design using CD, and the evaluation procedures and findings derived from these iterations will be presented in the following section.

For the design process we apply both qualitative and quantitative methods derived from the analysis, as we iterate the design.

In the Experimental Design chapter 14 we will present the final evaluation method used to answer the previously stated final problem statement.

10.1 Iterative Design Method

When designing games an iterative design approach can prove beneficial, and it has become an essential practice within game development today. Problems in the design can be detected during the development phase and redesigned before a release. User experience tests, community feedback, usability tests, etc. all contribute to provide developers with feedback.

Fullerton (2008) presents a layout of the iterative design process, which is based on the play-centric process. She lays out the following steps for a iterative design (Fullerton, 2008, page 14):

- Player experience goals are set.
- An idea or system is conceived.

- An idea or system is formalized.
- An idea or system is tested against player experience goals.
- Results are evaluated and prioritized.
- If results are negative and the idea or system appears to be fundamentally flawed, go back to the first step.
- If results are negative and the idea or system appears to be fundamentally flawed, go back to the first step.
- If results point to improvements, modify and test again.
- If results are positive and the idea or system appears to be successful, the iterative process has been completed.

For the iterative process in the development of our game, we will go through the steps presented by Fullerton (2008). We will therefore have several consecutive evaluations with the intent of improving the design before a final evaluation of our thesis.

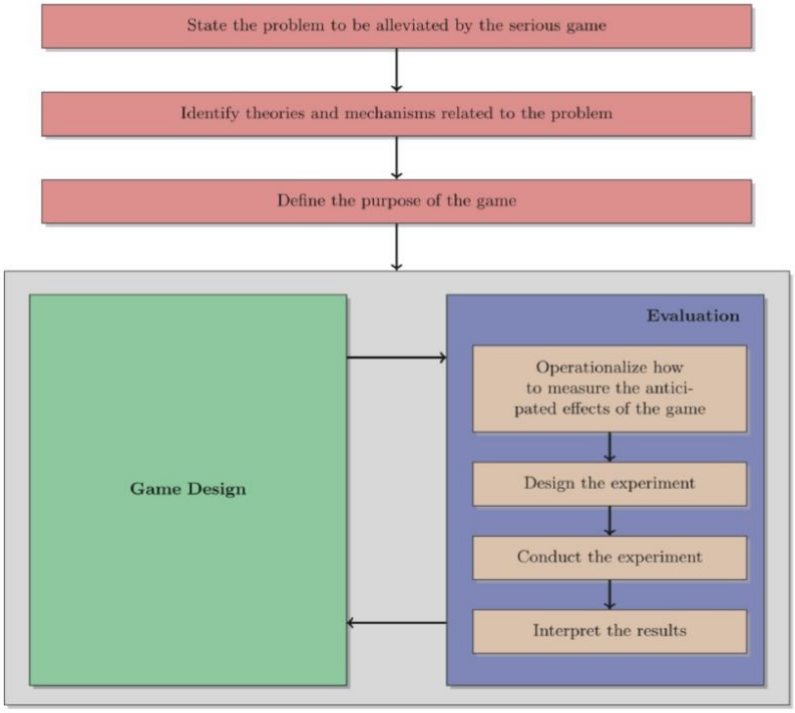
As derived from the analysis in the previous chapter, Continuation Desire, more precise the OA3 framework can be used as an iterative game design method (Schoenau-Fog, Birke, and Reng, 2012).

Through self-reported evaluations with the target audience, faults in the design can be detected and corrected for a future iteration.

This iterative design method is similar to the serious game framework, EDD by Emmerich and Bockholt (2016). Figure 10.1 shows how the EDD reaches a phase where Game Design and Evaluation happen in a repeating sequence. Once the evaluations of iterations provide satisfying positive feedback a final design can be reached.

We will apply Continuation Desire and the EDD to evaluate our iterations with the target audience (children ages 6-12), and follow the steps presented by Fullerton (2008).

Figure 10.1: EDD framework (Emmerich and Bockholt, 2016)



To design the game and each iteration the OA3 framework, the EDD, and the SGDA frameworks are used. The EDD and SGDA are serious game frameworks, therefore they both entail defining a purpose of the game (Emmerich and Bockholt, 2016; Mitgutsch and Alvarado, 2012).

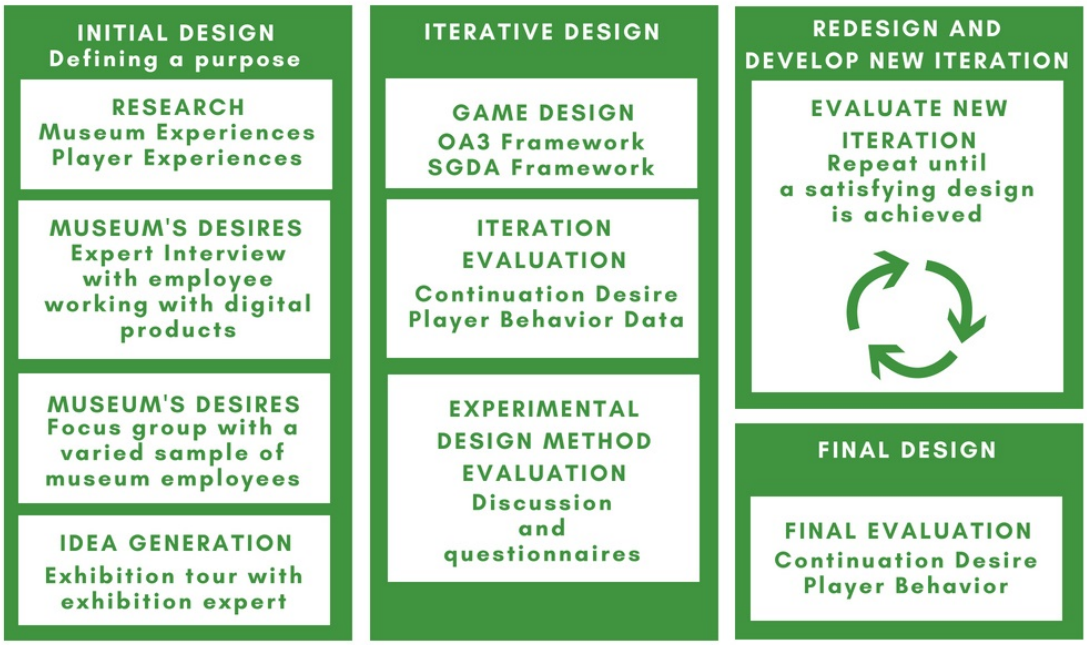
The EDD framework begins with a *Preparation* phase (red in Figure 10.1). During this initial phase the purpose of the game is defined. This phase is reminiscent of the research phase we have presented in the previous chapters. Thereafter the *Game Design* and *Evaluation* phases begin (green and blue in Figure 10.1), where the game is designed and iterations are evaluated.

In the *Game Design* process we will utilize the OA3 and SGDA frameworks. The OA3 can guide the design by its categories *Objectives, Activities* and *Accomplishments*, and our previously presented design guidelines have already used this structure. The SGDA framework by Mitgutsch and Alvarado (2012) proposes a game design loop, where the purpose of the game is reflected in all components. The components can be seen on Figure 10.2. These components will serve to guide the design, as with the OA3 framework. We will rely on the OA3 framework as our principal design tool, while the SGDA is used as support during the initial design phase.

Figure 10.2: SGDA framework (Mitgutsch and Alvarado, 2012)

Figure 10.3 shows the planned iterative design method. Meetings with the museum's employees, and the iteration evaluations are included.

Figure 10.3: Overview of the planned iterative design method.



10.2 Initial Design

The following section will provide an overview of how we will develop the initial design for the prototype. For this phase we will work with the museum, in an attempt to allocate their desires, needs, expectations, and opinions about digital games at the museum, and about what our design should include. Furthermore we will attempt to draw on the museum employee's experiences, as they have expertise within the field of museum experiences and we find it important to let the museum feel a sense of co-creatorship. The goal of the initial design phase is to reach a design and prototype which can be applied in an iterative design process.

The idea is then to iterate on the design based on the evaluation of how the children interact and perceive the experience.

Detailed methods and procedures for the meetings will be presented in the following Final Design chapter 12, to provide a chronological order of the design process.

Figure 10.3 shows that this phase begins with research into museum experiences and player experiences. By analyzing current studies and state of the art games we can allocate what a game for a museum should include, which will become the foundation for the design. This process has been described in the previous chapters, and the findings are presented on Figure 9.1.

10.2.1 Expert Interview

An expert interview with one of the employees working with digital products within the museum should then be held. This meeting can initiate the collaboration process with the museum, and serve to provide knowledge about the museum's digital strategy and vision. It can be held concurrently with the research phase, as it will function as an extension of the research about the museum's strategies.

We held the expert interview concurrently with the research phase, and therefore the interview method and procedure will be presented here.

The expert for the interview was Jacob Wang, the coordinator of digital initatives. We wanted to learn about the museum's digital strategy and vision. The questions were centered around gathering information about the museum's recently established Media House.

We utilized purposive sampling (Bjoerner, 2015, page 62) as Jacob Wang is the expert and coordinator of the museum's digital initiatives. We applied a semi-structured interview approach, as we at the time were not sure which department within the museum deals with digital games. We focused on the Media House, as we were told that it was this department that works with digital media (through the meeting we found out that we should focus on The Surprising Museum instead).

Table 10.1 shows the test procedure. It should be noted that the planned questions (specifically sub-questions) were used to help the test conductors. The questioning techniques presented by Bjoerner (2015) were used to construct the interview. Follow-up, probing, verification, and interpreting questions were planned, but not written down before the interview, as these depend on the answers obtained during the interview. Test conductors were aware of these questions, and they made sure to use them. A transcribe from the interview can be found in the Digital Appendix.

In the interview we learned that we were to focus on The Surprising Museum pillar, instead of The Media House. The findings from this interview are used in chapter 5, The Museum Experience. The Digital Appendix presents the results from the meaning condensation conducted on the transcription from the interview, see Folder Interview & Focus Group.

Once research into the field has been conducted, and the expert interview is held, the design guidelines should be used to create an initial prototype. Fullerton (2008) emphasizes that for the development of a game, it is important to prototype from an early stage (Fullerton, 2008). This enables the developers to show the game and its design to other people, instead of having to tell them about it.

Table 10.1: Expert Interview Method and Test Procedure.

Participant(s)
Jacob Wang, Coordinator for the museum's digital initiatives Alexander Risvang, Test conductor Daniel Ditlevsen, Test conductor
Method
Qualitative in-depth semi-structured interview with an expert, via purposive sampling (Bjoerner, 2015)
Test procedure
Date: 16th of March, 2018 Location: Meeting room at the museum, Ny Vestergade 10, 1471 København K. Data collection: Voice recording. Interview: One test conductor interviewed the expert, in a semi-structured interview. This conductor mainly asked Introductory and Structuring questions. The other test conductor supported by making sure all the planned questions were asked, and by assisting with Follow-up and Probing questions. Interview length: 18 minutes, 35 seconds
Measurement instruments
The voice recording was transcribed and meaning condensation was used to extract findings (Bjoerner, 2015, page 100) .
Planned questions
Name and position What is the purpose of the new Media House? (Direct introductory question) - Attract new visitors? (Direct question) - Maintain visitors? (Direct question) - Branding purposes? (Direct question) - Improve the museum experience? (Direct question) What is the Media House going to contain? (Direct introductory question) - Which platforms is it going to operate on? (Direct question) - What types of products will you develop? (Direct question) - What is your opinion on using digital games? (Indirect question) - What is the curation strategy? (Direct) What target groups does the Media House have? (Direct)

10.2.2 Focus Group

The next step in the Initial Design phase is to gather more of the museum's employees and present them with an early prototype. These employees should be sampled based on their area of expertise. The employees should come from varied areas of expertise, so that as many different perspectives as possible can be gathered. Due to the nature of the project, employees working with digital products such as games, should be sampled. An employee working with children and curation of the museum's exhibitions should also be present to provide insight to visitor behaviors. As we seek to connect the game with the museum's exhibitions, a researcher with knowledge about the content in the exhibitions should also be present to provide insight into how the exhibits can be included in the design of the game.

During the focus group their opinions and experience with digital games should be gathered, and then a participatory design session based on the initial prototype should be held. This phase lets the museum employees become co-creators of the game.

10.2.3 Idea Generation

In addition to the focus group it could prove beneficial to establish a meeting with a researcher from the museum. Ideas for the content of the game can be generated, and made sure to be accurate. It would be beneficial to have selected an exhibition before this meeting, to limit the amount of possible content for the game. This meeting with a researcher should also be held in the chosen exhibition, as a go-along interview.

Based on the research and meetings with the museum a more elaborate prototype can be developed. This ends the initial design phase, and iterations of the design can be begun.

10.3 Iterations

As a more elaborate prototype is developed, using the OA3 and SGDA frameworks, a prototype ready for an evaluation with the target group can be held.

As proposed by (Schoenau-Fog, Birke, and Reng, 2012) the iteration can be evaluated using an expanded version of the Game ESQ to allocate which categories of the OA3 framework are received well, and which are not, and how the player's engagement is affected.

Furthermore to allocate to understand player behavior, a record of their behaviour should be collected and logged. Which parameters to log depend entirely on the game genre and what the categories in the OA3 framework contain for the specific game.

The player behaviour log compared to the Game ESQ measurements, could provide deeper insight into player behaviors and how they report their experience, and in the end maybe provide some unobtrusive measures of engagement. Schoenau-Fog (2011a) also argues the desire of comparing the ESQ to other quantitative measures, such as player behaviour.

Players should also be observed while playing to allocate external influences and errors during the play sessions. Once the evaluation is held and the data is analyzed to detect the possibilities and limitation of the design, a redesign of the prototype can occur, and then the process starts over.

Additionally, the iterative design evaluations can serve to validate and provide insight into the evaluation method used to answer the final problem statement. When a satisfying response from the players is achieved, a final design and prototype can be developed, as well as the final evaluation method.

11. Iterative Design

The following chapter will describe the process of designing the developed game. The chapter will present each design iteration, how they were evaluated, what we changed, and then what the final design became.
As previously stated, we will use the OA3 framework to design and evaluate each iteration, the EDD and SGDA frameworks will be used as secondary frameworks (Emmerich and Bockholt, 2016; Mitgutsch and Alvarado, 2012). The two serious game frameworks (EDD and SGDA) both require that a purpose for the game is stated. The design of the game will follow the previously presented design guidelines. Specifically, we will utilize the design behind the game Hidden Folks as a foundation for our design.

The purpose of developing the game is to create an engaging experience for the children at the National Museum. The purpose of the game could then be stated as:

The game should hook the players, and draw them to the museum in an engaging manner.

Fullerton (2008) presents the playcentric design process. Here the game designer should initially define the experience the designer wants the player to have. Everything else in the game should support providing that experience to the player. We define our desired player experience to be:

The player should experience a sense of discovery, exploration, and completion.

This experience is designed according to the player experience of playing Hidden Folks and the derived conclusion from the state of the art analysis of museum games in chapter 7. The activities found most frequently in museum games where the Solving, Exploration, Socializing and Sensing activities. Hidden folks includes three out of the four, excluding the Socializing activity.

11.1 Initial Design

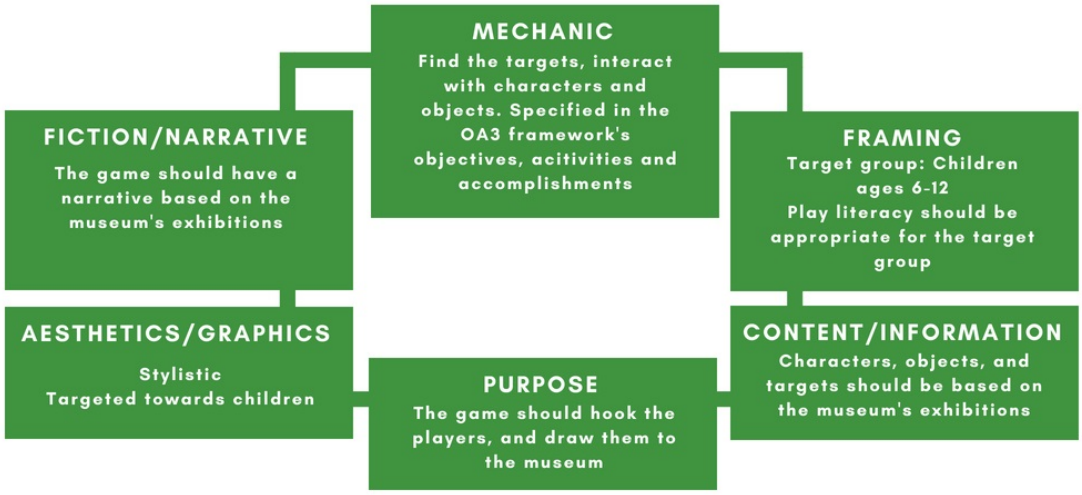
Figure 10.3 shows the iterative design process described in the previous chapter. The following section will describe the initial design phase.

The initial design for the game is based on Hidden Folks. Figure 11.1 shows how the design fits within the OA3 framework in a gameplay loop (top part of the figure). Some components on Figure 11.1 are tagged as (future), these are part of the design but will not be developed for the present study. The rest of the chapter will go through our components in the OA3 framework, and present how each one is designed.

Figure 11.1: Our initial design in the OA3 framework.

We also utilized the SGDA framework by applying our design to its components. We do this to be able to compare if there are aspects of our design which are limited if it is to be regarded as a serious game, for later studies. Figure 11.2 shows our initial design set in the SGDA framework based on our design guidelines.

Figure 11.2: Our initial design can also be described using the SGDA framework.



11.1.1 The Extrinsic Objective

To begin we will briefly define the Extrinsic objective of the design, which is based on the Extrinsic objective in Hidden Folks: To complete a level the player must find a set of objects or characters which are hidden in an environment.

From here on we will refer to the game objects which are to be found to complete the game's extrinsic objective (see Figure 11.1) as *targets*.

11.1.2 Bridging the pyshical and virtual space, and on site and online

Through our analysis, we found that including AR in our design could prove beneficial to engage visitors and to be in compliance with the museum's future strategies. Hidden Folks does not include any game elements which utilize AR. By implementing an AR feature, we can cater to the point of bridging the physical and virtual space, and that the game should have on site functionality.

We divide the design into two parts; the Game component and the AR component. The AR component can be applied on site in an exhibition, while the Game component can be applied online. By online means (i.e. Google Play Store, App Store, and the museum's website) the game can be downloaded and played anywhere on a mobile device.

To maintain coherence, we want the player experience to be similar in both components, meaning that the activities we design for the Game component should be similar to the activities we design for the AR component. By implementing tags in the exhibition detectable via AR, the core mechanic of the game stays the same in both components: look for certain hidden objects (i.e. targets and tags).

The bottom part of Figure 11.1 shows how the gameplay loop in the AR component will be.

To maintain the players, and give them a reward for visiting the museum to play the AR component, we have designed a system of progression.

By completing objectives in the AR component, additional content is unlocked in the Game component. This creates a loop, where the two components reinforce each other. When reaching a new level in the game component, the player can visit the according exhibition, play the AR component, and unlock new content for that level in the Game component. The game can be expanded to additional exhibitions, presenting different levels for each exhibition, ensuring new

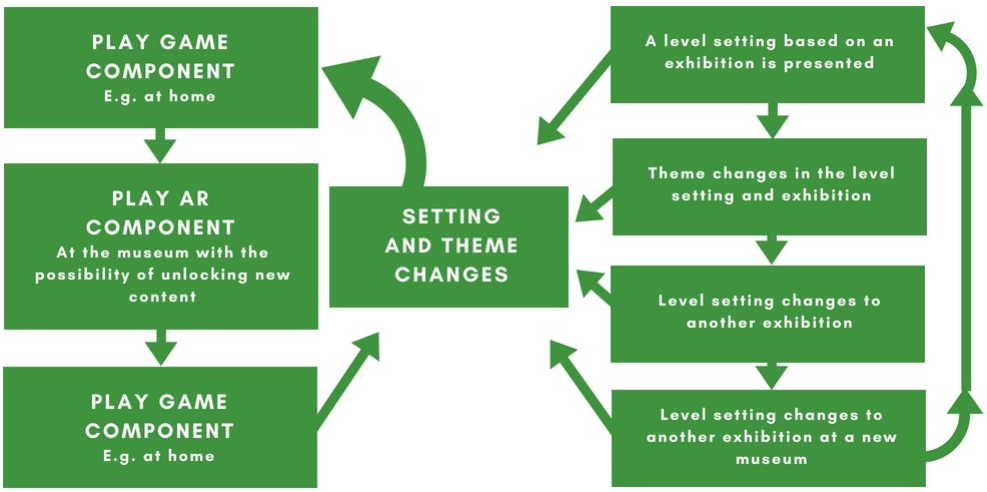
content for the player. Furthermore by changing the themes of each level, a steady stream of content can be made. E.g. a level based on an exhibition could have four versions, one for each season. Now that the content at the museum changes, players could be motivated to visit the museum four times over the course of one year (one time for new season).

Figure 11.3 shows the progression system, and how the game can be scaled up and down to include new levels based on exhibitions.

Collecting all the additional content through the AR component can become a Completion Accomplishment. Players can strive to visit all the museums included in the game, to collect the additional content.

This system is a feature to increase the children's desire to return to the museum, but for this thesis we will focus on developing the game first, and evaluate how that influences the desire to return. Once this has been evaluated, the addition of the progression system can be made. Future development should include evaluations where the AR component unlocks additional content, spread over several museums.

Figure 11.3: Planned Progression System.



11.1.3 Formal Elements

The previously presented OA3 framework (see Figure 11.1) and the progression system (see Figure 11.3) describe the game's formal elements. Fullerton (2008) defines the structure of a game as its formal elements (Fullerton, 2008). These are presented below, according to her categorization of the elements.

Players

First, the number of players, their roles, and how they interact with the system is established. For our game we are focusing on a single player experience, where the role of the player is to explore and find objects in the game. The player does not take the role of a certain character or avatar, instead the player acts as a detached entity.

Players play as themselves, peeking into the game world, with the ability to influence it by interacting with characters and objects. Inherently, the game is structured as single player versus the game. Including a multiplayer aspect to facilitate Falk and Dierking's sociocultural context (Falk and Dierking, 2012) could improve the museum experience, as museums are places where visitors socially interact with each other. For this thesis, we chose to limit the game to a single player

experience. Future possibilities of expanding the game to include multiplayer will be presented in the Discussion chapter 16, here we also provide a strategy on how we will implement the Socializing activity presented in our design guidelines. We still intend to support a social experience, as the game's activities are reminiscent of solving puzzles, the game can be shared between two players. They can discuss and explore together, by sitting around the same device. For the AR component, the experience can furthermore support social interactions as visitors can team up to search for the targets in the exhibition.

Objectives

Defining objectives is important to the game's formal elements. From our analysis of Hidden Folks, we have decided on defining the same form of objectives: find hidden targets. Following Fullerton's objective types, our game would present *Exploration* and *Solution* objectives (Fullerton, 2008). The players explore the world, sensing the game's aesthetics, and discover characters and embedded stories. The players also have to find solutions to where the targets are hidden. They have to deduce, based on the provided text hint and the layout of the level, where a target could be hidden.

Procedure

The procedure of the game is simple: the players begin by putting the game into play. This happens when the player starts the game, and decides which objective to complete. For our design, that could be choosing to find one of the targets, or simply choosing to explore the level without focusing on the game's objectives. The action progresses when players begin searching for the targets. Players will begin creating a mental image of the level, categorizing zones and inherently creating small narratives (an example from Hidden Folks is that throughout a level there's clusters of characters doing certain things: one group of characters are mechanics working on a car, while another group are farmers working in the fields). Special actions come in the form of experimenting with the environment. In Hidden Folks the player is able to slide, move, and alter the environment (e.g. opening a door to reveal a character behind it, lowering a draw bridge to let a character pass).

Finally, the actions of the player are resolved once the level has been completed by finding all the targets. This is the extrinsic goal of the game, but player actions can also resolve intrinsic objectives such as opening all the doors in the level.

Rules

Fullerton (2008) includes rules as part of a game's formal elements. It is the rules that frame the player's actions. For our game, the rules are that the targets are present somewhere in the level, and that characters and objects can be interacted with, revealing hidden objects (e.g. the targets).

Resources

Games provide the players with resources, which are based on the genre of the game. A first person shooter presents the player with health and ammunition as resources, while a real-time strategy game often presents materials (e.g. wood, stone, food, currency, etc.) as a resource to build more units and buildings.

For our game, the resource is the piece of text which provides a hint to where the targets are hidden. The player does not possess control over the resource as with the previously mentioned game genres, instead the player can choose to which degree they use the resource to solve the objective. A player can approach the text hints systematically, by thoroughly reflecting on the hint and comparing it to the level layout, or the player can ignore the hint and try to find the targets without help.

An abstract resource which Hidden Folks utilizes is the camera view. The players are able to zoom in and out, thus influencing how much information is displayed on the screen. By zooming out and seeing a larger portion of the map, players can create an overview of the level, and by zooming in players can avoid distractions and focus on certain objects.

Conflict

Fullerton (2008) states:

"Conflict emerges from the players trying to accomplish the goals of the game within its rules and boundaries" (Fullerton, 2008, page 77).

In our game we create a conflict by hiding the targets in the level. Other objects in the game become obstacles and distractions.

Boundaries

The boundaries of a game are defined as the element that separates the game from everything that is not the game (Fullerton, 2008).

We want to blur the line of where the game's boundaries end. This is based on our two component design: the Game component and the AR component. By including the AR component, players suddenly realize that the boundaries of the game extend to museums in the real world. Furthermore the museum boundary can be broken by hiding tags anywhere in the real world (e.g. at historical monuments, public spaces, etc.). This becomes reminiscent of games such as Geocaching (Groundpeak, 2018).

Outcome

The outcome in our game is to complete a level by finding all the targets. This includes visiting the museum and unlocking the additional content as well.

11.1.4 Setting: Defining the narrative content of the game

As the museum seeks to bridge physical and virtual spaces, and on site and online activities, we chose to base the setting and narrative of the game on one of the exhibitions in the museum. By working within the same theme as in one of the exhibitions, we can create a more coherent narrative. Objects in the game can be inspired by real artefacts in the exhibition, and we might be able to create a sense of familiarity in the players if they can recognize the same objects in the exhibition and in the game.

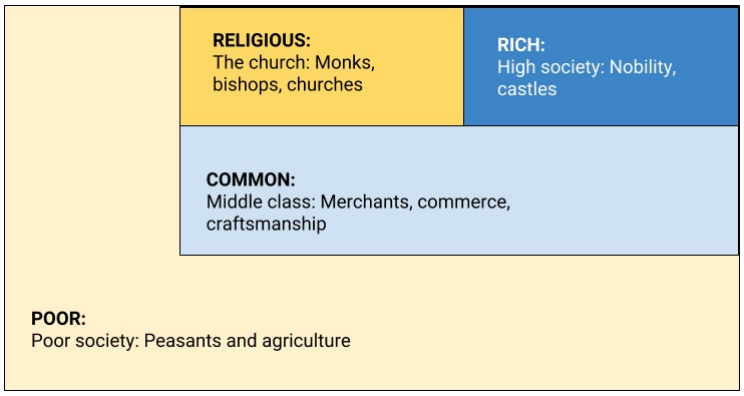
We chose to work with the exhibition called *Danish Middle Ages and Renaissance* (Nationalmuseet, 2018d) as the level setting for the initial design. Specifically, we focus on the Middle Ages part of the exhibition.

The exhibition is large, including many different elements from the Middle Ages, ranging from religious artefacts to everyday objects such as farming tools. Castles, weapons, and armors are also displayed. The exhibition puts a lot of emphasis on the church and its role in society, while also presenting the life of peasants, merchants, soldiers, nobility, and so on.

After a go-along meeting with the research expert of the exhibition, we chose the setting of the game to be a medieval town. As the game does not have an explicit learning goal, we want to focus on broader aspects such as different layers in medieval societies. Therefore we based the level design on making different areas which represent layers in society. Figure 11.4 shows a sketch of the level layout.

We have now specified the *CONTENT/INFORMATION* and *FICTION/NARRATIVE* components of the SGDA framework. The content and narrative of the game is based on the Middle Ages, where we want to convey the structure of that society.

Figure 11.4: Mockup for the level layout, with a poor, common, religious, and rich area.

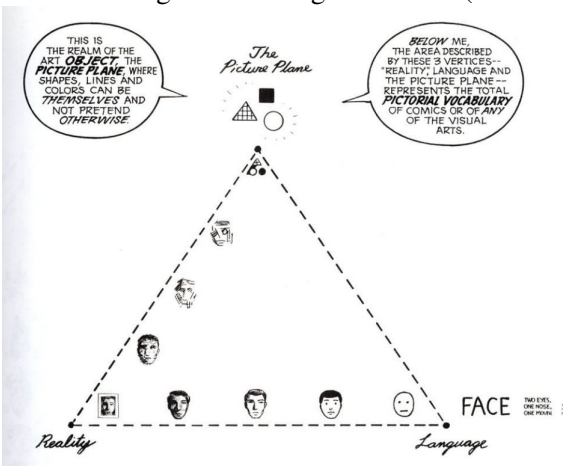


11.1.5 Aesthetics: The Sensing Activity

Hidden Folks uses stylized aesthetics, relying on humor and cartoons. These choices cater well to children, as they spark imagination and allow the designers to highlight and exaggerate certain points.

McCloud (1993) places three aesthetic drawing tendencies within a triangle, as seen on Figure 11.5 (McCloud, 1993).

Figure 11.5: The triangle of drawing tendencies (McCloud, 1993).



Well known drawing schools such as Disney, Zagreb School, and United Productions of America (UPA) use a style which according to McCloud (1993) can be placed between "Language" and "Reality", leaning towards the "Language" side (Furniss, 2008). The style Hidden Folks uses is a mix between "Reality" and "Language", where Hidden Folks is closest to "Language". To elaborate, the "Picture plane" represents abstract tendencies, where images can suggest dream states and generalized experiences (Furniss, 2008). The "Reality" is a more limited tendency, where the images are representational and photorealistic. The final "Language" tendency is a pictorial expression, such as icons. This tendency uses a more universal language by being less specific than the "Reality" tendency. McCloud (1993) argues that icons let the viewers identify with a character due to the lack of specificity and icons accommodate the viewer's self-perception (Furniss, 2008; McCloud, 1993).

We will, like Disney, Zagreb, the UPA, and Hidden Folks use a style which gravitates between

"Reality" and "Language", leaning towards "Language". Creating photorealistic art is also a cumbersome process, as reality is incredibly detailed and dense, and not within the scope of this thesis. With pictorial art, we can avoid falling into the trap of "uncanny valley" where we create an aesthetic which resembles real life but due to lack of skill and implementation resources has a "wrong feel" to it. Furthermore due to the museum context we have to be careful to not give the impression that the content displayed in our game is a true representation of historical artefacts, as we would not be able to reproduce the artefacts in detail unless we use 3D scanning techniques. Instead, by applying a pictorial and iconic style, players will understand that the content is a suggestive representation of the exhibits.

Our aesthetic will be based on cartoons and humor. With iconic characters and objects, we can be inspired by medieval art, while applying a light-hearted feel to the world which could appeal to children. With this aesthetic we attempt to support the Sensing activity of the OA3 framework, and the *AESTHETICS/GRAPHICS* of the SGDA framework.

The Visual Style

We began brainstorming a visual style for the game, where we took inspiration from medieval paintings. Figure 11.6 shows a moodboard of collected medieval art pieces used for inspiration (the images are found via Google Image search on 'Medieval drawings').

Figure 11.6: Moodboard.

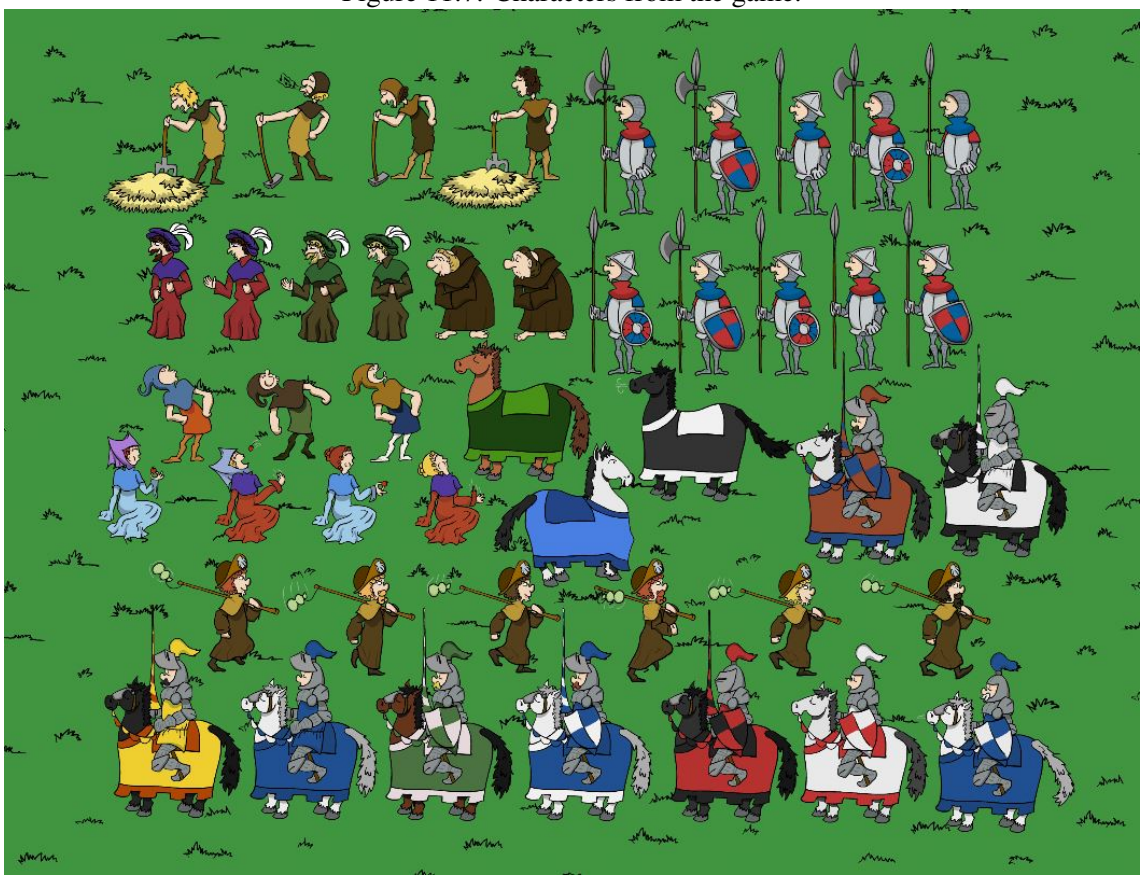
We want the visual style to convey a feeling of craftsmanship and artisanry, as this ties with the art exhibits where the artefacts are hand crafted. We chose a hand drawn style, utilizing simple

saturated colors. By saturating the colors, we can avoid sharp contrasts which can strain the player's eyes. Furniss (2008) includes an analysis on the aesthetics of color by Feisner (2006), where she states that primary color hues (red, green, and yellow) create a strong contrast, while secondary and tertiary color hues (orange, green and violet, and red-orange, red-violet, blue-green, blue-violet, yellow-green and yellow-orange) work well in large masses and they create less contrast. We chose an earthly color scheme, using different hues of browns, greens, reds, and greys, as these are present in medieval environments.

Strong and clear silhouettes are important, as the player should be able to discern the characters and objects easily. Therefore we chose to add a black outline to all the drawings, and to give the characters strong poses that indicate the personality and profession of each character. These design decisions describe our chosen form style. The character silhouettes use organic shapes, which can impart a comforting feel (Furniss, 2008), and they resemble shapes found in nature, something which is associated with the Middle Ages.

We used different color schemes for characters which belong to different layers in society. Peasants have brownish colors, while nobles have red and blue colors. Figure 11.7 shows the designed characters, and how they have different silhouettes and color schemes.

Figure 11.7: Characters from the game.



With these visual choices, we can create dense levels without confusing or frustrating the players. We are attempting to reach a fine balance between providing the player with clear information about what they are looking at, while letting the targets blend in with the scenery to create difficulty.

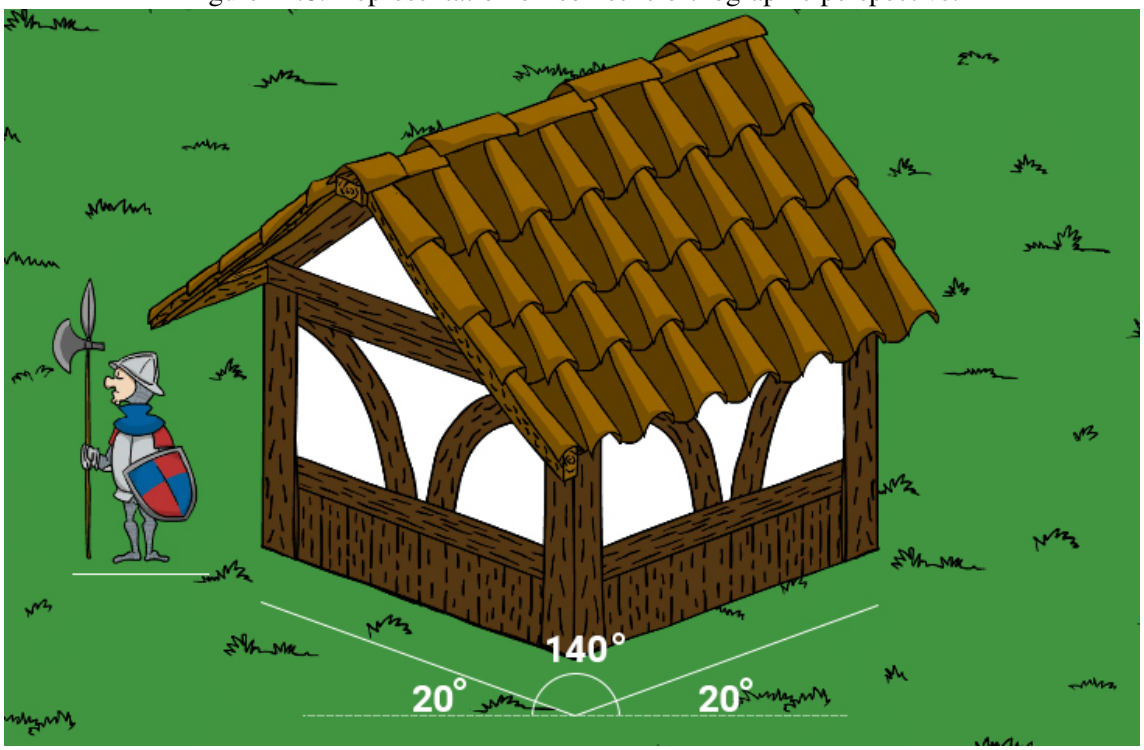
The Graphical Style

We chose a top down 2D isometric projection style, also used by Hidden Folks. The camera looks down on the environment, and the depth of the objects becomes flat with an orthographic isometric style.

All objects follow the same angles, allowing a constant depth perspective which is not affected by the camera's movement and position. Traditional isometric styles use 120 degrees as the angle between each dimension in 3D (x, y, and z). We use 140 degrees, to create an illusion of the camera being closer to the ground. This facilitates the process of drawing characters, as we can get away with drawing them from a straight-on view. This is a tendency we detected within the medieval drawings used for the moodboard on Figure 11.6.

Figure 11.8 shows how objects are angled according to our isometric style, and the flat straight-on perspective of our characters.

Figure 11.8: Representation of isometric orthographic perspective.

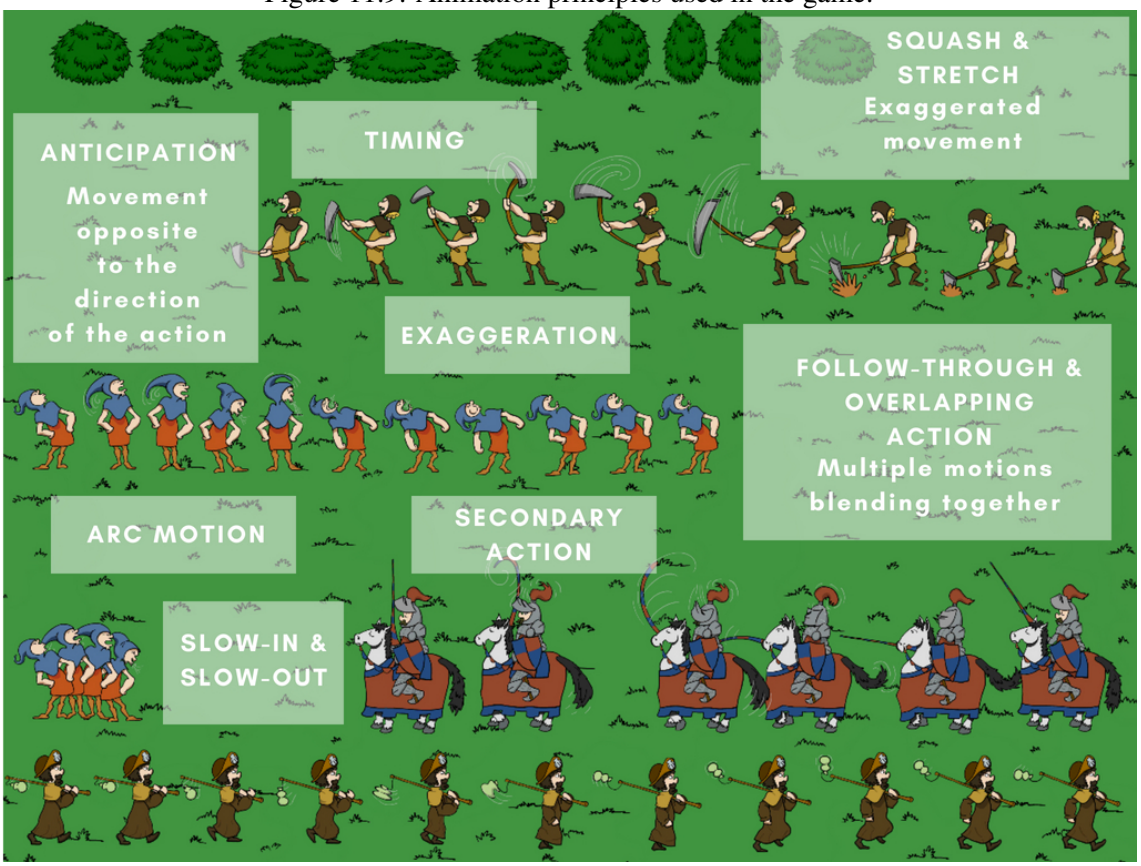


Our target platform is mobile devices, which can encompass many different aspect ratios, and they can either be landscape (widescreen) or portrait modes (tallscreen). To simplify the level design process, we chose to target a 16:9 aspect ratio, and lock the mobile devices to portrait mode.

The Animation Style

To maintain a handcrafted feel we use frame-by-frame animation, also known as cel animation (Furniss, 2008; Kerlow, 2004). We use the 12 animation principles, used by e.g. Disney in their traditional animations (Furniss, 2008; Kerlow, 2004). Figure 11.9 shows how we utilize some of the principles.

Figure 11.9: Animation principles used in the game.



The Auditory Style

As we are going for a cartoonish style, we complement the character's actions with exaggerated and iconic sounds. If a character throws or swings something, we use *"whoosh"* and *"swoosh"* sounds. The characters themselves have funny voices, often mumbling weird sounds saying indecipherable words. This is a technique also used by Hidden Folks. Exaggerating the sounds help making the characters humorous.

For the environment we use ambient sounds of e.g. a town or rural area. These help set the setting and mood.

All of these described style choices are what support the Sensing activity from the OA3 framework. With a pleasing aesthetic that can emotionally connect with the player, it can become an Intrinsic Objective to simply take in the aesthetic and discover more of the world.

If the aesthetic is interesting to the player, the progression system explained earlier in this chapter, is further reinforced as there's another motivating factor to unlock new characters.

In relation to the SGDA framework, we can further elaborate on the *AESTHETICS/GRAPHICS* component with the style choices.

11.1.6 Gameplay: Solving and Exploration Activities and Completion Accomplishment

Exploration

To create gameplay, we do as Hidden Folks, where many objects are interactable. Once they are pressed, they can play an animation, make a sound, reveal targets, change the environment, and so on. The important factor is that the objects react to the player. This motivates the player to explore

and experiment by pressing objects, keeping the player active.

This interaction with the objects is what will constitute a large part of the player's activities, specifically Exploration and Sensing from the OA3 framework. It also supports the desired player experience which is central to the playcentric design process, as players can discover and explore the environment by interacting with it. Characters and objects can be designed with embedded narratives, and used to make the game come to life.

We define interactable objects that can reveal other objects as *searchables*. These can be windows which open and reveal the interior of a room, or hay bales that when pressed scatter revealing characters that are hiding. Figure 11.10 shows the designed windows and hay bales. Hidden Folks utilizes searchables a lot, which creates a dynamic environment. There's many possibilities of designing searchables, such as doors, moving carts, gates, and so on.

Figure 11.10: Images of the *searchable* objects in the game.

These searchables are intended to provide the players with the possibility of creating their own Intrinsic Objectives, such as opening all the windows, or removing all the hay. This could provide the player with the Completion accomplishment from the OA3 framework and the desired player experience.

The player is allowed to move freely through the level by swiping on the screen. This moves the camera in the desired direction, and it is the interaction that the player is going to be doing most. The player is also able to zoom in and out, by pinching the screen. Players can choose to inspect certain details by zooming in, and they can get an overview of the level by zooming out. This controls the amount of information the player can have on the screen at the same time, and it is a powerful tool for us as designers when designing the difficulty of the game. We can define how far the camera can zoom out, limiting how much of the level the player can see. This can also be used

to give an impression of the level being larger than it actually is. Ultimately the camera controls let the players use it as a form of searchable, as more of the level is revealed when moving the camera. Hopefully this can instill a sense of wonder and discovery within the player.

Solving

As the objective of the game is to find the targets, they themselves should be unique objects in the game. They should be given simple narratives, e.g. a target could be a sheep which has become lost, away from its herd. These small narratives help bring the targets and the world to life, and the narratives can be based on the exhibits in the museum.

The targets are presented to the player by showing an image of them in the User Interface (UI), so that the player knows what to look for.

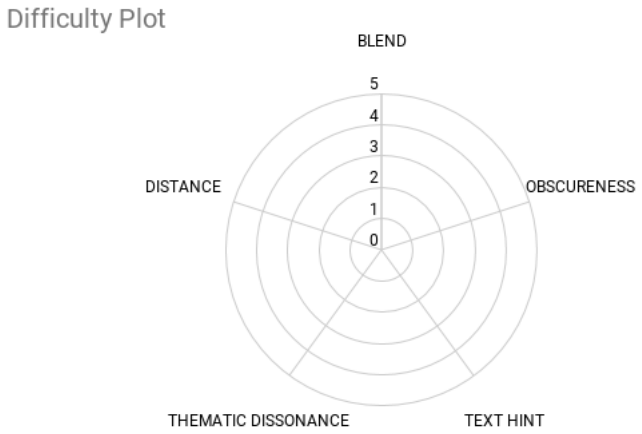
To provide help, we use hints in the form of text that the player can read. This is a technique used by Hidden Folks. The text hints should tell the narrative of the targets, and give either an indication of the target's location or appearance.

These targets should be placed deliberately, and the difficulty for each one should be designed. We have four primary parameters to control the difficulty of finding each target:

- **Blend**: How much the target blends in with its surroundings, based on silhouette, color, and movement.
- **Text Hints**: How vague the text hints are. These can explicitly or implicitly point to the location of a target.
- **Thematic Dissonance**: If the narrative theme of a target is harmonious or dissonant with the narrative theme of its surroundings.
- **Obscureness**: To which degree a target is covered by other objects, and if the target is hidden behind a searchable (thus the target is totally obscured).
- **Distance**: How far away the target is from the player's starting position.

We award each target with a score of 0 to 5 for each of these parameters, where 0 is easy and 5 is hard. Later in this chapter we will present specific examples of how the difficulty of targets can be expressed via these parameters. Figure 11.11 shows the difficulty parameters on a radar plot. Later in this chapter we will present how targets can be expressed via these plots.

Figure 11.11: Empty plot of the difficulty parameters.



Furthermore it should be noted that the camera's zoom in and out boundaries can affect the difficulty, as the further out the player can zoom the more information they can have on the screen at one time.

The interplay between where targets are hidden and what their respective texts hint at, is what constitutes the Solving activity. Players have to figure out where the targets are hidden by understanding how the text hints relate to the level layout and the narratives within.

All these described gameplay features make up the *MECHANIC* and *CONTENT/INFORMATION* concepts of the SGDA framework.

Completion

The main accomplishment is the design is Completion, which occurs when the Extrinsic objective is solved, i.e. when all the targets are found. As per the progression system described earlier in this chapter, Progression could become an accomplishment if additional levels or targets could be unlocked when completing a level or finding targets in the exhibitions.

Furthermore Completion can occur as a result of the player completing their Intrinsic objectives, such as interacting with all the characters or all the searchables.

11.1.7 Presenting the Prototype to the museum

We implemented a prototype with the initial design which we brought to a focus group interview with five of the museum's employees (as proposed in the previous Iterative Design Method section 10.1).

This early prototype included a level with the areas presented on Figure 11.12 in the form of buildings (a castle, town houses, a church, and peasant huts). Only one character was developed at the time (with three different color schemes), which was used to get a feel for how character dense the game should be. This character was meant as a town crier, individuals which travelled through town shouting news and decrees from the authority in the town. The character also worked as a generic commoner. The character is interactable: when pressed, he will begin shouting news. Furthermore we added interactable bushes and trees. When pressed, the leaves would make a 'boing'-sound, and an animation played showing the leaves bouncing.

This prototype did *not* include the AR component. Figure 11.12 shows a screenshot from the early prototype. Unfortunately, parts of the early prototype were lost, and therefore the figure does not show the complete prototype. There were roads and fields, a river, a church, and the towncrier was placed repeatedly through the world.

Figure 11.12: Early prototype screenshot.

11.1.8 Focus Group with the museum

As the next step in the initial design phase was to conduct a focus group, we held a focus group with several of the museum's employees based on their expertise. The participants were suggested by Jacob Wang after the previous expert interview and gathered through purposive sampling (Bjoerner, 2015, page 62). Jacob Wang was responsible for contacting and arranging the meeting.

The purpose of the focus group was to gain a further understanding of how the museum operates and what their opinions and desires are about digital games. It was divided into three parts; first and second part for exploring their opinions on and knowledge of digital games, and the third part functioned as a participatory design session where the employees could provide feedback to our prototype, and influence the design for future iterations.

To make sure that all participants had a common terminology when discussing the prototype, we held a presentation where we laid out general terms and concepts within game design, such as game genres, objectives, mechanics, art styles, and so on. We also presented successful museum and commercial games. The presentation slides can be found in the Digital Appendix, folder Interview and Focus Group.

As described for the expert interview in the previous Design Method chapter, the planned questions for the focus group were based on a semi-structured interview structure, and during the interview we asked follow-up, probing, verification, and interpreting questions (Bjoerner, 2015). Some of these were planned before the interview, others arose during the interview.

Tables 11.1 and 11.2 show the procedure of the test (on the following pages). A transcribe from the focus group can be seen in the Digital Appendix, folder Interview & Focus Group.

Through meaning condensation of the transcribed focus group recording, we found that they combined had varied experiences with playing games, and developing games. Some types of games they had developed and their opinions of the games' success are:

- Board games (successful)
  - Strategic games
- Learning games (unsuccessful)
  - Children found the games boring, and teachers had a hard time including the games in their classes because the subject of the games did not fit within the curriculum of schools.
- Location-based experiences (successful)
  - It was not specifically a game, but used interactive digital media. Was an interactive tour implemented on a pilgrim route, where visitors could find tags which provided information about the pilgrims.

A point which was raised during the discussion was that, in their experience, using established games and their genres, mechanics, and formats, worked very well. Visitors could recognize the format, and therefore had an easier time engaging with the experiences. This coincides with our design, as it is based on Hidden Folks, an established game.

Table 11.1: Detailed overview of the focus group.

Participant(s)
Jacob Wang, Coordinator for the museum's digital initiatives Mette Boritz, chief curator at the museum Poul Grinder-Hansen, Senior researcher Charlotte S H Jensen, Development Rune Clausen, Web coordinator Alexander Risvang, Test conductor Daniel Ditlevsen, Test conductor
Method
Qualitative semi-structured focus group interview with experts from the museum via purposive sampling, using a dual moderator approach (Bjoerner, 2015).
Test procedure
Date: 5th of April, 2018 Location: Meeting room at the museum, Prince's Mansion, Ny Vestergade 10, 1471 København K. Data collection: Voice recording and note taking. Interview: A dual moderator focus group was used. One test conductor acted as the moderator asking questions, while the other acted as the moderator making sure that the planned topics were covered, and that the time plan was kept. Presentation: Both moderators held parts of the presentation, which consisted of slides on a TV. Participatory design session: Dual moderator approach as described above. Interview length: 1 hour, 20 minutes
Measurement instruments
The voice recording was transcribed and meaning condensation was used to extract findings. Observations and note taking was also used.

Table 11.2: Planned questions used during the focus group.

Planned questions
Names and positions
Interview (part 1): 1: What are your opinions on digital games in general? (In-direct introductory) - What do you associate with digital games? (Probing) - Can you talk about strengths and weaknesses of digital games? (Introductory) 1.1: What are your experiences with digital games? (Introductory) - Have you tried games before? - Have you tried games at other museums? - Which platforms? - Have you made any interactive digital media products before? - What was your target group, and why? - In your opinion, was it a success? - Which platforms?
Post-presentation (part 2): 2: What are your opinions on the presented games? 2.1: Which possibilities could a digital game provide for the museum? - How can a game change the museum visitor experience? - What is good/bad? 2.2: Which expectations would you have towards a digital game developed by the museum? - To which degree should a game educate? - To which degree should a game entertain?
Participatory design session (part 3): 3: What are your opinions about the presented prototype and idea? - What do you like/dislike? - What would you change? - Problem areas? 3.1: How would you use this game to curate the exhibition? - Where should the balance between fact and fiction be? 3.2: How could the museum sell such a product? 3.3: How can the museum keep the users engaged with the product over a longer period of time?

When asked about how games can support museums, and what they expect from a game developed by the National Museum, they answered that games can support the museum by providing visitor data (heatmaps, user behaviors, etc.) and exhibitions can be revitalized without having to change the physical context of the museum, something which is costly. They expect that a game developed by the museum should support the existing exhibitions, while not taking too much focus away from the museum.

This is in accordance with our design, as the game itself is related to the exhibition through its theme. The Game component is meant to be played online, and not while visiting the exhibition thus not taking focus away from it, while the AR component is integrated in the exhibition, meaning that to complete it, visitors have to focus on the exhibition and the exhibits to find the targets.

The last part of the focus group was intended as a participatory design session. First, we presented our prototype and asked for feedback. They found the prototype interesting, and in general provided positive feedback. They had many remarks as to how the design could be expanded, and they suggested the following:

- It is important to make a rich universe (game world) in a "deep" prototype, and then expand with additional exhibitions and museums.
- It is important to make a plan for the future (e.g. a 3 or 5 year plan with continuous releases of new content).
- Levels can change based on seasons or events related to the exhibitions.
- The game should cater to the visitor's "collector-gene" (i.e. the desire to achieve Completion).
- The ability to enter interiors in the level is important, enabling the inclusion of more content from the exhibitions.
- Finding an aspect in the game that drives the game forward.

We agree with their suggestions, and many of their suggestions were already planned for the game. A core concept of the design is to drive the game forward by continuously adding new content by changing the setting and theme of each level. The player's "collector-gene" is what we attempt to appeal to by having unlockable content when playing the game at museums, and the nature of the objective of the game is to collect all the targets. A list of unlocked and locked content can be presented to the player, giving them an overview of what they have collected and what they are yet to collect.

Making a plan for the future will be presented in the Discussion chapter 16.

The feature of entering interiors could be added to work similarly to the searchables. Doors could give access to interiors, changing the level to a much smaller compact level. This would give the game more depth, as players would be able to travel into the buildings.

11.1.9 Exhibition Tour

To extract content which could be implemented in the game, we had Poul Grinder-Hansen, a senior researcher with expertise in the Middle Ages and Renaissance, take us on a tour of the exhibition.

This interview was in the form of an unstructured interview and held while walking through the exhibition. We had previously studied the exhibition by ourselves, taking pictures and brainstorming ideas on how to utilize the exhibits in the game. We wanted Poul to act as the navigational guide, leading the conversation, in order for him to have as much influence as possible. We took notes during the tour, writing down ideas for the design of the game.

We wrote down ideas for characters and objects that could appear in the game. Far from the majority of the ideas made it into our final prototype, but they are still elements we will look into implementing in the future.

Based on the findings from the interviews we further developed the prototype, and were ready to evaluate the iteration with the target group. The design of the first iteration and how it was evaluated will be presented later in this chapter.

Table 11.3: Overview of the method used for the exhition tour.

Participant(s)
Poul Grinder-Hansen, Senior researcher Alexander Risvang, Test conductor Daniel Ditlevsen, Test conductor
Method
Qualitative unstructured go-along interview (Bjoerner, 2015).
Test procedure
Date: 12th of April, 2018 Location: Middle Ages exhibition, Prince's Mansion, Ny Vestergade 10, 1471 København K. Data collection: Note taking. Interview: Poul acted as the navigational guide, leading the test conductors through the exhibition. One test conductor noted down answers, while the other engaged in dialogue with Poul. Interview length: Approximately 1 hour.
Measurement instruments
Note taking.

11.1.10 Iteration Evaluations Participants

To evaluate each iteration we sampled 4-8 children aged 12-16. The children were sampled from a game development class taught by one of the authors, Alexander Risvang. These classes were held consecutively each week, and iterations were evaluated before these classes providing us with the possibility of consistently recruiting test participants.

The purpose of these tests were to evaluate on the design of the given iteration using CD and the in game data logs for player behavior. Furthermore we could evaluate on the test procedures and data gathering methods to plan how the final evaluation could be conducted, as it can be difficult to design simple measurements which are easy to understand for children (Bell, 2007).

It should be noted that these children are too old to fall within our chosen target group (6-12 y/o versus 12-16 y/o), this was taken into account when evaluating on the tests. Bjoerner (2015) states that a few years in age difference in children can have large effects on their understanding of questions and the quality of their answers. Tests and questions have to be worded differently for a 10 year old than a 15 year old. The children available for the design iteration tests were sampled by

convenience (Bjoerner, 2015). All the results and questionnaires from the design iterations can be found in the Iteration Results folder in the Digital Appendix.

11.2 Iteration 1

After the meetings with the museum employees, we expanded the design by adding an additional character: a peasant with a hoe (see Figure 11.13), and two types of searchables: windows and hay bales (see Figure 11.10).

Figure 11.13: Peasant from the game.

Furthermore we added the main objective to the prototype: two targets which had to be found. One was the peasant character which we hid behind a hay bale on a field and the other was a painting of Jesus, which we hid behind a window in the top tower of the church. Both of the targets were hidden behind searchables. These two targets make up the Extrinsic objective for this iteration.

We designed a simple UI which displayed the targets and the text hints. Table 11.4 shows an overview of the targets and the provided text hints.

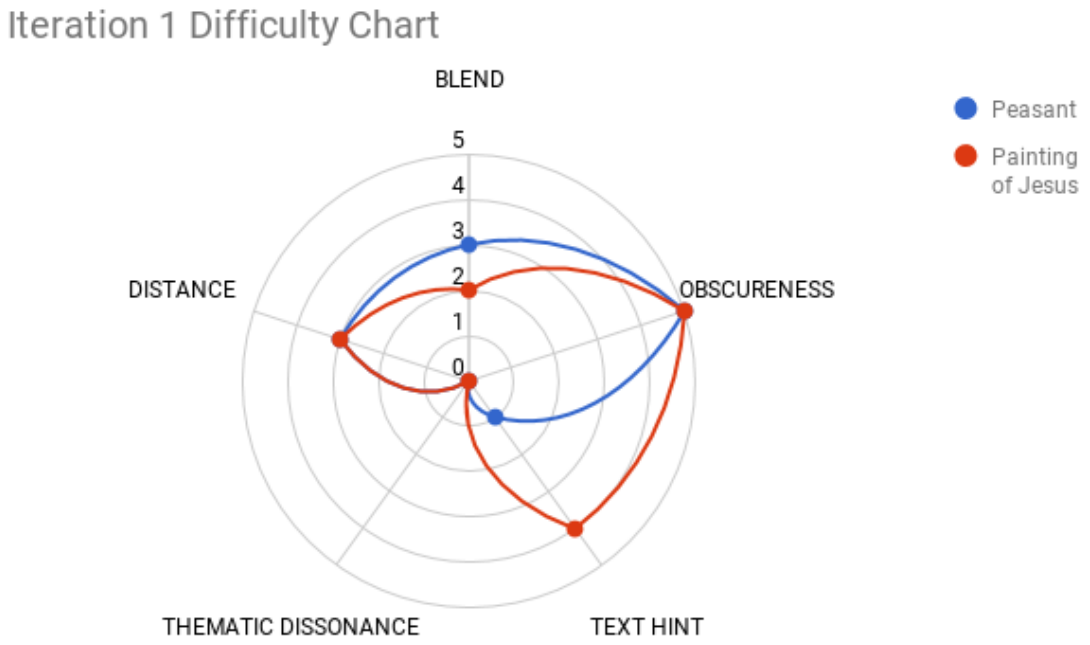
Table 11.4: Iteration 1 targets and hints.

Targets	Text hint
Peasant	"Find the peasant taking a rest from working on the fields..." "Find bonden som tager et hvil fra arbejdet på marken..."
Painting of Jesus	"Find the holy savior in the holy heights..." "Find den Hellige Frelser i de hellige højder..."

The first hint explicitly tells the players that the target is hidden in the field area, while the second text implicitly hints at the location of the painting (holy heights hinting towards the highest point of the church).

To design and keep track of the targets and how difficult they are to find, we awarded the targets with the difficulty parameters explained earlier in this chapter. We can visualize the difficulty using radar plots, as can be seen on Figure 11.14. We see how the painting of Jesus should be more difficult to find due to the vagueness of the text hint.

Figure 11.14: Target difficulty for iteration 1.



We can now explicitly add that the Extrinsic objective of the game is to find the peasant and the painting. We also further defined the player's activities, as the difficulty system enables them to Solve the Extrinsic objective. The level and *searchables* allow for Exploration, while the humorous aesthetic supports Sensing. Due to the Extrinsic objective, the Completion accomplishment entails finding all the targets (e.g. the peasant and the painting).

In regards to the SGDA framework, we can specify the *FICTION/NARRATIVE* and *CONTENT/INFORMATION* as the medieval setting, and the text provided to the players. The *AESTHETICS/GRAPHICS* component has also further been defined, as the humorous 2D cartoon style. The *MECHANIC* component mirrors the development of our OA3 framework in regards to the Extrinsic objective, Activities, and the Completion accomplishment. In the following chapter 12, Final Design, we present our design in the OA3 framework on a figure.

11.2.1 Evaluating Iteration 1

The purpose of the first iteration evaluation was to detect the children's desire to continue playing, and their reasoning for their answer in order to detect early engagement and disengagement triggers. Table 11.5 shows an overview of the test.

Table 11.5: Overview of the iteration 1 evaluation method.

Participant(s)
8 children ages 12-16. Alexander Risvang, Test conductor.
Method
Gameplay session with post-test questionnaire based on a basic version of the ESQ (Schoenau-Fog, Birke and Reng, 2012). In game player behavior logging.
Test procedure
Date: 9th of April, 2018. Location: Hovedgaden 39, 4140 Borup. Game play session: Eight children played the first prototype for around 5 minutes. The children were supplied with each their mobile device (Samsung Galaxy S7). Post-test questionnaire: On the same device they played they answered a short questionnaire. After the test was completed the test conductor asked the participants if they understood the question in the questionnaire. No misunderstandings were brought forth.
Measurement instruments
Observations and Continuation Desire questionnaire (Basic Game ESQ).
Questionnaire
Post-test questionnaire: I want to continue playing. (Basic Game ESQ, 5-point Likert scale where 1 is Disagree and 5 is Agree) Why? (Reasoning, Text field)

Iteration 1 Results

The results from the Basic Game ESQ are shown on Figure 11.15 and Table 11.6. The sample size (N), mean of the responses (M), median of the responses (Mdn), standard deviation (SD), standard error (SE) and Interquartile range (IQR) is presented.

Figure 11.15: Plot of reported desires to continue playing.

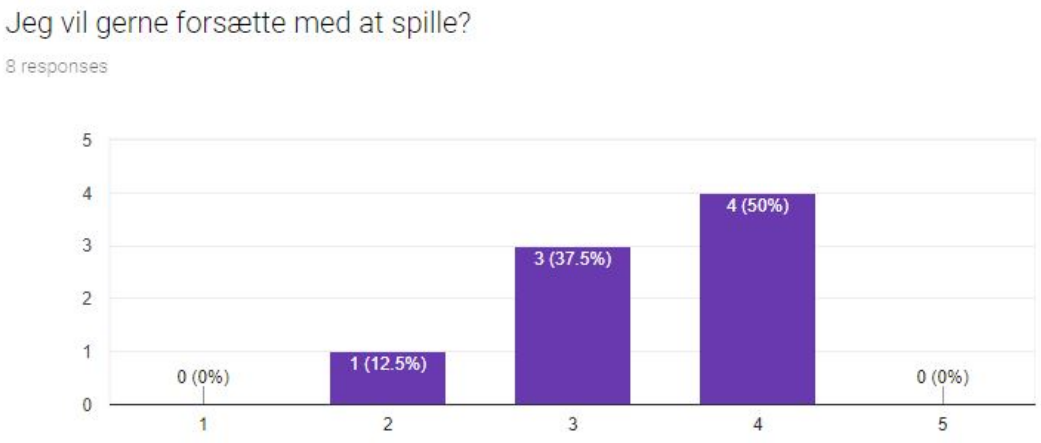


Table 11.6: Descriptive statistics of the reported desires to continue playing.

	N	M	SD	SE	Mdn	IQR
I want to continue playing	8	3.38	0.74	0.26	3.50	1.00

We can discern that the participant's in general did have a desire to continue playing, as the mean is above the center. When asked about the reason for their answer (regarding their desire to continue) the participants responded the following positive and negative feedback (see Table 11.7).

Table 11.7: Positive and negative feedback given by participants for iteration 1.

Positive
"It is fun to search for small figures in a gigantic place."
"I love that you had to look behind windows and hay bales."
"I like this type of games"
"I think its fun"
"Because it is a fun pastime activity"
Negative
"I wish I had to look for more people and things."
"Could become boring in the long run"
"It was not the most fun game, but it was not boring either"
"Does not seem as fun as new games on your phone"
"Its missing more things to look for"

Two participants mentioned that there were not enough targets. This makes sense, as we only included two. We can now discern that the participants did want to engage in the Solving and Exploration activities, or at least that they wanted to complete the Extrinsic objective. Future iterations will include new and higher amounts of targets.

Other comments such as that the prototype did not seem as fun as other mobile games, and that it could become boring in the long run, do not clearly indicate what the problem was with the prototype. No comments were made in regards to the Sensing activity. Further evaluation is needed to allocate these problems.

Player Behavior

To evaluate on player behaviors, we implemented the in game player behavior logging system. The system logged every time a player pressed an interactable object (for this iteration: the targets, towncriers, windows, hay bales, bushes, and trees). The following parameters were logged when such an event occurred:

- Object name and type.
- Position of the object.
- Camera size.
- Camera position.
- Time since the game began.

With these parameters logged we can begin to study player behavior in the game, such as how much time they spend before finding a target, which types of objects are pressed the most, how often they press the screen, how zoomed in or out the camera is, and so on.

Via our game data logging system, we created heatmaps for the first iteration, showing which interactable objects the players pressed on. Figure 11.16 shows a heatmap combining all the players' sessions. The red circles represent players pressing on interactable objects and the blue dots represent the locations for the two targets (peasant and painting). Unfortunately, we lost parts of the level from the early prototype resulting in the heatmaps not showing the full content of the prototype. Future iterations do not suffer from this problem. From the heatmap, we can see that there are some areas where the majority of the players pressed the same objects, especially above the center of the map which had a lot of searchable windows.

Figure 11.16: Heatmap from iteration 1. Blue icons are markers for the targets.

We also collected the data shown on the following Table 11.8 (note that by touches we mean the player pressing on an interactable object):

Table 11.8: Reported means of player behaviors for iteration 1.

	M
Number of touches	46
Time spent playing	343.10 seconds
Time between each touch	3.09 seconds
Camera Size	11.19
Time to find the painting	329.12 seconds
Time to find the peasant	294.12 seconds
Camera size when the painting was found	11.62
Camera size when the peasant was found	12
Number of pressed windows (total 40)	18.5
Number of pressed hay bales (total 22)	4.5
Number of pressed bushes and trees (total 126)	12.6

The objects that were pressed the most were the searchable windows. On average windows were pressed 18.5 times, and there were 40 windows in total. We find the average high, considering that only one window was a requirement to complete the level. The heatmap also shows a concentration of presses on the windows (see above the center of Figure 11.16).

The average time between each touch on an interactable object is 3.09 seconds, which we find low, indicating that the players did continuously interact with the game. It should be noted that this measure does not take *every* press into account. It records a press when certain objects are interacted with. For future iterations we should record the data for every press the player makes.

On average, the players had their camera zoomed almost all the way out (Mean = 11.19). Technically, the camera could zoom from a size of 2.5 to 12. This number is specific to Unity, the game engine used for development, and it is a measure for the camera's size (we defined the size in Unity to be half of the amount of characters which can fit on top of each other on one screen, thus a size of 2.5 would fit 5 characters, while a size of 12 fits 24 characters).

The high camera size indicates that players preferred a large overview, rather than zooming in. This could be due to the size of the level, as players could be confused and overwhelmed, thus zooming out more to gain an overview.

We can see that the camera was also zoomed almost all the way out on average when they found the two targets. This could indicate that the targets did not blend in much with their surroundings as players could see them while zoomed out. We did not design the targets to blend in with the scenery, but it is something we should evaluate on in the next iterations.

It took the players about 5 minutes on average to find the two targets. This was not intended as we want the players to feel accomplishments much earlier than 5 minutes.

We want to make clear that the assumptions made based on the game data log are purely speculations and assumptions. We can not say if a certain number being high or low has a positive or negative effect on the player. We can use the data to compare it to the following iterations, as it can function as a baseline.

Redesign for the next iteration

From the evaluation of this iteration of the design we chose to reduce the size of the level for two reasons: according to our initial expectations it took the children too long to find the targets, and we are able to create a much more dense and content filled level. A more dense level was also created in order to force a more divers camera size.

We kept working on additional content such as more characters and targets, as the participants reported that they would like if there were more content and targets to find.

Figure 11.17 shows the average desire to continue measured during the first iteration.

Figure 11.17: Average desire to continue for iteration 1.

11.3 Iteration 2

For the second prototype we changed two major things: we redesigned the level making it more compact, and we added several new characters and objects. To create a more diverse level, we made several different versions of each character, where clothing and hair changes color, and some characters hold different items (e.g. different tools or weapons), they might have a hat or show their hair, and they might be shaved or have a beard. With these variations we are able to create a more dense and diverse level, without the workload of designing new characters over and over. Variety in the content further supports our desired player experience of feeling a sense of discovery. Some of these characters can be seen on 11.7.

The new level can be seen on Figure 11.18.

Figure 11.18: Overview of the level for iteration 2 with blue banners behind targets.

11.3.1 Targets

As we found during the evaluation of the previous iteration, the participants reported that they thought there were not enough targets. For this iteration, we changed the targets to three new ones, described on Table 11.9. Figure 11.19 shows the drawings of the targets.

Table 11.9: Targets and hints for iteration 2.

Targets	Text hints
The Monk with a drinking horn (referred to as Monk)	"This monk is enjoying the performance with a horn of beer..." "Denne munk nyder forestillingen med et horn øl..."
The Guard holding a lance (referred to as Guard)	"This guard did not have time to change weapons after the tournament..." "Denne vagt havde ikke tid til at skifte våben efter turneringen..."
The Lost pilgrim (referred to as lost pilgrim)	"According to the map, the pilgrim should be there by now..." "I følge kortet burde denne pilgrim være nået frem nu..."

Figure 11.19: The three targets in iteration 2.

The Monk and the Pilgrim, were ideas conceived during the earlier described exhibition tour with Poul Grinder-Hansen. The exhibition itself displays a drinking horn that belonged to a monk and figurines of pilgrims.

We placed the new targets and wrote the text hints to be able to test different levels of difficulty. Figure 11.18 shows where each of the targets were placed.

The Monk with a drinking horn

For the monk, we deliberately placed him on the opposite side of the level compared to the church and the religious area. In the text we provide a hint about his location, we write that he is enjoying the *"performance"*. We designed one area between the common and rich areas to be a jousting tournament, with knights holding lances, jousting each other. Understanding the hint requires the players to discover the jousting tournament, then make the connection that the tournament is a performance, and then they have to find the monk himself. Furthermore we hid the monk behind a searchable hay bale, removing him from clear view. Lastly, the monk that has to be found looks identical to all the other monks in the level. Only when interacting with the character it is revealed to the player that he is holding a drinking horn (instead of a cross). We placed several other monks in lightly obscured or isolated locations to give the player false hope every time they see a monk, as seen on Figure 11.18. We designed this to appeal to the player's determination to find the right monk, it might frustrate the player, which can either reduce their engagement with the game, or create determination and a strive to complete the objective.

The Guard holding a lance

The guard with the lance was placed on the city walls without being obscured by anything. The difficulty in finding this target was designed to come from two things: his silhouette and colors blend in with his surroundings (he is primarily of a grey color, and he is standing on top of the grey wall surrounded by other guards which are very similar), and the text hint does not provide any information about his location, only about his appearance (he is holding a lance instead of a spear).

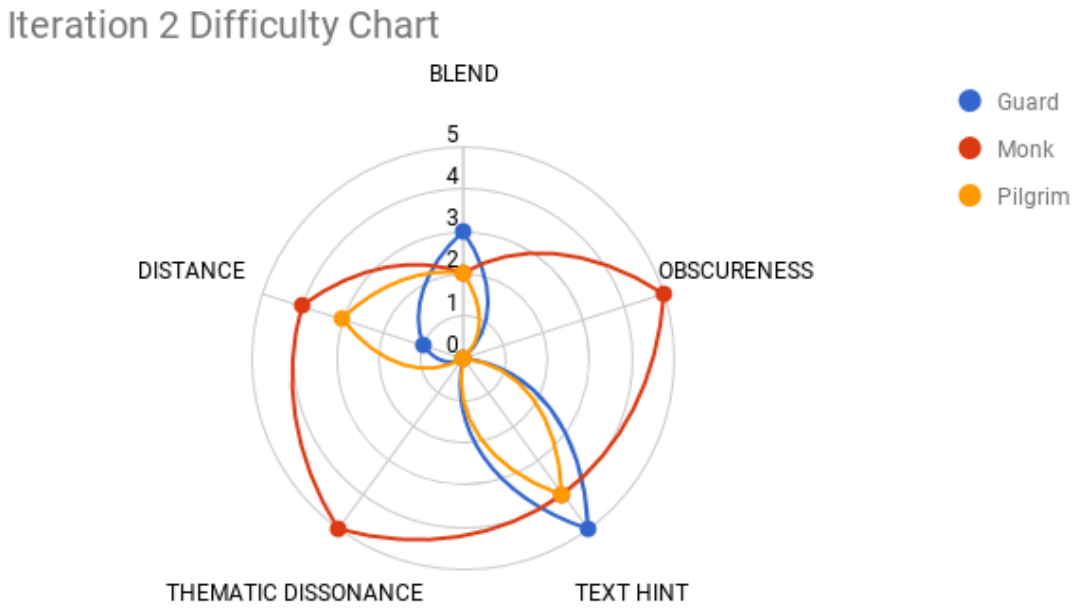
The lost Pilgrim

The lost pilgrim was also placed unobstructed by anything. The difficulty of finding this target comes from two aspects: the children might not know exactly who the pilgrims were, and if they do not know that pilgrims travelled to religious sites, the text hint becomes very difficult to use.

Iteration 2 Difficulty System

We can now present the following Figure 11.20, which sets the targets in context with the difficulty system.

Figure 11.20: Target difficulties for iteration 2.



Here we see that the Guard and Pilgrim targets are designed to be of similar difficulty, while the Monk is supposed to be the hardest to find.

User Interface

As we now had one more target than in the previous iteration, we redesigned the UI. Now the targets are displayed after the players press a UI button. This gives us reason to evaluate on the UI changes.

We reduced the camera's zoom out boundary, to 10 (it was 12 in the first iteration). This means that the players can't have as much information on the screen at once, making it more difficult to find the targets. In the previous iteration the average camera size between all the players was almost at its maximum zoom out, and we wanted to test if reducing the camera size would influence that number.

11.3.2 The OA3 and SGDA frameworks for iteration 2

We can now update our OA3 and SGDA frameworks, as players have three new targets to find, thus further expanding the Extrinsic objective, Solving activity, and Completion accomplishment. Furthermore the Exploration and Sensing activities have more content to support them, as the level layout has changed and this iteration introduces several new characters.

The SGDA framework further follows the OA3 objectives, activities and accomplishments in its *MECHANIC* component. The *CONTENT/INFORMATION, AESTHETICS/GRAPHICS* and the

FICTION/NARRATIVE components can be specified more in detail due to the additional content, but otherwise they have not changed.

11.3.3 Evaluating Iteration 2

The purpose of this evaluation was to dive deeper into the prototype design, and allocate how the components of our OA3 framework were received by the participants. Continuation Desire was used as the measurement instrument. As the children had already tried the previous prototype, the following design iteration tests were also used to detect their desire to begin playing again, as an indicator for repeated gameplay sessions, with changes and additional content. Tables 11.10 and 11.11 show an overview of the test (on the following pages).

Iteration 2 Results

The results from the conducted test will now be presented. Before they played the prototype, we asked them about their desire to begin playing. The answers are reported on Figure 11.21 and Table 11.12.

Figure 11.21: Reported desire to being playing iteration 2.

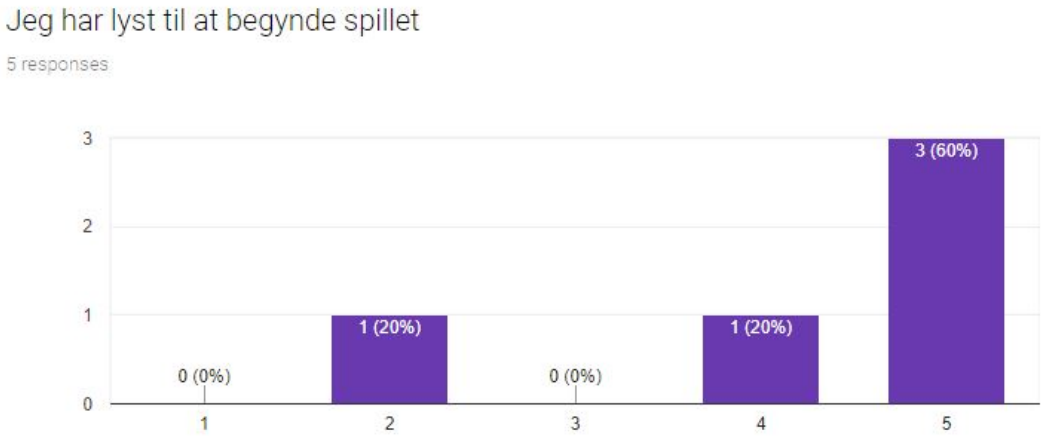


Table 11.12: Descriptive statistics of reported desire to begin playing iteration 2 (question 0).

	N	M	SD	SE	Mdn	IQR
I want to begin playing	5	4.20	1.30	0.58	5.00	1.00

We see a very high mean score, proving that the game might hook the players. It could be argued that the children might answer positively to please the test conductors.

We only use this measurement to achieve an indication of their desire to play the game again. Comparing it to their previously reported desire to continue playing during iteration 1, we see that the scores are more positive. This could be due to the participants having consumed all the content when answering after the previous iteration, while they might have been looking forward to new content in this present iteration.

After finding all three objectives we asked about their desire to continue playing. Results are shown on Figure 11.22 and Table 11.13.

Table 11.10: Iteration 2 test procedure and method.

Participant(s)
5 children ages 12-16. Average age was 13.4. Gender distribution was 80 % male and 20 % female. Alexander Risvang, Test conductor.
Method
Gameplay session with post-test questionnaire based on a basic version of the ESQ (Schoenau-Fog, Birke and Reng, 2012). The test conductor observed the participants, looking for errors that could disrupt the test. In game player behavior logging.
Test procedure
Date: 30th of April, 2018. Location: Hovedgaden 39, 4140 Borup. Pre-test questionnaire: The children answered a set of demographic questions (age and gender) and they answered on their desire to begin playing. Gameplay session: Five children played the second prototype for around 5 minutes. The children were supplied with each their mobile device (Samsung Galaxy S7). Post-test questionnaire: On the same device they played they answered the Basic Game ESQ.
Measurement instruments
Observations and Continuation Desire questionnaire (Basic Game ESQ). All the questions based on the Basic Game ESQ use a 5-point Likert scale, ranging from 1 being Disagree to 5 being Agree. Reasons were gathered by providing the participants with text fields where they could write the reasonings for their answers, this functioned as a qualitative measure. Questions about usability issues also used a 5-point Likert scale, as with the Basic Game ESQ.

Table 11.11: Questionnaire for evaluating iteration 2.

Questionnaire
Pre-test questionnaire: Age (Demographics, text field)
- Gender (Demographics, checkbox)
0: I want to begin playing. (Basic Game ESQ)
Post-test questionnaire:
1: I want to continue playing. (Basic Game ESQ)
- Why? (Reasoning, Text field)
2: It was easy to figure out what I was supposed to do.
(Basic Game ESQ, Objectives)
3: It was easy to figure out what I was supposed to do. (Usability)
4: I found it difficult to create an overview of the world. (Usability)
- Why? (Reasoning, Text field)
5: I thought the text hints made it easy to find the targets.
(Basic Game ESQ, Objectives)
6: I thought the Lost Pilgrim was easy to find.
(Basic Game ESQ, Objectives and Activities)
7: I thought the Guard with the lance was easy to find.
(Basic ESQ, Objectives and Activities)
8: I thought the Monk with the drinking horn was easy to find.
(Basic Game ESQ, Objectives and Activities)
9: I enjoyed spending time discovering things in the level.
(Basic Game ESQ, Activities and Affect)
10: I was only looking for the objectives the menu posed.
(Basic Game ESQ, Objectives)
11: I had difficulty navigating the world. (Usability)
12: I had difficulty zooming in and out with the camera. (Usability)
13: I had difficulty pressing things in the world. (Usability)
14: I missed not being able to press more things in the game.
(Basic ESQ, Activities)
15: I felt it was boring to look for things in the game.
(Basic Game ESQ, Objectives, Activities and Affect)
16: Were there too many questions in this questionnaire?
(Method evaluation, Checkbox)

Figure 11.22: Reported desire to continue playing iteration 2.

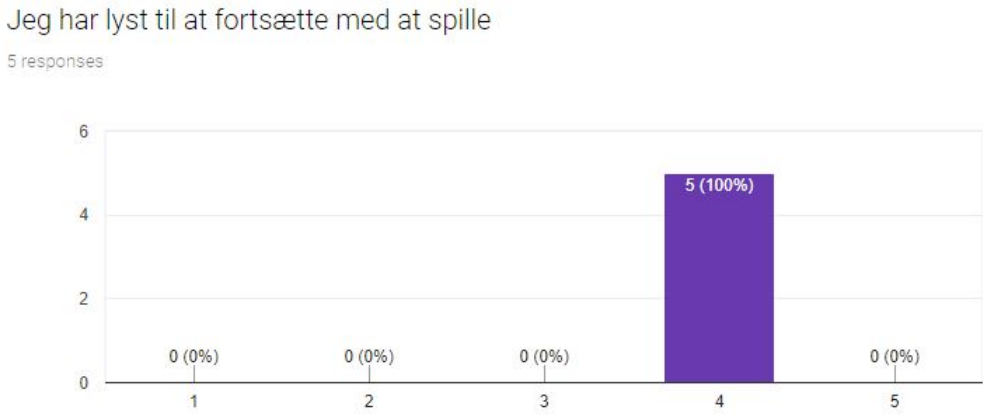
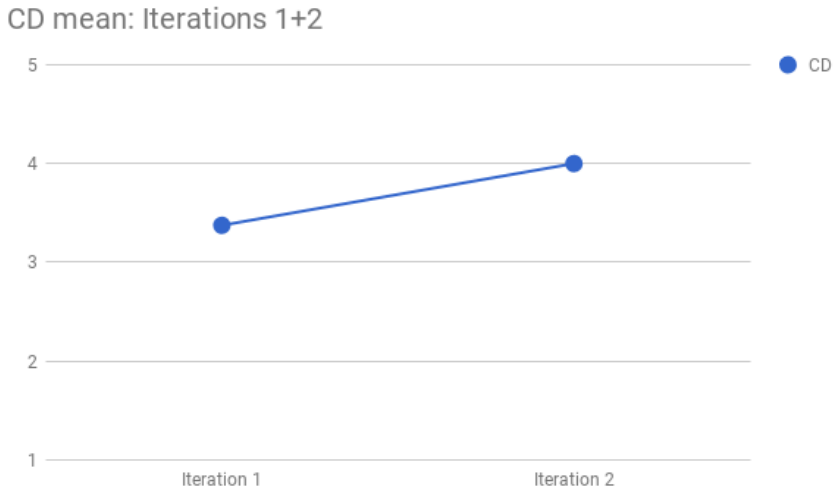


Table 11.13: Descriptive statistics of reported desire to continue playing iteration 2 (question 1).

	N	M	SD	SE	Mdn	IQR
I want to continue playing	5	4.00	0.00	0.00	4.00	0.00

Again, they report a positive score, indicating that the game might be engaging. We see that the mean and the median are the same, as all participants reported the same answer. Overall their desire to continue playing is lower than their desire to begin playing was. We can now add this score to the overall development of the participants desires to continue playing across iterations, as shown on Figure 11.23. Here we see a slight increase in the desire to continue playing after playing iteration 2 compared to iteration 1. This could be due to the addition of the new content, as the level is much more varied and dense in iteration 2 compared to iteration 1.

Figure 11.23: Desire to continue playing across iterations 1 and 2.



When asked about the reason for their answer they answered with mostly positive remarks:

"I love the game concept, and all the sounds and figures."
"I like the game because you can thoroughly search the level."
"It is difficult and fun, because it is like a Where's Waldo book."
"It was fun, but I found the last one without knowing it."
"I don't know why."

These comments are positive (except the last comment, which neither describes a positive or negative aspect), and they do not bring up any flaws in the design. The first comment indicates that the participant did engage in the Sensing activity, the second comment indicates that Exploration occurred. The third comment indicates Solving and Exploration, as the participant found the game difficult but fun.

We asked if they found it easy to discern what the objective of the game was, and if they used the UI to understand the game's objectives. Their answers are shown on Table 11.14.

Table 11.14: Descriptive statistics of self-reported questionnaire (questions 2 and 3).

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
It was easy to figure out what I was supposed to do	5	4.80	0.45	0.20	5.00	0.00
I used the menu to figure out what I was supposed to do	5	3.40	1.67	0.75	3.00	2.00

We can see that they answered positively as to how easy they found it to understand the objective. This was expected as the objective of the game did not change since the previous iteration, meaning that they were already familiar with it.

Their answers in regard to them using the menu to discern the objective are more scattered, with answers in both ends of the scale. We do see positive mean and median scores, but they are close to the center and we would like to increase the numbers for future iterations. We want to redesign the UI in the future, to give it a more aesthetic look and to convey the objective of the game in a more efficient manner.

To summarize, we can see that the children understood the game's Extrinsic objective.

We asked them if they found it difficult to create an overview of the world. Their answers, shown on Table 11.15, could help us with insight about how the camera's zoom boundaries are received. The answers could also indicate that the level layout is confusing, not allowing the players to create accurate mental images of the level.

Table 11.15: Descriptive statistics of self-reported questionnaire (question 4).

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
I found it difficult to create an overview of the world	5	2.60	1.67	0.75	3.00	2.00

The mean and median show that in general the participants were able to create an overview of the world, though not by a large margin as the values are close to the center. When asked about the reason for their answers they answered:

"It was so easy to get an overview."
"You had a good overview of the world because you could use your fingers to zoom in and out."
"There were many things, and some were hidden, which made them difficult to find."
"It was easy to get an overview of where things were, but not where the characters were."

We are satisfied with these answers, as none of them raised any usability problems meaning that the participants were able to engage in the Exploration activity. The last two quotes mention that some objects were hard to find, and that it was difficult to get an overview of the characters. We are satisfied with these responses, as we want the smaller objects in the world (characters, objects, targets) to be difficult to find, while the different town areas (castle, church, jousting tournament, etc.) to be easy to get an overview of.

We asked the participants if the text hints made it easy to find the targets. Their answers can be seen on Table 11.16.

Table 11.16: Descriptive statistics of self-reported questionnaire (question 5).

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
I thought the text hints made it easy to find the targets	5	3.40	0.55	0.24	3.00	1.00

As shown on Figure 11.20, that depicts the difficulty of finding each target, none of the targets were meant to be very easy. We are satisfied with their answers as the participants did not report that the text hints did not make it easier to find the targets, as we can see by the mean and median being above center. These findings can indicate that the participants did engage in the Solving activity, as they were able to use the text hints.

Our designed difficulties for each target also fits with how difficult the participants reported the targets to be (the Guard and Pilgrim were supposed to be of similar difficulty, while the Monk was supposed to be difficult to find). Table 11.17 show their answers.

Table 11.17: Descriptive statistics of self-reported questionnaire (question 6, 7, and 8).

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
I thought the text hints made it easy to find the targets	5	3.40	0.55	0.24	3.00	1.00
I thought the Guard with the lance was easy to find	5	2.80	1.10	0.49	2.00	2.00
I thought the Monk with the drinking horn was easy to find	5	1.20	0.45	0.20	1.00	0.00

The monk was designed to be difficult to find, which is reflected in their answers. The results indicate that the difficulty could be too hard, especially the monk target. Therefore we want to make the monk easier to find. For the Guard and the Pilgrim we are satisfied with their answers, as they reflect that they were easy to find without it being too easy.

To discern if the players felt they did the Exploration and Sensing activities, we asked them if they enjoyed discovering things in the level and if they only searched for the targets. Table 11.18 shows their answers.

Table 11.18: Descriptive statistics of self-reported questionnaire (questions 9 and 10).

	N	M	SD	SE	Mdn	IQR
I enjoyed spending time discovering things in the level	5	3.80	1.10	0.49	3.00	2.00
I was only looking for the objectives the menu posed	5	3.40	1.14	0.51	3.00	1.00

In both figures we can see that the answers were generally on the positive side, as both means and medians were above the center. We did not expect these answers to be overly positive, as both Exploration and Sensing can depend a lot on player types and preferences. We are satisfied with their answers.

To inquire about the controls we asked if they found it difficult to move around in the level, use the camera's zoom function, and pressing (interacting) objects in the level. Table 11.19 shows that the majority of the participants did not have any problems with these.

Table 11.19: Descriptive statistics of self-reported questionnaire (questions 11, 12, and 13).

	N	M	SD	SE	Mdn	IQR
I had difficulty navigating the world	5	1.60	1.34	0.60	1.00	0.00
I had difficulty zooming in and out with the camera	5	1.60	1.34	0.60	1.00	0.00
I had difficulty pressing things in the world	5	1.80	1.30	0.58	1.00	1.00

It is worth noting that the responses were identical in regards to the perceived difficulty of navigating the world and using the camera's zoom function. All three medians are 1.00, the minimum score.

We then asked if they had wanted the game to have more objects that were intractable. Here their answers were spread out, with the majority answering right in the middle. Table 11.20 shows their answers.

Table 11.20: Descriptive statistics of self-reported questionnaire (question 14).

	N	M	SD	SE	Mdn	IQR
I missed not being able to press more things in the game	5	2.60	1.14	0.51	3.00	1.00

Compared to the first iteration, where the participants mentioned they wanted more interactable objects in the level, we see an improvement in their answers as the mean indicates that in general they were satisfied with the amount of interactable objects. We as designers are not satisfied with the amount of interactable objects, as we want the game to be much more responsive and alive.

This can further support the Exploration activity. Adding more interactable objects is something we will look into in the future.

We asked the participants if they found it boring to look for things in the game. Their answers are shown on Table 11.21.

Table 11.21: Descriptive statistics of self-reported questionnaire (question 15).

	N	M	SD	SE	Mdn	IQR
I felt it was boring to look for things in the game	5	1.80	1.10	0.49	1.00	2.00

The majority answered that they did not find it boring as can be seen by the mean and median being low. We are satisfied with these answers, as they indicate that the players might have engaged in the Exploration activity.

Finally, we evaluated the length of the questionnaire, by asking if the participants thought there were too many questions. All five participants answered no. This finding provides us with information about how we can structure our final evaluation of the game's purpose.

Player Behavior

As with the first iteration we also logged the player's in game behaviour. We further developed the game data logging system so that it stored data every time the player's pressed *anything*. This provides us with a precise measure of their behaviour and much larger amount of data.

Figure 11.24 shows a heatmap of all the participants' combined presses.

Figure 11.24: Heatmap from iteration 2.

From the heat map we can see that combined the players pressed all the searchables in the prototype. Furthermore we see that the players mostly pressed the same places. To remind the reader, the intensity of the red color increases per press.

Table 11.22 shows the averages of different statistics that we measured:

Table 11.22: Reported mean of player behaviors for iteration 2.

	M
Number of touches	131
Time spent playing	339.43 seconds
Time between each touch	2.56 seconds
Camera Size	8.47
Time to find the Pilgrim	114.77 seconds
Time to find the Guard	149.34
Time to find the Monk	309.51 seconds
Camera size when the Pilgrim was found	8.54
Camera size when the Guard was found	8.44
Camera size when the Monk was found	7.37
Number of pressed windows (total 47)	28.5
Number of pressed hay bales (total 8)	4.9

As we now measure *every* time they press, we see that the average number of touches has increased and time between touches has decreased compared to the first iteration. The average time spent is similar as previously (around 5 minutes), but this time due to the inclusion of more and easier targets we can see that they on average first found the lost Pilgrim, and then the Guard, within two and a half minutes of playtime. It can be argued that to keep providing the player with small accomplishments it would have been desirable to have a larger time difference between the time it took to find the Guard and the Pilgrim. Furthermore our difficulty system seems to also fit on the game data, as the Pilgrim and the Guard were found around the same time. The Monk took 5 minutes to find on average, indicating that it was the most difficult one to find.

In regards to the Completion accomplishment, and our idea of the players making Intrinsic objectives about opening all the windows, and scattering all the hay bales, we can see that on average every player pressed over half of the occurrences in the level of the windows and hay bales. In the data, we see that one of the participants pressed on 44 out of 47 windows, very close to opening every window in the game. To give the full perspective it should also be noted that one participant only pressed on 13 windows.

We changed the maximum zoom out of the camera from 12 to 10, and can now see that the average camera size is 8.47 (compared to 11.19 in the first iteration). The average camera size when finding the targets was between 7.37 and 8.54.

The guard was meant to blend in with the scenery, and as the average camera size was 8.44 when he was found, he might not have blended in as much as we had intended. For future iterations

we should design a target which blends in even more to see if we can have the players zoom in more to find it. This is something we want to design for, as we want varied solutions to finding the targets.

Redesign for the next iteration

The major findings from this evaluation were that the monk was too difficult to find, and that we should explore if having the targets blend in more with the scenery can increase the difficulty.

11.4 Iteration 3

For the third iteration we did not change anything about the level and its layout, as we wanted to only change the targets which were to be found, as we want to further explore how we can affect how difficult they are to find.

11.4.1 Targets

For the third prototype we changed the targets. We designed two new, as shown on Table 11.23 and Figure 11.25.

Table 11.23: Targets and hints for iteration 3.

Targets	Text hints
Shield	"Typical that the Prince forgot his shield in his chambers..." "Typisk af Prinsen at glemme sit skjold på sit kammer..."
Helmet	"This helmet was forgotten by a guard when he took a rest in the town..." "Denne hjelm blev glemt af en vagt da han tog et hvil i byen..."

Prince's Shield

The shield was hidden behind a searchable window in the castle, an area of the map where we had not hid any targets in the previous iterations. The text hints at the castle, as the words *"Prince"* and *"chambers"* are mentioned, which we chose as we assume that children make a connection between princes and castles. Also, by including the wording "in his chambers..." we hint that the target is hidden in an interior, and the only way to access interiors is by pressing the windows. This hint is relatively explicit (compared to the Helmet), meaning that we do not expect it to be too difficult to find.

Helmet

As the previous target, the Guard, did not give a good indication of how blending the targets in with their surroundings effects the difficulty we designed a helmet, which is supposed to blend in much more than the Guard. We placed it on a background of solid grey color (cobblestones) and gave it a slightly different tone of grey, and made it small. Our intent was to see if the size could have an effect on the player's camera sizes. We also filled the surrounding area with weapons and armors, such as spears, shields, and breastplates, to make it seem like the merchants in the area are selling such gear. These objects resemble the helmet in color, letting it blend in even more.

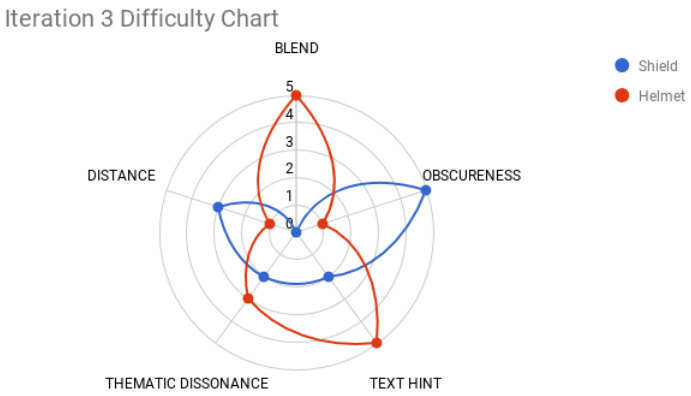
For the text, we only hint at its location: the town. One of the areas of the map has a high concentration of houses, and is supposed to be the town area. There's also a market, which might have been a better area to include in the text, as it is smaller than the town. The players might think of the whole level as the town, making the hint very vague.

Figure 11.25: Level layout and new targets for iteration 3.

Iteration 3 Difficulty System

Figure 11.26 shows how the two new targets fit in our difficulty system. Here we can see that the Helmet is designed to be more difficult than the Shield.

Figure 11.26: Target difficulties for iteration 3.



11.4.2 The OA3 and SGDA frameworks for iteration 3

The OA3 framework is now updated with the new targets, so the specifics of the components have again changed. For the SGDA framework, the *MECHANIC* component changes (as the Extrinsic objective and the other components of the OA3 framework also have), while the rest of the components have not changed. There is no additional content for the *FRAMING, CONTENT/INFORMATION, AESTHETICS/GRAPHICS* and the *FICTION/NARRATIVE* components.

11.4.3 Evaluating Iteration 3

The purpose of this iteration evaluation is similar to the purpose of the previous evaluation. We did change some questions to focus more on the player's affect as a result of playing the game. Furthermore we wanted to use the Again-Again table to measure their desire to repeat the activity. Instead of using the *Yes, No,* and *Maybe*, measures which are part of the Again-Again table, we adapted it to a Likert-scale item, ranging from 1 (Disagree) to 5 (Agree). Tables 11.25 and 11.26 show the method and procedure used for the third iteration evaluation (on the following pages).

Iteration 3 Results

The results from the conducted test will now be presented. Before they played the prototype, we asked them about their desire to begin playing. The answers are reported on Figure 11.27 and Table 11.24.

Figure 11.27: Reported desire to begin playing iteration 3.

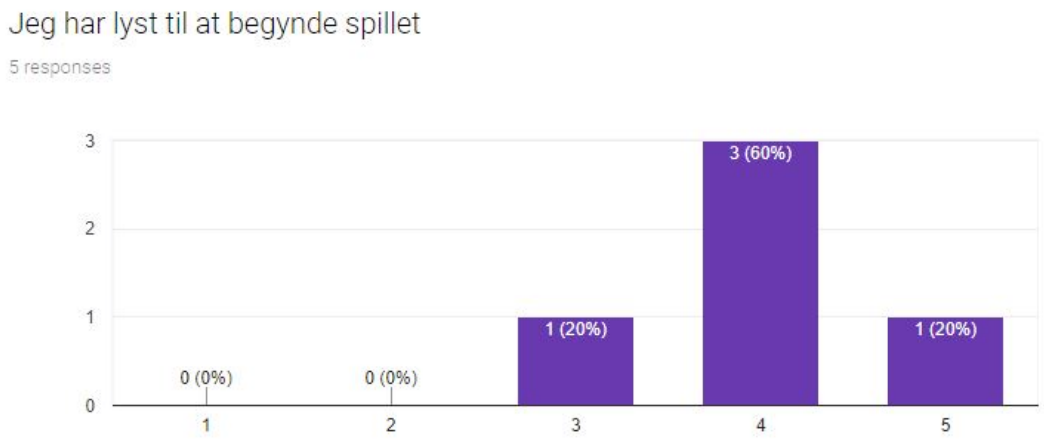


Table 11.24: Descriptive statistics of desire to begin playing iteration 3 (question 0).

	N	M	SD	SE	Mdn	IQR
I want to begin playing	5	4.00	0.71	0.32	4.00	0.00

Table 11.25: Test procedure and method for evaluating iteration 3.

Participant(s)
5 children ages 12-14. Average age was 12.8. Gender distribution was 80 % male and 20 % female. Alexander Risvang, Test conductor.
Method
Gameplay session with post-test questionnaire based on a basic version of the ESQ (Schoenau-Fog, Birke and Reng, 2012). The test conductor observed the participants, looking for errors that could disrupt the test. In game player behavior logging.
Test procedure
Date: 7th of May, 2018. Location: Hovedgaden 39, 4140 Borup. Pre-test questionnaire: The children answered a set of demographic questions (age and gender) and they answered on their desire to begin playing. Gameplay session: Five children played the second prototype for around 5 minutes. The children were supplied with each their mobile device (Samsung Galaxy S7). Post-test questionnaire: On the same device they played they answered the adapted Basic Game ESQ.
Measurement instruments
Observations and Continuation Desire questionnaire (Basic Game ESQ). All the questions based on the Basic Game ESQ use a 5-point Likert scale, ranging from 1 being Disagree to 5 being Agree. Questions about usability issues also used a 5-point Likert scale, as with the Basic Game ESQ. Here we also began asking about ‘returnance’, meaning their desire to repeat the experience, (Again-Again table).

Table 11.26: Questionnaire used to evaluate iteration 3.

Questionnaire
Pre-test questionnaire: Age (Demographics, text field)
- Gender (Demographics, checkbox)
0: I want to begin playing. (Basic Game ESQ)
Post-test questionnaire:
1: I want to continue playing. (Basic Game ESQ)
- Why? (Reasoning, Text field)
2: I felt like the text hints made it easy to find the figures in the game. (Basic Game ESQ, Objectives)
3: I felt like "the helmet" was easy to find. (Basic Game ESQ, Objectives and Activities)
4: I felt like "the shield" was easy to find. (Basic Game ESQ, Objectives and Activities)
5: I felt happy when I found a "target" (shield or helmet). (Basic Game ESQ, Affect)
6: I felt unsatisfied when I found a "target" (shield or helmet). (Basic Game ESQ, Affect)
7: I enjoyed spending time discovering things in the game. (Basic Game ESQ, Activities and Affect)
8: I only searched for the figures stated by the objective of the game. (Basic ESQ, Objectives)
9: I had a hard time pressing things in the game. (Usability)
10: I missed not being able to press more things in the game. (Basic Game ESQ, Activities)
11: I felt it was boring to look for things in the game. (Basic Game ESQ, Objectives, Activities and Affect)
12: I want to play the game again. (Basic Game ESQ, Again-Again)
- Why? (Reasoning, Text field)
13: I felt compelled to press all the characters, windows or trees. (Basic Game ESQ, Objectives, Activities and Accomplishment)
14: I felt I played for much longer than I did. (Basic Game ESQ, Affect)

Compared to the previous iteration, their desire to begin is lower by a small margin (for the previous iteration the mean was 4.20, and the median was 5.00). None of them answered below the middle. We do not know which participants participated in the previous iteration, and being or not being familiar with the previous iteration could have very different effects on their desire to begin playing. This is something we can not detect, and therefore we will not make any assumptions based on this measure. We can only see that it is in general positive, meaning that the children did have a desire to begin playing. We can also see that the CD measure pre test derives a high median, which could be evidence of a ceiling effect occurring, making it impossible to measure an increase between pre and post.

We asked about their reasoning, and they answered the following (one respondent did not answer the question):

"Because it was fun."
"Because I think that the purpose of the game is clever."
"I thought it was fun the last time."
"The game is fun, but right now I don't feel like playing that much."

When talking about the game they describe it as "being fun". None of them responded that they were excited to see if there was anything new to do, but we assume that they want to play again because they think the game could have changed since the last time they played.

After playing they answered how much they wanted to continue playing, as can be seen on Figure 11.28 and Table 11.27.

Figure 11.28: Reported desire to continue playing iteration 3.

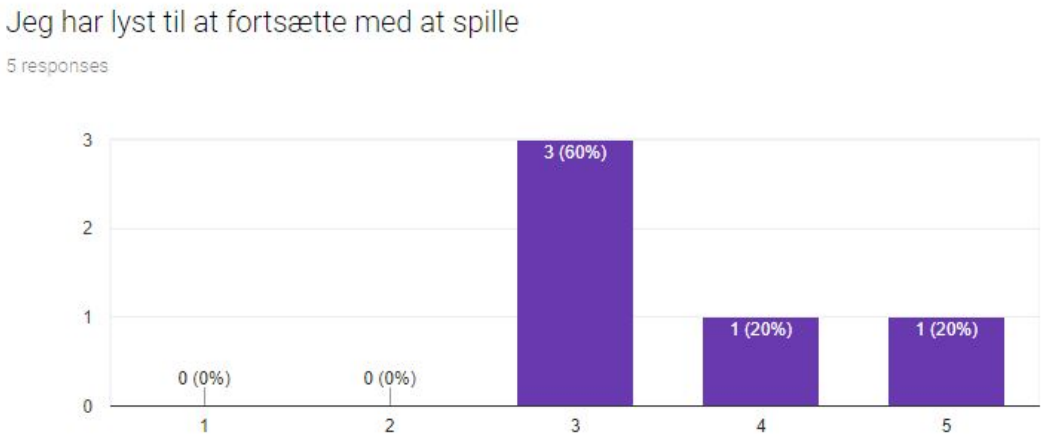


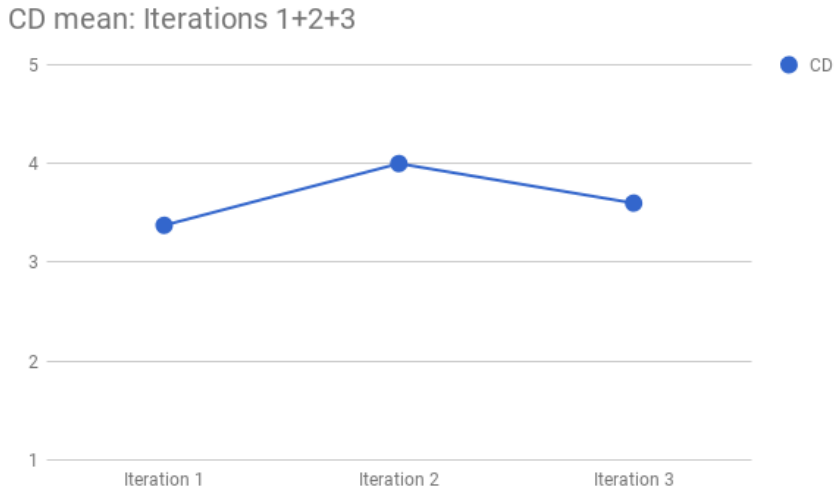
Table 11.27: Descriptive statistics of desire to continue playing iteration 3 (question 1).

	N	M	SD	SE	Mdn	IQR
I want to continue playing	5	3.60	0.89	0.40	3.00	1.00

Again they report a positive score. The mean and median are lower than for the previous iteration. As also occurred with the previous iteration, their desire to begin playing was higher than their desire to continue playing. It could be argued that they were expecting more new content.

We can now compare the participants desire to continue with what they reported for the previous two iterations, the development of their desire to continue can be seen on Figure 11.29.

Figure 11.29: Desire to continue playing across iteration 1, 2, and 3.



When asked why in regards to their desire to continue, they answered:

"It was quite easy, so it was over fast."
"It was fun, but very difficult."
"It is a bit too difficult, but not too difficult."
"I like the game, but I'm not very good at it."
"You wanted to continue once you got started, and you didn't want to stop before you had found all the things you had to find."

We see that the majority answered that the game was difficult, which might be a reason for their desire to continue being lower than in the previous iteration. This could indicate that if the game becomes too difficult, their desire to continue playing falls, becoming an disengagement trigger.

We asked them again if they thought the text hints made it easy to find the targets. Table 11.28 shows their answers.

Table 11.28: Descriptive statistics of self-reported questionnaire (question 2).

	N	M	SD	SE	Mdn	IQR
I thought the text hints made it easy to find the targets	5	3.00	1.22	0.55	3.00	1.00

In the previous iteration their answers were more positive, but they are similar. We are satisfied with it being scored in the center, as we expect the players to be distributed evenly between those who find that the hints make the game easy, and those who do not.

We asked them how difficult the targets were to find, as shown on Table 11.29. The Helmet was reported to be difficult to find, and compared to the Monk in the previous iteration, it was reported to be a bit easier. Compared to the Guard, who was also supposed to blend in with his surroundings, the Shield was reported as more difficult to find.

Table 11.29: Descriptive statistics of self-reported questionnaire (questions 3 and 4).

	N	M	SD	SE	Mdn	IQR
I thought the Prince's Shield was easy to find	5	2.40	1.67	0.75	2.00	2.00
I thought the Helmet was easy to find	5	1.60	0.89	0.40	1.00	1.00

We asked if they felt happiness to detect Affect, when they found a target and if they felt unsatisfied when finding a target. They answered as shown on Table 11.30.

Table 11.30: Descriptive statistics of self-reported questionnaire (questions 5 and 6).

	N	M	SD	SE	Mdn	IQR
I felt happy when I found a "target" (shield or helmet)	5	4.60	0.89	0.40	5.00	0.00
I felt unsatisfied when I found a "target" (shield or helmet)	5	1.60	0.89	0.40	1.00	1.00

The players must have felt some form of Affect, as their answers in regards to feeling happy are very positive. The high scores could be due to the Shield being difficult to find, and once they finally found it they felt happiness and satisfaction. Furthermore we can see that their self-reported values for if they felt happy and if they felt unsatisfied are mirrored around the center of the scale indicating that the children might have regarded the two questions as being opposite and that the questions measure the same feeling.

We again asked if they enjoyed spending time discovering things in the level, and if they only searched for the targets provided by the UI. The level had not changed much since the last iteration, therefore we expect the first measure to decrease and the second measure to increase (as they do not have new content to discover, they might focus more on the objective). Their answers can be seen on Table 11.31.

Table 11.31: Descriptive statistics of self-reported questionnaire (questions 7 and 8).

	N	M	SD	SE	Mdn	IQR
I enjoyed spending time discovering things in the level	5	3.20	0.84	0.37	3.00	1.00
I was only looking for the objectives the menu posed	5	3.80	1.10	0.49	3.00	2.00

The scores are lower than in the previous iteration in regards to them enjoying discovering things, and they focused more on the objectives, as expected. We can still see that they could have felt a Positive affect, as they did report above center in regards to enjoying discovering the level.

Again we asked about usability in regards to pressing things in the level. Their answers are shown on Table 11.32, and they are very similar to the previous iteration.

Table 11.32: Descriptive statistics of self-reported questionnaire (question 9).

	N	M	SD	SE	Mdn	IQR
I had difficulty pressing things in the world	5	1.40	0.89	0.40	1.00	0.00

To see if there is any difference in how boring they thought it was to find the targets between the previous iteration and this iteration, we asked them once more if they found searching for the targets boring. Their answers can be seen on Table 11.33.

Table 11.33: Descriptive statistics of self-reported questionnaire (question 10).

	N	M	SD	SE	Mdn	IQR
I felt it was boring to look for things in the game	5	2.20	0.84	0.37	2.00	1.00

The scores are higher than in the previous iteration, meaning that they found it more boring during this iteration. There were fewer targets, and they were not as elaborate as in the previous iteration. This coincides with their desire to continue also being lower than in the previous iteration.

We then asked if they had wanted the game to have more objects that were intractable. Table 11.34 shows their answers.

Table 11.34: Descriptive statistics of self-reported questionnaire (question 11).

	N	M	SD	SE	Mdn	IQR
I missed not being able to press more things in the game	5	2.00	1.22	0.55	2.00	1.00

Compared to the first and second iteration, we see improvement in their answers as the mean indicates that in general they were satisfied with the amount of interactable objects (in the previous iteration the mean was 2.60 and the median was 3.00). We would still like the level to be even more intractable. This will be saved for future development of the game.

To further inquire about the Completion accomplishment and if they made any intrinsic objectives, we asked if they felt compelled to press all the characters, windows or trees. Their answers are on Table 11.35.

Table 11.35: Descriptive statistics of self-reported questionnaire (question 12).

	N	M	SD	SE	Mdn	IQR
I felt compelled to press all the characters, windows or trees	5	3.60	1.95	0.87	5.00	3.00

We can see a large difference between the participants (a standard deviation of 1.95 and interquartile range of 3.00), where the majority answered that they did feel like they had to press the objects (as the mean is 3.60 and median is 5.00). This difference could be due to the participants being different player types and having different preferences. The game never asked them to press on the objects. We are satisfied with the amount of positive scores, as these might indicate that players do engage in Exploration and they do make Intrinsic objectives for themselves. They might

have misunderstood the question as that to complete the game you had to press some characters (the targets).

To detect if the participants felt any form of Absorption, we asked them if they felt that they had played for longer than they did. Their answers can be seen on Table 11.36.

Table 11.36: Descriptive statistics of self-reported questionnaire (question 13).

	N	M	SD	SE	Mdn	IQR
I felt I played for much longer than I did	5	2.00	1.00	0.45	2.00	2.00

Their scores are below the center, indicating that they did not feel a high degree of Absorption. This is something we would like to change, but further evaluations should be made to allocate what could make them feel more absorbed.

Finally, we asked if they wanted to play the game again, and we asked them why. Their answers are shown on Table 11.37 and their reasons why are written below (two participants did not answer why).

Table 11.37: Descriptive statistics of self-reported questionnaire (question 14).

	N	M	SD	SE	Mdn	IQR
I want to play the game again.	5	3.80	0.84	0.37	4.00	1.00

"It was fun, but only if there's new things."
"The game is good, but it is a bit difficult in the beginning. Thanks to the hints it becomes a bit easier."
"It is like a "searching"/memory game, just in a phone world."

We see a positive score for their desire to play again. One participant responded that the game requires new things (we assume objects and targets) for it to be fun. This is the hook we are striving for, to keep the players engaged by releasing new content as shown in our progression system on Figure 11.3.

Player Behavior

From the game data log, we can present a new heatmap from this iteration, as shown on Figure 11.30.

Figure 11.30: Heatmap from iteration 3.

Table 11.38: Reported means of player behaviors for iteration 3.

	M
Number of touches	343
Time spent playing	504.91 seconds
Time between each touch	1.46 seconds
Camera Size	7.57
Time to find the Shield	144.02 seconds
Time to find the Helmet	496.78 seconds
Camera size when the Shield was found	7.59
Camera size when the Helmet was found	3.33
Number of pressed windows (total 47)	35.8
Number of pressed hay bales (total 8)	8

We see a much higher amount of presses than in the previous iteration. Table 11.38 above, could shed light on why that is.

The average number of touches and average time spent playing is much higher than in any of the previous iterations. Their number of touches increased by more than two and a half times, while the time spent playing increased by almost one and a half times, than in the previous iteration. There were fewer targets, indicating that they were much more difficult to find than the previous targets.

Their average time between each touch is much lower for this iteration, than in any of the other iterations. When looking at the average number of pressed windows and hay bales, the participants pressed them much more than in previous iterations.

This supports their answers to the question if they felt like they had to press all the objects, as they reported positive scores (mean was 3.60), and they on average pressed almost all the windows and every participant pressed all the hay bales. This supports the Completion accomplishment, and that they could have made Intrinsic objectives for themselves. It should be noted that these numbers could also indicate boredom, as the players might have given up on finding the targets and instead tried to entertain themselves with something else.

The Shield target was found in a similar time frame to the Pilgrim and Guard targets, but the Helmet took much longer than any of the other targets. It seems as we might have made the Helmet blend in too much and the text hint might have been too vague. We are satisfied with this indication, as we did attempt to see if we could make it difficult by having it blend in more. We should make the shield easier to find for future iterations.

We can also see that the average camera size was smaller than before, and the average camera size when they found the Helmet was much smaller than we have seen in any of the previous iterations. This also indicates that making the targets small, will make the players zoom in more.

Redesign for the next iteration

For the next iteration we will redesign where the shield is hidden, to make it easier to find. Furthermore we have not yet added the *Poor* area presented in the previous section 11.1.4, Setting: Defining the narrative content of the game. We will also evaluate on a larger number of targets to evaluate further on the objective of the game.

11.5 Iteration 4

For this iteration we chose to use it as a pilot test for our final evaluation for this thesis. As this iteration became the last, we will present the design in the following Final Design chapter 12.

Therefore this section will only present the results from the evaluation of this fourth iteration.

For context when reading this section, we had five targets in this iteration. These targets had already been used in previous iterations, thus we knew the participants would have prior knowledge about their locations, and thus the difficulty of the game was devoid.

Some of the targets were redesigned such as the Helmet and its location to make it easier to find, and the searchable hiding the Monk with the drinking horn was removed to make the monk easier to find. The environment was expanded with the addition of the poor area, which consists of fields, barns, and huts.

The UI was reworked to match it with the rest of the game's graphical style, as one of the participants had found a target without noticing.

Furthermore we had by this iteration developed the AR component, which was part of the test. As previously mentioned, the design for this iteration of the prototype (including the AR component) is presented in the following Final Design chapter 12.

Both the OA3 and SGDA frameworks have not changed much since the previous two iterations, except that it has combined them by including all five targets. The inclusion of the AR component does expand the models, which can be seen for the OA3 framework on the previously presented Figure 11.1.

11.5.1 Evaluating Iteration 4 and pilot testing the final evaluation method

The test procedure was changed from iteration 3 to iteration 4. The purpose of the evaluation is to answer the final problem statement, and specific to the present iteration, we wanted to simulate the final evaluation to allocate test procedure errors. The presentation of the method behind Iteration 4 and the final experiment can be found in chapter 14, Experimental Design Method. The test procedure for the fourth iteration evaluation can be seen on Table 11.39.

Table 11.39: Test procedure for evaluating iteration 4.

Participant(s)
4 children ages 12-14. Average age was 12.75. Gender distribution was 75 % male and 25 % female. Alexander Risvang, Test conductor.
Method
Pre-test questionnaire, followed by one of two types of gameplay sessions, followed by a mid-test questionnaire. Then the participants played the other type of gameplay, followed by a post-test questionnaire. A method evaluation discussion ends the test. In game player behavior logging.
Test procedure
Date: 14th of May, 2018. Location: Hovedgaden 39, 4140 Borup. The participants were asked to imagine themselves being at the museum, playing the game. Pre-test questionnaire: All participants answered an initial questionnaire. Then the participants were divided into two groups: A and B. Group B was sent to another room, while group A stayed. Group A played the Game component, and group B played the location-based AR component. Both levels were set to last 5 minutes, with a timer stopping the play session once the time ran out. Mid-test questionnaire: Both groups answered the respective questionnaires (one for each of the two groups). Then the groups switched rooms, and they played the other level. Again a 5 minute limit was set. Post-test questionnaire: Both groups answered the respective questionnaires. Method evaluation discussion: The groups were gathered and they were asked about the test procedure, which evaluated on their understanding of the test and questions.
Measurement instruments
Game ESQ. Expanded Game ESQ. Adapted Again-Again table. Structured discussion. The three measures are explained in the Experimental Design Method chapter.
Questionnaire
Pre- and Post-test questionnaires are presented in the following test description.

Iteration 4 Results

We were not able to fully replicate how the final test procedure would be, as the fourth iteration was not evaluated at the museum. Instead, two classrooms were used, one to simulate the exhibition at the museum and one to simulate being outside the exhibition.

As we were not able to replicate the final test environment, we disregarded the questions regarding the participants' desire to return to the museum.

At first the participants answered how much they desired to begin the game, their answers are reported on Table 11.40. Note that the response ranges are from 0-100 as the VAS was used instead of the 5-Point Likert scale. This change was made due to our suspicion of there being a ceiling effect present in several of the previous iteration evaluations for the self-reported measurements, as medians of previous iteration were clustered in the higher end of the scale around 4 and 5, this will be discussed further in the Experimental Design Method chapter 14.

To be able to compare the responses from this evaluation with the previous evaluations, we order the VAS responses into five ranks, where 0-20 is awarded 1, 20-40 is awarded 2, 40-60 is awarded 3, 60-80 is awarded 4, and 80-100 is awarded 5. These adapted responses are also shown on Table 11.40.

Table 11.40: Descriptive statistics of the desire to begin playing iteration 4 (Game ESQ pre-experience).

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
I want to begin playing	4	74.00	18.50	9.25	75.00	27.50
Adapted to a 1-5 scale	4	4.00	1.15	0.58	4.00	2.00

Here we see that their desire to begin playing is high, and compared to previous iterations it is very similar.

After playing both the game and AR component, they were asked about their desire to continue. Their answers are shown on Table 11.41.

Table 11.41: Descriptive statistics of the desire to continue playing iteration 4 (Game ESQ between and post-experience).

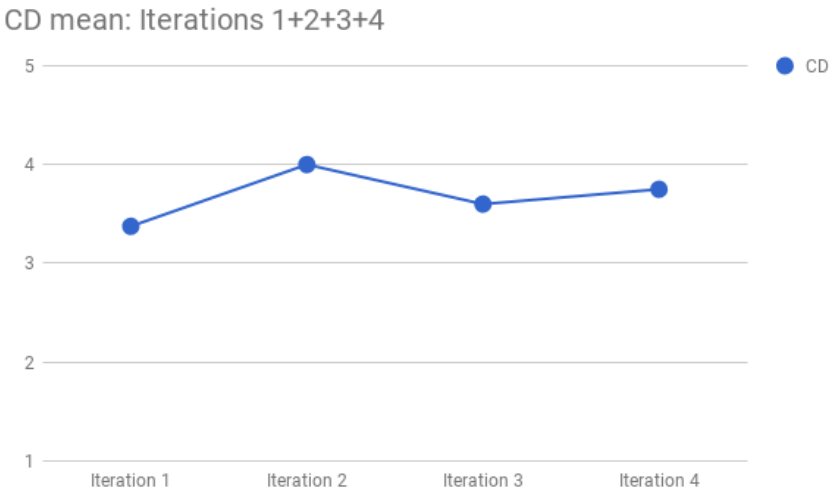
	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
I want to continue playing	4	72.75	26.40	13.20	76.50	26.75
Adapted to a 1-5 scale	4	3.75	1.26	0.63	4.00	0.75

We see that their desire to continue playing after the test has decreased compared to their desire to begin the game by a small margin. As previously stated, the targets in the game component were similar to targets they had found in earlier iterations, meaning that the Game component would not be challenging for the participants, which might have been a disengagement trigger. The AR component was completely new to the participants, and they did not play it in the natural environment (at the museum), instead they played in a simulated environment (a classroom).

We can now plot the desire to continue from this iteration with the results from the previous iterations, as seen on Figure 11.31. Here we see that CD has increased by a small margin (could be

a result of our adaption of the VAS values to a 1-5 scale). We are satisfied with how the participants desire to continue has evolved over the different iterations, with possibilities for improvement in further development of the game.

Figure 11.31: Desire to continue playing across iterations 1, 2, 3, and 4.



As per the test procedure, the participants were divided into two conditions which started with opposite components of the prototype (Game component and AR component). The following results present their combined responses when answering the questionnaires for after playing each respective component of the prototype.

To detect if they engaged with the Solving activity, we asked if they wanted to continue completing the game's objective. Their answers can be seen on table 11.42.

Table 11.42: Descriptive statistics of self reported questionnaire (Expanded Game ESQ: Response item 1)

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
Game: *It was fun to figure out where the things were hidden*	4	63.00	14.60	5.65	67.50	12.00
AR: *It was fun to figure out where the things were hidden*	4	81.25	23.60	9.14	87.50	29.75

We can see that the participants scored higher after playing the AR component than the Game component. This is expected as the participants already knew where the targets were hidden in the Game component, and because of the AR component presented something entirely new for them to try.

Then we asked about their desire to continue exploring (in order to detect how our design the Exploration activity performed). The responses are shown on Table 11.43.

We can see that the answers are very similar, and in general very positive, meaning that the participants had an engaging time exploring the game world. We are satisfied with the responses, and thus also satisfied with the reception of the Exploration activity of the design, in regards to conducting the final evaluation. For a final release version we are not completely satisfied yet.

Table 11.43: Descriptive statistics of self reported questionnaire (Expanded Game ESQ: Response item 2).

	N	M	SD	SE	Mdn	IQR
Game: *I want to continue exploring the game*	4	74.50	22.07	8.55	79.50	21.00
AR: *I want to continue exploring the museum with the game*	4	73.75	22.23	8.61	75.00	22.25

To allocate disengagement triggers within the design, we asked if the participants had a hard time focusing on the game. Table 11.44 shows their answers.

Table 11.44: Descriptive statistics of self reported questionnaire (Expanded Game ESQ: Response item 3).

	N	M	SD	SE	Mdn	IQR
Game: *I had a hard time focusing on the game.*	4	48.00	30.39	11.77	46.00	31.50
AR: *I had a hard time focusing on the game.*	4	33.50	22.50	8.70	43.00	13.50

Here we see that they in general did not have a hard time maintaining focus on the game. The answers for the Game question are close to the center, with a very high standard deviation. This could be due to the participants had played the game component several times before, and their answered might be very scattered. It is also possible that further changes should be made to make the game easier to focus on.

The last question we asked was if they had fun while playing. Table 11.45 shows their answers.

Table 11.45: Descriptive statistics of self reported questionnaire (Expanded Game ESQ: Response item 4).

	N	M	SD	SE	Mdn	IQR
Game: *I had fun while playing*	4	71.50	20.60	7.98	75.00	21.00
AR: *I had fun while playing*	4	62.75	33.26	12.90	64.5	36.75

We did not expect the AR component to score lower than the Game component. As earlier, it appears that the answers are very scattered for the AR question, as the standard deviation is very high. This could also be due to the targets for the AR component being easy to find, and thus some of the participants might have found the activity boring. When implementing the AR component at the museum the targets should be placed with more care.

Player Behavior

The player behaviour was again logged by the Game component. The heatmap generated for the fourth iteration is shown on Figure 11.32. Table 11.46 shows the in game player behavior data means.

Figure 11.32: Heatmap from iteration 4.

Table 11.46: Mean of in game player behavior data.

	M
Number of touches	166
Time between each touch	1.65 seconds
Touches per second	0.56
Camera Size	7.43
Camera Size on Targets	7.86
Number of targets found	4.75
Time to find a target	86.50 seconds

For this iteration there was a time limit set in place to stop the game after 5 minutes of playtime. Compared to iteration 2 which had a duration of approximately 6 minutes the average amount of touches were similar, with more touches for this iteration. The amount of time between each touch and the average camera sizes are similar for all the iterations.

It will be interesting to see how well the participants in the final evaluation will perform compared to the participants in these iteration evaluations, as it can be argued that they through the

repeated play sessions may have mastered the game. Compared to the previous iterations, we see that participants on average found each target after 86.50 seconds. This is lower than previously, and it could be due to the higher amount of targets and their expertise with the game.

11.6 Evaluating the iterative design method

We were able to use the OA3 framework to guide the design and evaluate the iterations. The EDD framework and Fullerton's iterative design process steps were followed as well, as these also suggest consecutive evaluations which can reinforce the design.

Furthermore we used the SGDA framework as a secondary design framework, and we were able to follow its components. The purpose of the game which is important to both the EDD and the SGDA frameworks, was not explicitly evaluated, but it was implicitly evaluated by measuring engagement with CD throughout the iterations. The purpose was:

The game should hook the players, and draw them to the museum in an engaging manner.

We see on Figure 11.31 that the desire to continue playing is positive, thus the purpose of the game (to hook the players in an engaging manner) might have been accomplished. It is evident that the purpose has not been validated, but we have found indications of it being accomplished. The purpose also states that the players should be drawn to the museum, which we have not evaluated on due to the lack of the natural environment.

Fullerton (2008) proposes the playcentric design process, and that it should focus on delivering the desired experience. We defined this desired experience as:

The player should experience a sense of discovery, exploration, and completion.

Throughout iterations 2, 3, and 4, we saw that participants did score positively in regards to the Exploration activity and Completion accomplishment. We did not explicitly evaluate the discovery aspect, but we have indications as the Exploration and Sensing activities scored positively.

The final design of the game will be presented in the following chapter. It should be noted that we do not regard this final design as completely satisfactory, but it is satisfying enough for the final evaluation of this thesis. Future development should continue the iterative design method.

12. Final Design

The design has been iterated four times, where the game's objective and difficulty has been refined and additional content has been developed.

This following chapter will present the final design which was used for the final evaluation of this thesis, divided into the Game component and the AR component.

12.1 Game Genre

The game is a 2D isometric exploration puzzle game, designed for mobile platform. The purpose of the game is to find hidden targets in the form of characters and objects in a medieval landscape.

Characters react to the player's taps, and the levels can be explored by swiping the screen. One level of the game converts the game to a location based AR treasure hunt, where visitors of the National Museum can search the *Middle Ages and Renaissance* exhibition for characters hidden between the exhibition's artefacts.

The two different gameplay experiences are defined as the Game component (the medieval landscape level) and the AR component (the location based AR treasure hunt). These two components can be played in any given order.

The final design set in context of the OA3 framework can be seen on Figure 12.1, which shows the game play loop.

Figure 12.1: Final design in the OA3 framework.

12.2 Game Component OA3

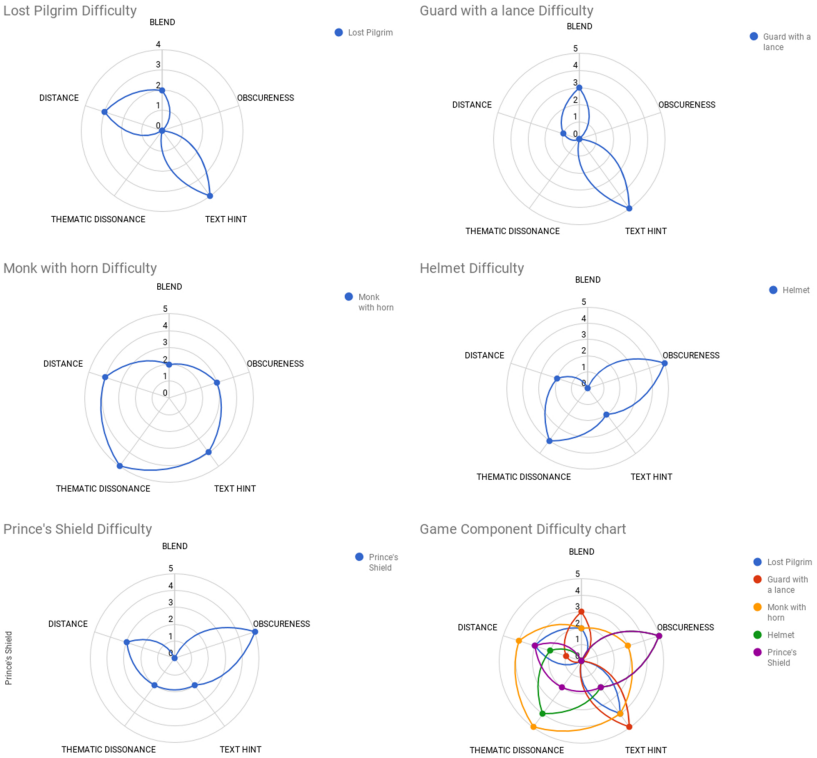
12.2.1 The Extrinsic Objective, the Solving Activity and the Completion Accomplishment

As can be seen on Table 12.1, the objective of the game is to find five targets hidden throughout a medieval environment. Table 12.1 presents the targets, and their corresponding hints to help the player find them. The difficulty of finding each target is visualized on Figure 12.2.

Table 12.1: Final targets and hints.

Targets	Text hints
The Lost Pilgrim	"According to the map, the pilgrim should be there by now..." "I følge kortet burde denne pilgrim været nået frem nu..."
The Guard with a lance	"This guard did not have time to change weapons after the tournament..." "Denne vagt nåede ikke at skifte våben efter turneringen..."
The Monk with a drinking horn	"This monk is enjoying the performance with a horn of beer..." "Denne munk nyder forestillingen med et horn øl..."
Helmet	"This helmet was forgotten by a guard when he was out to check on the harvest..." "Denne hjelm blev glemt af en vagt da han var ude for at se til høsten..."
Shield	"Typical that the Prince forgot his shield in his chambers..." "Typisk af Prinsen at glemme sit skjold på sit kammer..."

Figure 12.2: Final target difficulties.



To inform players about the Extrinsic objective and their progression towards the Completion accomplishment of finding all the targets, the game presents a UI menu with the targets and text hints. Once a target has been found, the targets are marked providing feedback to the player. The targets themselves play a special fanfare once they are found, to clearly inform the player when they find a target. The UI and the fan fare can be seen on Figure 12.3.

Figure 12.3: Screenshots of UI and fan fare feedback.

12.2.2 The Exploration and Sensing Activities

The level of the game features a medieval town, surrounded by fields and a forest.

Figure 12.4 shows an overview of the level.

The player can explore the environment by controlling the camera, and enjoy the hand drawn visuals and stylized sounds. Throughout the environment, characters and objects hide behind windows and hay bales, creating a drive for the player to explore what is hiding behind these covers.

The players can let themselves be immersed in the world, creating small narratives for the characters living within it.

The five targets are hidden in different areas of the level, as can be seen on Figure 12.4.

Figure 12.4: Screenshots of the final level layout.

12.3 AR Component OA3

In the *Middle Ages* exhibition of the National Museum, the game transforms into a location based AR game.

12.3.1 The Extrinsic Objective, the Solving Activity and the Completion Accomplishment

It resembles the Game Component as the objective of the AR component is to find five targets hidden throughout the exhibition, through the use of the camera on the mobile device. These targets are printed drawings of characters from the game, which function as tracking points for the camera. Figure 12.5 shows an image of one of the printed drawings.

Figure 12.6 shows images of the targets placed throughout the exhibition.

Once a target is found and detected by the camera, the target is virtually layered on top of the real world and thus the characters come to life on the screen. The targets hide close to thematic elements that tie them to the exhibition, as presented in their appropriate text hints. Table 12.2 presents the five targets, and which exhibits they tie to. The difficulty of the targets are described on the following Figure 12.7. Here, the distance parameter is defined as the distance from the entrance to the exhibition, and the obscureness parameter is defined as how much out of sight the target is hidden. The blend parameters is removed.

Figure 12.5: Picture of a printed target hanging in the exhibition.

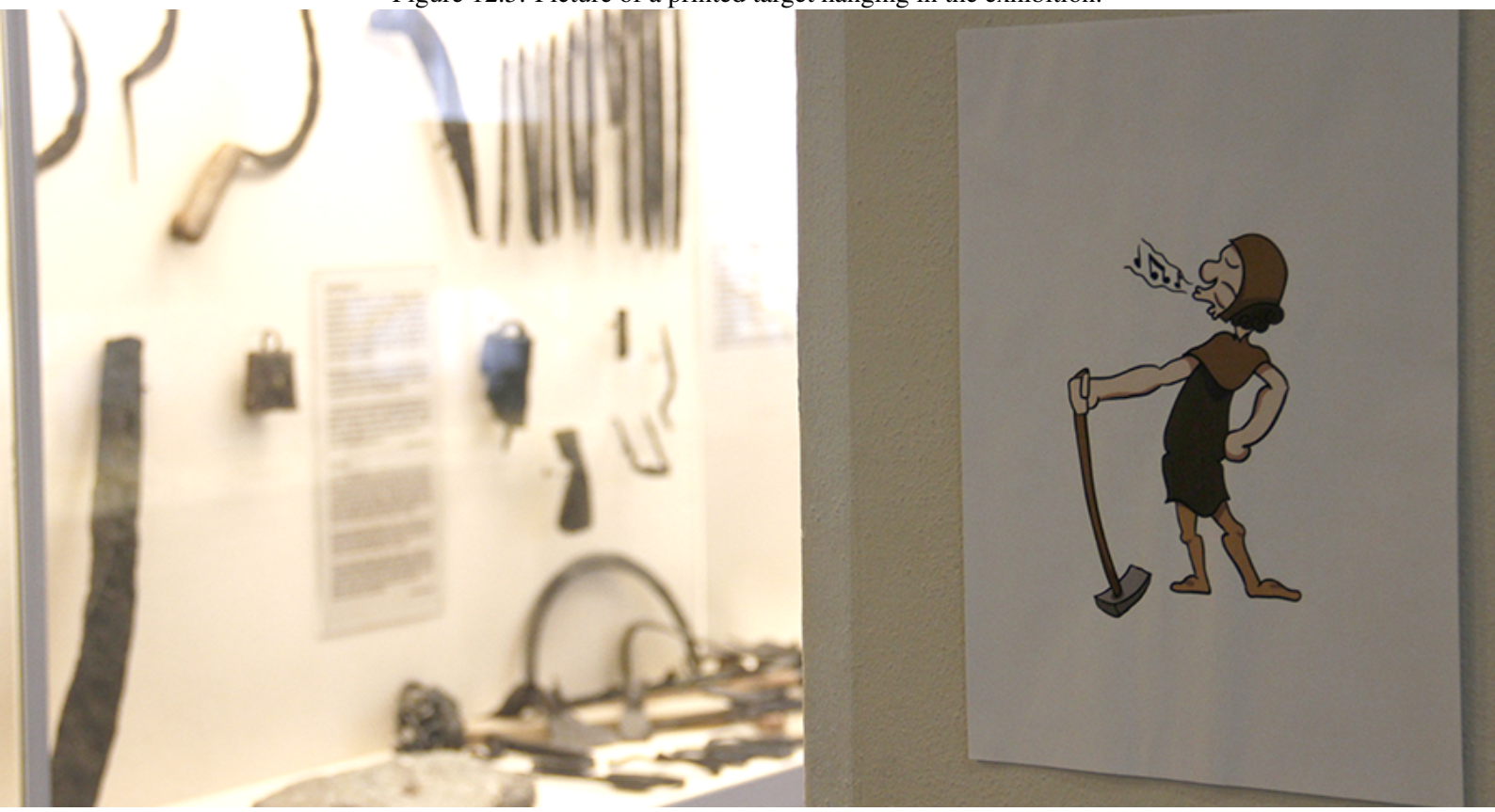


Figure 12.6: Overview of the five AR component targets and how they are placed throughout the exhibition.

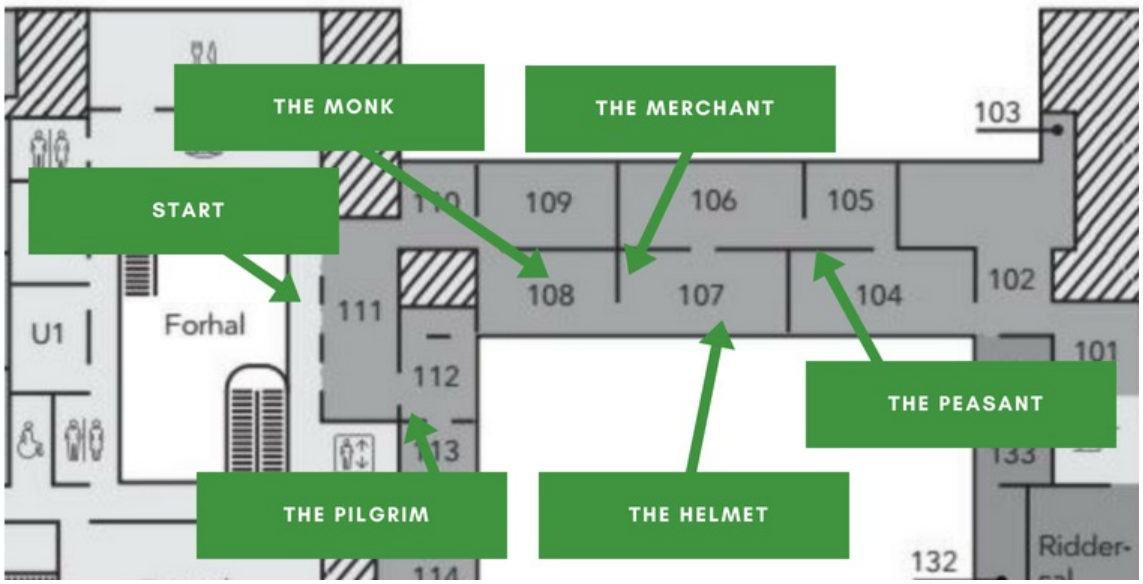
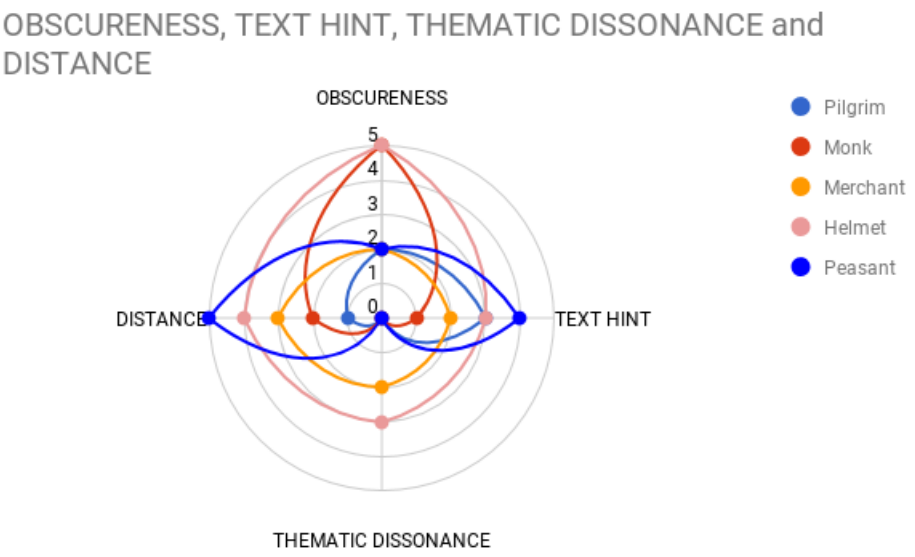


Table 12.2: Final AR component targets, hints, and the related exhibits.

Targets	Text hints	Exhibits
The Pilgrim	"The pilgrim is going to see the holy relic. They say that the bone is from an arm... Or was it a leg?" "Pilgrimmen er på vej for at se det hellige relikvie. Det siges at være knoglen fra en arm... Eller var det et lår?"	A holy relic (the remains of a holy knight), with a descriptive text explaining how people had thought it was an arm bone, when it actually was a leg bone.
The Monk	"This monk was having a new bell made for the church. But what should he write on it..." "Munken er ved at få støbt en ny klokke til kirken. Men hvad skal han mon skrive på den..."	Two large bells, and the exhibit text describes the evolution of written texts on bells.
The Merchant	"The merchant can't wait to count all of his coins. They almost can't fit within the bowls!" "Købmanden glæder sig til at tælle alle sine mønter. De flyder næsten ud over krukkens kanter!"	Two large iron cauldrons filled with coins.
The Helmet	"I wonder if this helmet can resist the shot from a canon..." "Gad vide om hjelmen kan modstå et kanonskud..."	A large canon, and several helmets.
The Peasant	"This peasant is looking for new tools to farm with..." "Denne bonde kigger på nye redskaber som han kan dyrke jorden med..."	Several farming tools, such as hoes, shovels, plows, etc.

Figure 12.7: AR component target difficulties.



12.3.2 The Exploration and Sensing Activities

The players have to explore the exhibition, searching amongst the exhibits to find the targets. The exhibition itself presents a variety of impressions, due to the vastness of the collection. Players experience the museum visit, where they can come alone or in groups as they please.

The final design and its two components, have now been presented in context with the OA3 framework. The following chapter will present the implementation phase of the game's development.

13. Implementation

The following chapter will present certain concepts in the process of implementing the previously presented design. We will explain how the developed level building tools work, and how we implemented the data logging system to automatically upload the in game data via email, and to fill out a Google Forms according to the questionnaire answers (Google, 2018).

There were many other aspects to the implementation phase such as developing the player's control schemes, tweaking the camera's movement, UI implementation, texture atlasing, defining unit sizes based on resolution and pixel per units, and so on. The Digital Appendix, folder Applications, includes the game project, where the interested reader can investigate code, assets, and tools.

The prototype was implemented on two different mobile devices, made available to us through Aalborg University's booking system:

- Samsung Galaxy S7 (Samsung, 2018a).
- Samsung Galaxy Tab S2 (Samsung, 2018b).

The two devices have different native resolutions and aspect ratios. We chose to focus on the S7, designing the levels according to its aspect ratio. The game was later adapted to the tablet format.

To develop the prototype we used Unity 2017.3.1 (UnityTechnologies, 2018). With Unity's Collaborate feature, we were able to work from different computers on the same project, as it is stored on Unity's cloud storage (UnityTechnologies, 2018). To script and design editor tools we used Odin, a plug-in for Unity (Sirenix, 2018). All code was written in the C# language.

To draw and animate the in game objects, we used Adobe Animate (Adobe, 2018a), on a Microsoft Surface Pro 4 with a stylus (Adobe, 2018c). Animations were packed together using TexturePacker to fit within spritesheets with a maximum size of 4096x4096 pixels (CodeAndWeb, 2018).

The audio for the game was edited and designed in Adobe Audition (Adobe, 2018b). Sound effects were downloaded from Zapsplat (Zapsplat.com, 2018) and Free Sounds (Freesound, 2018). Voices were recorded using a Zoom NTG3 Røde microphone (Roede, 2018) and performed by the authors.

The AR component was built using the Vuforia plugin for Unity (PTC, 2018).

13.1 Level Building Tools

13.1.1 Profile System

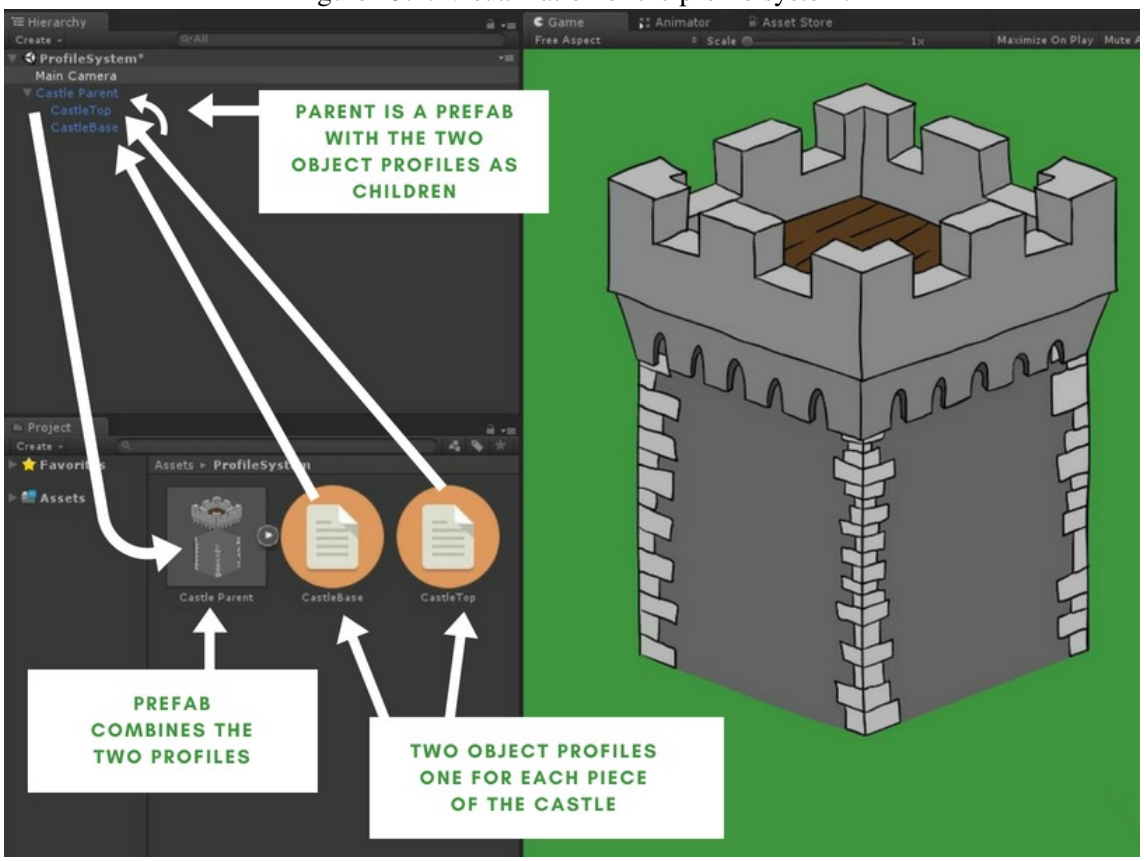
As per the nature of the game, the levels are intended to be dense with content. To develop a dense level it is important to establish an efficient workflow and pipeline. Once a level has been built with more than a couple of hundred objects in it, it is important to be able to change and tweak objects as feedback is received without having to manually access each object.

The standard tool for these functionalities is Unity's prefab system, where objects reference *templates*. These templates can be changed, resulting in all the according objects in the level also being changed. This is efficient, but Unity does not support what is known as *nested prefabs*: prefabs made out of other prefabs. Once a level reaches a certain complexity, it becomes favorable to have prefabs of the combined objects, with prefabs of the individual objects inside.

As Unity does not support this, we developed a profile system for each object type in the game, using what is known as *scriptable objects*. Scriptable objects are objects which exist as files within the Unity project. Code can be run in the editor to alter these objects (without having to be in run time).

With these profiles, we can combine objects together to create a parent prefab, while using the profiles as templates for the individual objects within the prefab. This saved us a lot of time in development, as we could group together elements and still have control of each object. Figure 13.1 shows a visualisation of this implemented concept.

Figure 13.1: Visualization of the profile system.



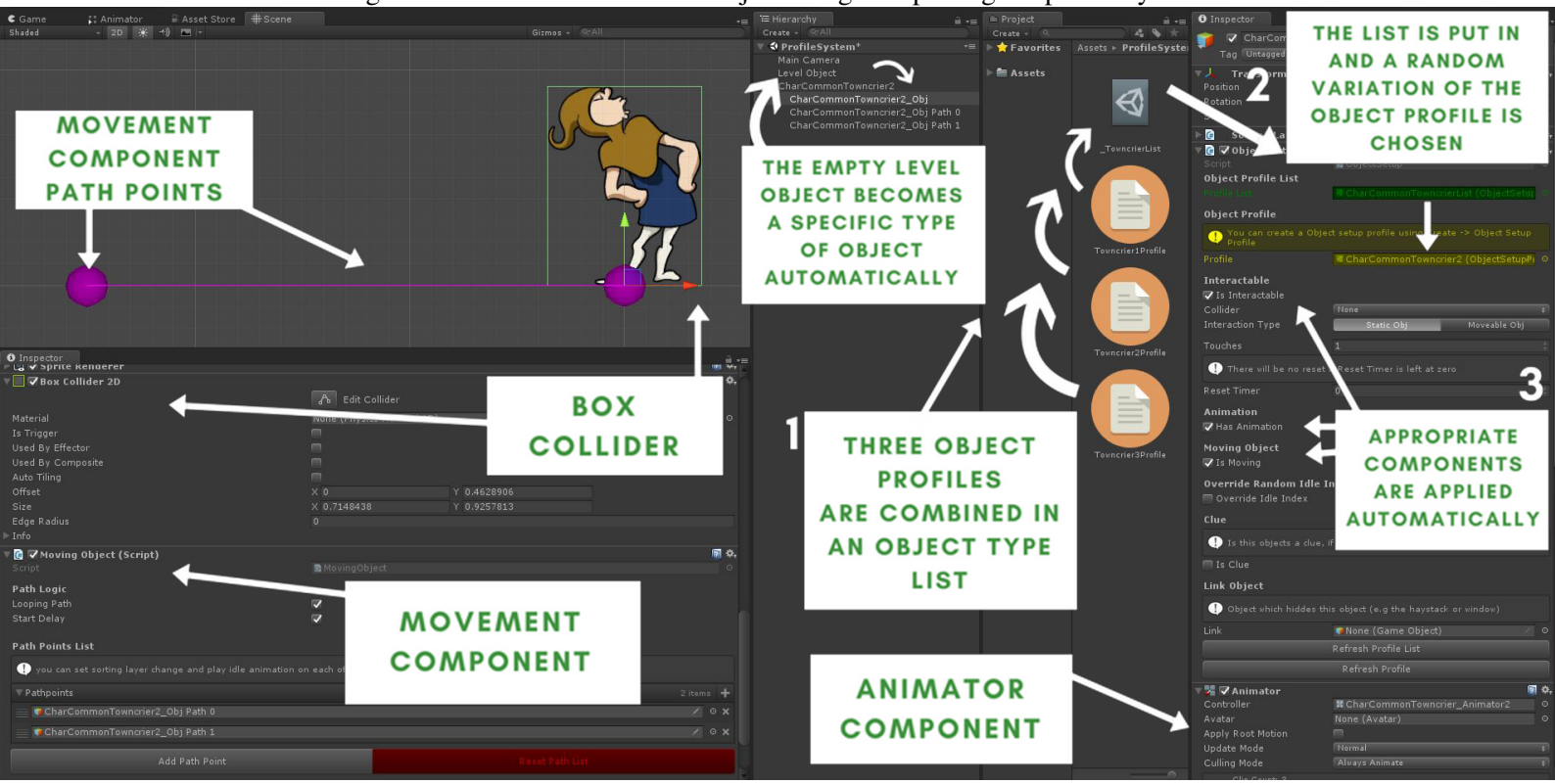
These profiles were also used to efficiently build the levels. As we have many different objects, it would be cumbersome to search through the asset library for each individual object.

With the profiles, we could group together object types in lists, e.g. all the walls for buildings, all the guard characters, all the trees, etc. and use these new profile lists to quickly choose between object types. Once a type is chosen it randomly chooses one of the object variations and runs all the setup required for the object to be inserted in a level. The setup includes:

- Proper naming according to a predefined naming convention (i.e. ObjectTypeLevelAreaObjectName_Parenthood)
- Adding appropriate gameobject components depending on the type of object (i.e. colliders, sprite renderer, etc.)
- Object functionality tools (e.g. if the object is interactable, if it has animations, if it moves, if it is one of the targets, etc.)

Figure 13.2 shows how an object that is supposed to both move and be interactable is set up using the profile system.

Figure 13.2: Visualization of an object being set up using the profile system.

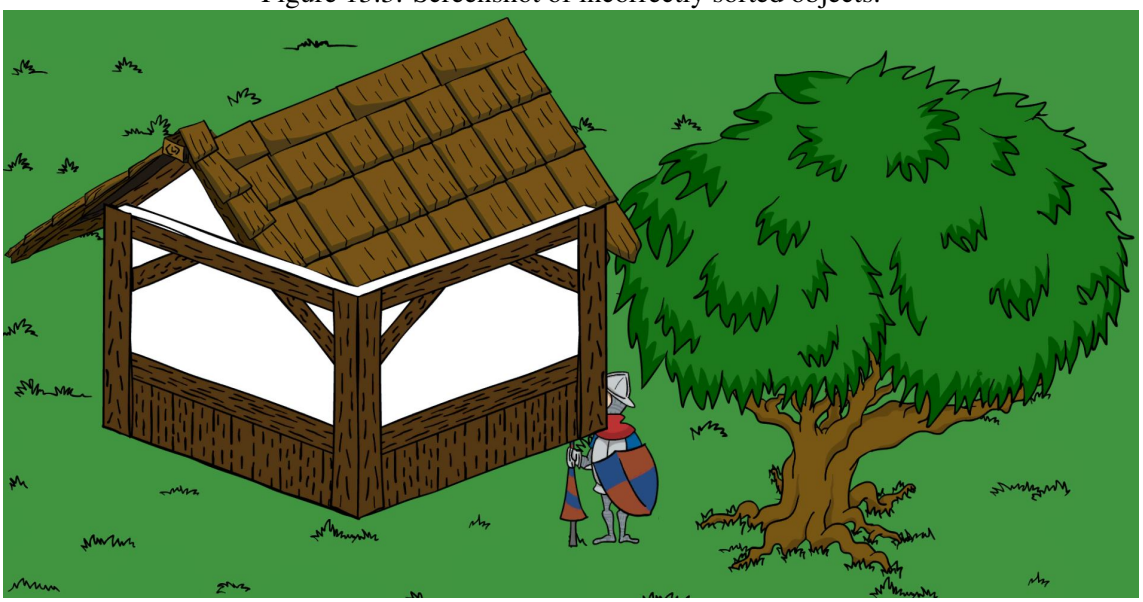


13.1.2 Sorting Objects

When working in 2D compared to 3D, and with an isometric perspective, sorting the objects according to which one should be drawn on top of others becomes a problem. Figure 13.3 shows a representation of this problem.

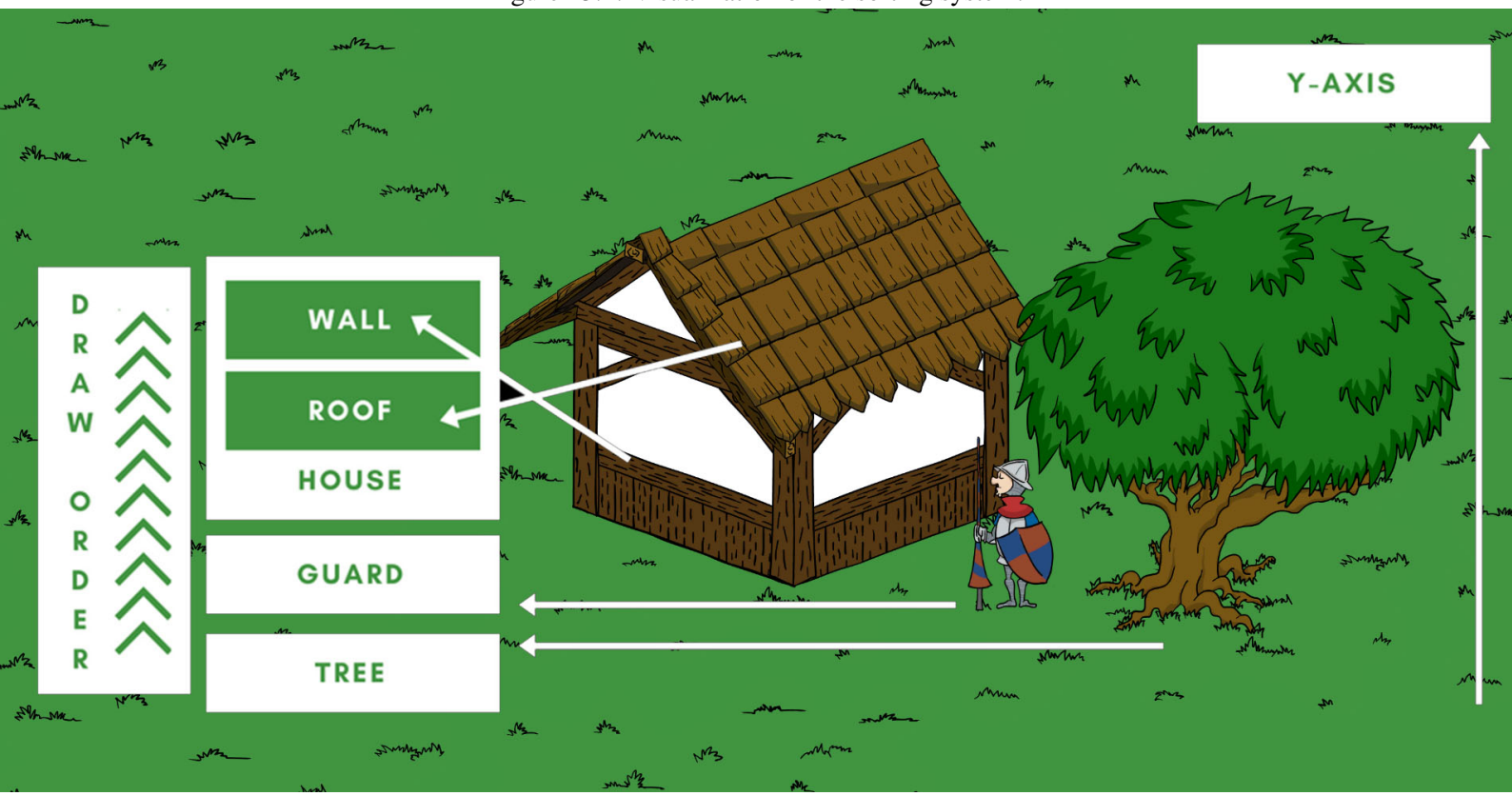
In Unity each 2D element contains a sprite renderer, which has parameters for a sorting layer and a sorting order in that layer. The object with the highest sorting order is the one drawn on top of all other objects. This works similarly to the depth-buffer, where the object drawn last is drawn on top. Manually managing the sorting order of objects quickly becomes unreasonable, as one might have to take over 20 other objects into consideration each time the sorting order for one object is set.

Figure 13.3: Screenshot of incorrectly sorted objects.



We developed a sorting system which uses the pivot point (origin) of each object to set the sorting order, Figure 13.4 gives an overview of the system.

Figure 13.4: Visualization of the sorting system.



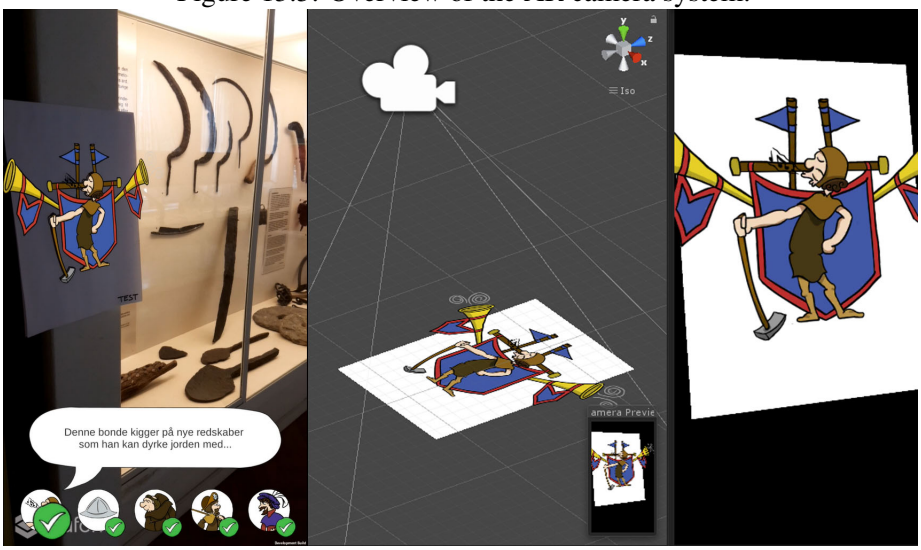
The vertical coordinate (commonly the y-coordinate) of an object is used to determine its sorting order. The lower the y-coordinate, the more in front the object should be drawn, in most cases. By the press of a button in our tool, we could automatically sort all the objects in the level, making the level building workflow much more efficient and fast. Some cases are special, such windows having to be drawn on top of walls. Here, the wall's y-coordinate is the lowest, which means that the wall will be drawn on top of the window. Therefore we expanded the tool with a subsystem based on the object's parenthood. Children objects are sorted according to their parent, and the child object with the *highest* y-coordinate is drawn on top within the child hierarchy. The parent objects are sorted in incremental steps of over 30, giving a range of 30 different draw orders to the children objects. By this method, whole hierarchies of objects can be moved around in the level without breaking the draw order.

These level building tools were developed to support rapid prototyping and being able to change the level layout throughout iterations. These tools were developed after the first iteration, for which we had no custom tools. The necessity for the tools became very apparent when we opted to change the level layout. The level building time for the first iteration took more than a week, while it took a few days to build the level in the second iteration after developing the tools. It should be noted that the second iteration had a large increase in assets compared to the first one, making the necessity for efficient tools even greater.

13.2 Augmented Reality using Vuforia

We utilized the Vuforia platform for the implementation of the AR component. Vuforia works as a plugin for Unity, where the virtual camera is replaced with an AR camera that uses the device's real camera. The camera can then detect target images, which in our case are the printed drawings of the targets. We uploaded images of the five targets to a Vuforia database, which is referenced by the camera to see if a match is on screen. In Unity, we can define a new origin point which will be in the center of the detected image. Everything we create in the Unity scene will then be drawn on top of the target image, based on the origin point. The real world camera is tracked based on its angle to the detected target image, and the virtual camera is set to follow its movements. This matches the perspective between the real world camera and the target image, with the perspective between the virtual camera and the virtual content. Figure 13.5 shows a visual representation of how the physical and virtual cameras align.

Figure 13.5: Overview of the AR camera system.



13.3 Data Logging

13.3.1 Player Behavior Data Logging

For each playthrough we store certain parameters of the player's actions and the game state. To reduce the performance impact of the data logging on the game, the system stores values every time the player presses the screen (as opposed to constantly storing data which would take processing power each frame). When a press occurs the following parameters are stored:

- Objects that are being pressed.
- Time elapsed since the start of the game.
- Coordinates for the player's press.
- The camera's size.
- The camera's position.

With the data we can create heatmaps, calculate the average time between presses, detect targets and when they were found, and so on.

The system stores the values after each press to a profile, similar to the level building profiles. The profile is filled with information throughout a play session, and once the game is stopped the data is automatically sent by the application itself as text in an email to a target email defined by us. By storing the data in the profile, we can avoid loss of data if the game crashes or is closed, as the data is written to a file instead of a variable.

Furthermore, the system will not shut down the game until the data has been sent, meaning that if the device is not connected to the internet, the game will wait to shut down until an internet connection is found so that the data can be sent.

13.3.2 Questionnaire Data Logging

Questionnaires were implemented into the game application to let the players answer questionnaires without having to change the application. These questionnaires were created as UI, using sliders as the VAS, presented in the following Experimental Design Method chapter 14.

The player's answers were stored by having the game send the data to a Google Form set up in Google Drive (Google, 2018). The data can then be downloaded from Google Drive, and used for statistical analysis. The data is uploaded as the players fill out the questionnaire to avoid loss of data.

13.4 Experimental Design Implementation

The following chapter will present the experimental design method. This section will provide an overview of how the experimental design was implemented into a single app, where questionnaires and the game experience's components are presented to the participants automatically.

The app was sequenced according to the following order:

- Begins by opening the pre questionnaire, and automatically stores the self-reported answers online.
- Opens either the Game component or the AR component, and automatically stores the player behavior data online.
- Opens either the Game or AR Between components questionnaire, and automatically stores the self-reported answers online.
- Opens the opposite game experience component (e.g. Game or AR component) than before.
- Opens the Post questionnaire for the respective component, and automatically stores the self-reported answers online.

Two builds were made, for each combination of the game experience components. A version was also implemented in english.

IV Evaluation

14. Experimental Design Method

The chapter will present the experimental design for the present study, and the method for evaluating engagement and the visitors' desire to return to the museum (i.e. the purpose of the game). The method was derived from the analysis of museum experiences (chapter 5) and player experiences (chapter 6). In total across all tests 24 different participants (all of them children) were part of the tests, with 4 to 8 (dependent on the test) of them being the subjects of the four design iterations previously presented. The remaining 16 participants took part in the final experiment.

The study is taking a confirmatory approach with a mixed-methods evaluation (Bjoerner, 2015) in order to examine if the game experience (consisting of the Game component and the AR component) has an effect on the children's (who are visiting the museum) desire to to continue playing, as a measure of engagement. The study is also taking a exploratory approach in order to investigate to which degree the OA3 framework has influenced the design of the two components and how the player behavioral data associates with engagement.

As the experiment is to be conducted on children several limitations have to taken into account when designing the experimental method. The physical setting and test setup may influence the way children respond to the questions (Bell, 2007). Children can be influenced by the wording and formulation of the questions, therefore guidelines for designing the questions have to be followed.

Bell (2007) suggests guidelines in order to design appropriate questions for children. As mentioned in the analysis the simplicity of the questions is key. Bell (2007) presents several factors which need to be present for a question to be simple and understandable. First and foremost the language should be easy to understand and unambiguous. Second, the questions should be short, direct and specific in order to avoid misinterpretation. Third, Negatively turned questions should be avoided together with suggestively-phrased questions as children are prone to please the evaluator. These guidelines are all taken into account in the design of the questions in the previous iterations and especially in the final experiment.

The final problem statement of the current study is formulated as following:

How can Continuation Desire be used as an iterative design method to develop an engaging mobile game for children at the National Museum of Denmark, and to which extent does the game have an effect on the children's desire to continue playing and their desire to return to the museum in the future?

As stated earlier the problem statement is threefold:
- How does CD perform as a tool for designing and evaluating the game experience
- Does the game experience affect the participants' desire to continue playing
- Does the game experience affect the participants' desire to continue return

This chapter will describe how we seek to evaluate these three problems.

14.1 Why the Mixed Method Design

The experiment is a mixed method design, including both a within subjects and between subjects experimental design. The reason for choosing the within subjects design is that we seek to measure the impact of our experience against a baseline and then repeat the measure twice, one for each game experience component (i.e. Game component and AR component).

If the game has to work in a natural environment, it would not be possible to tell if the Game or AR component would be played first. Therefore a between subjects approach was added to see which chronological combination of the two game experience components have the largest effect on the participants' desire to continue and to make sure that the results reflected the natural environment of the experience. This can provide the knowledge of how the experience should be marketed if one combination proves more efficient than the other. The between subjects design can also provide information about the limitation of the components.

The experiment has to take place in the natural environment of the museum, as the on site AR component of the game experience is connected to the *Middle Ages and Renaissance* exhibition.

The online (e.g home, other place than the museum) environment is then simulated in the rest area (i.e. sofa groups) located in the foyer of the museum, which has no exhibited artifacts.

14.2 Engagement Measures

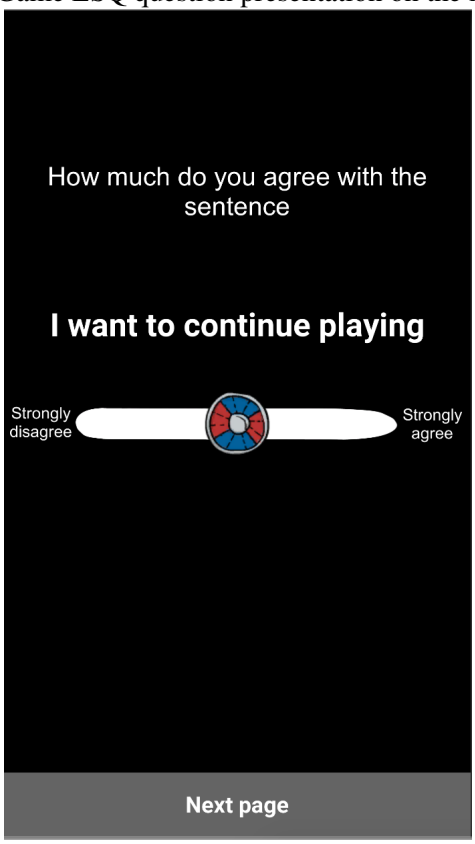
In order to measure if the game experience has an affect on the participants' desire to continue playing an adapted version of the Basic Game ESQ used by (Schoenau-Fog, Birke, and Reng, 2012) was applied. The adapted measurement is defined by the present authors as the Game ESQ. This measure was chosen due to its simplicity, both in overall implementation and in its question formulation.

Our adapted version of the Game ESQ does not include the qualitative part of the ESQ (i.e. the *"why?"* question). The qualitative aspect was removed in order to provide more time for the game experience, and because information in regards to how the activities perform is measured using the expanded Game ESQ, described in the following section.

The Game ESQ has the following formulations, dependent of the three levels of the within subjects experiment:
- Pre test (baseline): *"I want to begin the game."*
- Between components: *"I want to continue playing."*
- Post test: *"I want to continue playing."*

Each of the three questions were presented together with the sentence “How much do you agree with the following sentence”. The responses were measured using an adaption of the Visual Analog Scale (VAS), this adaption is described later in this chapter. Figure 14.1 shows the implemented presentation of the question.

Figure 14.1: Game ESQ question presentation on the mobile device.



The questions from the Game ESQ were presented to the participants in danish. The questionnaire can be found in Appendix 18.

14.3 Engagement Measures for Activities and Affect

In order to evaluate the design and the OA3 framework as a design tool, five additional questions were asked between components and post test. It was derived from the analysis of the usages of the Basic Game ESQ, that further expansion of the scale could provide additional information in regards to specific aspects of the design. In total five additional questions were added and they are defined by the authors as the expanded Game ESQ. As with the Game ESQ, the participants' responses are measured using the adapted VAS scale.

The five questions attempt to allocate the limitations and possibilities of the designed activities and their affect. The five questions were designed with the guidelines proposed by Bell (2007) in mind.

The first question seeks to evaluate the Solving activity. The Solving activity is related to the targets (i.e. Helmet, Shield, etc.) that the participants have to find. The question should measure how well the activity performs in relation to engagement, while still being understandable for children. The statement was formulated as following; *“It was fun to figure out where the things*

were hidden". The presentation of the question resembles the presentation of the Game ESQ questions, seen on Figure 14.1, this is also the case for the rest of the questions in the expanded Game ESQ.

The second question was added in order to evaluate the Exploration activity. The question has the purpose of measuring the participants' willingness to interact with the two game experience components. The statement was formulated as following, *"I want to continue exploring the game"*.

The third question was added after the pilot test (which is explained later in this chapter) in order to evaluate the Sensing activity. The question was designed to measure how the participants react to the drawings and sounds (i.e. the aesthetics) of the game experience. The statement was formulated as following, *"I liked the drawings and the sounds"*.

The fourth question was included in order to measure the Absorption affect. As the test took place in the natural environment, we expected that some level of noise, other people etc. could affect the level of absorption reached by the participants. The statement was formulated as following, *"I had a hard time focusing on the game"*. The authors are aware that the question is turned, this was also kept in mind when piloting the method, but no suggestions indicated that the participants misunderstood the question.

The last question was included to measure the Positive affect (or Negative) of the game experience. The statement was formulated as following, *"I had fun while playing"*.

Each question in the expanded Game ESQ was presented to the participants in either danish or english, and some of the questions were altered to fit either the Game component or AR component. The questionnaires can be found in Appendix 18.

14.4 Player Behavior Measures

In order to further investigate our game experience design, and if the way the participants interacted with the game experience components, could relate to the measure of engagement, player behaviour measures were logged via the digital implementation (as previously presented). The application logged several behaviours from the players. The application only logged behaviour when the player explored the game (i.e. pressed the screen), it did not collect data when the camera was moved. The data collected at each press are all presented in the following list:

- Objects that are being pressed.
- Time elapsed since the start of the game.
- Coordinates for the player's touch (press).
- The camera's size.
- The camera's position.

From these measures we were able to calculate multiple different measures, such as touches per second (level of interaction), when each target was found and thereby an average of how quick they found the targets, average camera size, average camera size when targets are located, and number of targets found. These were collected in the Game component, whereas the AR component only measured when the targets were located and the amount of targets located.

All these measures will be evaluated in relation to the questions in the expanded Game ESQ.

14.5 Again-Again Table

The last part of the problem statement seeks to investigate if the game experience has an affect on the participants' desire to return to the museum. This also relates to the purpose of the game, derived from the SGDA. From the analysis (see chapter 5) we derived the Again-Again table as a measurement. The Again-Again table in its original form asks the participants if they want to repeat or return to an experience, and provides them with three choices *Yes, No* and *Maybe*. The Again-Again table was chosen as earlier discussed due to its simplicity in its question formulation (e.g very similar to the Game ESQ) and because it can be used to measure if the game experience affects the participants' desire to return to the museum. In order to use it together with the Game ESQ, the Again-Again table was adapted to use the VAS.

The willingness to return to return was measured at three levels: pre experience, between components, and post experience. The presentation of the questions are identical to Figure 14.1. The questions are formulated as the following:

- Pre test (baseline): *"I want to visit the museum today."*
- Between components: *"I want to visit the museum again."*
- Post test: *"I want to visit the museum again."*

The questions from the adapted Again-Again table were presented to the participants in danish or english. The questionnaire can be found in Appendix 18.

14.6 The Visual Analog Scale

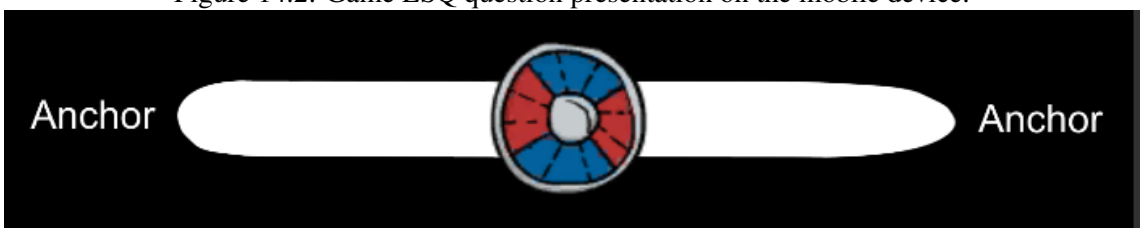
The Visual Analog Scale was developed with the purpose of providing patients with a tool to communicate the level of pain they feel, in order to ease the diagnosis process for doctors (Crichton, 2001). The VAS scale in its basic form, is a horizontally-fixed line which measures 100 mm. In each end of the line there is one anchor: No pain (i.e. 0 mm) and Very severe pain (i.e. 100 mm). The patient then reports the level of pain they feel by marking the line at a point between the anchors. The amount of millimeters from No pain to the mark are measured and translated into a self reported measure of the participants' pain, at a value between 0 and 100. The use of the scale on children has been widely discussed. Baeyer (2006) compares the scale to several other scales such as adjective scales, numerical scales, and faces scales as a function of validity studies and categorizes the scale as extensively validated on children. Among the scales which are extensively validated is the faces scales, similar to the Smileyometer.

Baeyer (2006) argues that the VAS can be used for children at the age seven and above. Laerhoven, Zaag-Loonen, and Derkx (2004) compare the VAS scale against Likert Scales and found that children had an easier time understanding the Likert Scale. The present study is expecting a ceiling effect to occur due to the small difference between the means in the pre and post questionnaires in earlier evaluation iterations (see chapter 11). To avoid the effect we will use the VAS, as it enlarges the scale providing more room for diverse responses. As argued by Hasson and Arnetz (2005) the VAS can prove to be hard to understand. The scale should be piloted before the use in the final experiment.

The natural environment in which the test was set to take place demanded a digital implementation of the scale. The authors made the scale smaller to fit the screen of a mobile device and designed it more graphical with a shield to slide from anchor to anchor, see Figure 14.2.

It is important that the visual representation of the scale is equal for all participants, therefore only the same model of Samsung phones (i.e. Galaxy S7) were used in the experiment. The definition of the anchors is important for the understanding of the VAS scale (Scott and Huskisson, 1976). The present study chose to name the anchors after the anchors of the Game ESQ Likert

Figure 14.2: Game ESQ question presentation on the mobile device.



scale, in order not to differentiate too much from the intended measurement.

14.7 Pilot Test of The Experimental Design

The fourth iterative test had the experimental design implemented. The descriptive statistics and conclusions in relation to the iterative evaluations are presented in the Iterative Design chapter 11. The participants of the fourth iteration were asked to raise their hand if they did not understand what they were asked in the questionnaires.

After the test a structured discussion was held going through the different elements which needed evaluation. The elements which needed evaluation were:

- Was the overall experience confusing?
- Did the participants understand the question formulation?
- Did the participants understand the VAS scale and its anchors?
- Did the test feel long?

None of the participants found the overall experience confusing. The participants found it easy because the application (prototype) told them what to do when they were finished with either a questionnaire and one of the game experience components. When asked if the participants understood the questions, the answers were positive and did not bring up problems. One participant stated that he or she had been confused about the questions regarding being at the museum, despite the conductor explaining that the questions should be disregarded.

In order to evaluate the understanding of the VAS scale the participants were asked to describe how it worked to the conductor. The conductor showed some different examples of answers on the scale and asked the participants what the results meant. The participants were generally aware of how it worked and understood the function of the anchors. The participants were in general satisfied with the length of the test.

The results of the pilot test concluded that the participants at the fourth iteration test understood the VAS scale and the question formulations. It should be added that the third question of the expanded Game ESQ was added after this test, in order to measure the performance of the sensing activity.

As an additional measure to make sure that the children could understand the questions, two limitations were introduced. First the participant had to be together with an adult, preferably their parent, when answering the questionnaire, and secondly each participant together with their parent should be provided with a visual and verbal presentation of the question design and the VAS scale.

14.7.1 The Application

All three questionnaires were implemented into an application which runs seamlessly between the playthrough of the components. In order to progress in the test, a password had to be input. This was done to make sure that the participants were at the right place at the right time (i.e. playing the

Game component in the foyer, etc.). The application was developed in order to limit the strain on the participants, when participating in the experiment.

14.8 Experimental Procedure

The experimental test took place on the 19th of May 2018 at the National Museum of Denmark. The test was conducted on 19 participants ages 5-13. The test took place in two areas of the museum. The Game component was played in the foyer and the AR component was played in the *Middle Ages and Renaissance* exhibition. The tests were completed on a SAMSUNG Galaxy S7 smartphone.

Convenience sampling was used to gather the test participants. When a suitable (i.e. appropriate age) subject had bought their ticket to the museum they were approached and asked if they wanted to participate in the experiment and they were told that it would take about 15 minutes. If they agreed to participate they were allocated into one either group A or B. Group A played the Game component first and the AR component second, and vice versa for group B.

Three test conductors were present at the test. The first conductor found participants in the foyer and introduced them to the test procedure. The second conductor observed participants while they took the questionnaires and played the game. The last test conductor was stationed in the exhibition and handled the participants when they played the AR component.

The test procedure was as following:

- The participants were first asked about their age and gender, this was noted down by the conductor on the smartphone.
- The participants were then presented with a visual and verbal explanation of the question design and how to answer them.
- The participants were then provided with a smartphone.
- The participants then answered the pre questionnaire containing the first question from the Game ESQ and the adapted Again-Again table.
- The participants then called upon a test conductor to insert the progression password.
- The participants then played either the Game or AR component dependent on group. If they had to play the AR component, they were pointed towards the third test conductor stationed in the exhibition.
- The participants then called upon a test conductor to insert the progression password.
- Then they answered the Between components questionnaire, containing the second question from the Game ESQ and the adapted Again-Again table, together with the expanded Game ESQ questions.
- The participants then called upon a test conductor to insert the progression password.
- The participants then played either the Game or AR component dependent on group.
- The participants answered the Post questionnaire, containing the third question from the Game ESQ and the adapted Again-Again table, together with the expanded Game ESQ questions.
- Lastly, the participants then called upon a test conductor, in order to finish the test.

At the end of the test the participants were thanked for their participation. The results from the experiment are presented in the next chapter.

15. Results

In this chapter the processed data from the experimental test is presented. The experimental test was designed as a mixed method experiment with three within subject levels. The first level was the baseline level measuring the participants desire to begin the game experience (Pre). The second level, asked them in the middle of the test (when switching between the two game experience components) if they wanted to continue playing (Between). The last and third level asked the participants after the game experience if the participants' desired to continue playing (Post). The game experience consisted of two parts: A five minute playthrough of the Game component and a five minute play playthrough of the AR component. Both parts were played on the same mobile device. While playing the Game component several measures of player behaviour were collected. A few measures of player behaviour were also collected while playing the AR component.

The hypothesis of the study is split into three hypotheses, one main hypothesis and the sub hypotheses.

The null hypothesis of the study was formulated as:

The game experience has no effect on the participants' desire to continue playing.

First sub null hypothesis:

Playing the Game component before the AR component has no effect on the participants' desire to continue playing.

Second sub null hypothesis:

Playing the AR component before the Game component has no effect on the participants' desire to continue playing.

These hypotheses are defined in three conditions, which are presented on Table 15.1.

Table 15.1: Test Conditions

Main Condition
How does the overall experience affect the participants' desire to continue playing.
Sub Condition A
How does playing the Game component and then the AR component affect the participants' desire to continue playing
Sub Condition B
How does playing the AR component and then the Game component affect the participants' desire to continue playing

The Main Condition will be evaluated using the Game ESQ responses from the Pre Experience questionnaire, Between experience questionnaire, and Post experience questionnaire. Sub Condition A and Sub Condition B will be evaluated using the same responses as the Main Condition, but categorized based on the chronological order of which participants experienced the two components. In addition to the within group conditions the differences between the Sub Conditions will also be presented.

In order to evaluate the design and its process, player behaviour data was gathered unobtrusively while playing the Game component and the AR component. The data will be compared to the responses collected by the Game ESQ. The behavioural data will also be compared to relevant items from Expanded Game ESG in order to allocate the effect of specific elements in the game on the participants' desire to continue playing. Association between the behavioural data samples will also be investigated.

In order to validate the Expanded Game ESQ items as a tribute to the measurement of engagement, correlation between the Game ESQ and the expanded Game ESQ items are investigated and analyzed.

Lastly the responses from the adapted Again-Again table will be compared to the responses from the Game ESQ, in order to investigate the validation of the Again-Again table as a measurement of engagement, and possibly the validation of the Game ESQ as a measurement for engagement of games in a museum setting. The adapted Again-Again table will also by used to evaluate the game experience purpose (i.e. if they are drawn to the museum in the future).

Appropriate statistical methods were conducted on all samples. This was done in order to determine parametricity. To test for parametricity three assumptions were analyzed for each sample. The first assumption of parametric data is that the samples have to consist of continuous data (either interval or ratio). The second assumption is that the sample has to follow a normal distribution. The assumption was analyzed by observing histograms and qq-plots for indications of normality. To ensure the degree normality in the samples the Shapiro Wilks test for normality was conducted. The last assumption of parametricity is that the variance of the compared samples has to be homogeneous. In order to test for homogeneity of variance the Levene's test for equal variance was conducted. If the samples fail to reject the hypothesis of both the Levene's Test and the Shapiro Wilks test, the sample is assumed parametric, if one or both hypotheses are rejected the sample is assumed nonparametric. All the inferential tests are presented with a statistical significance level at

alpha = 0.05.

As both within condition and between condition results are investigated, appropriate inferential test are used for both methods. The inferential tests used in specific scenarios will be presented with the results of the test. As both increases and decreases in the participants' desire to continue playing are useful in order to evaluate the design, two-tailed inferential tests were used to analyze the difference in samples. All the results included in this chapter can be found in the Experimental Results folder in the Digital Appendix.

15.1 Differences within conditions in participants' desire to continue playing

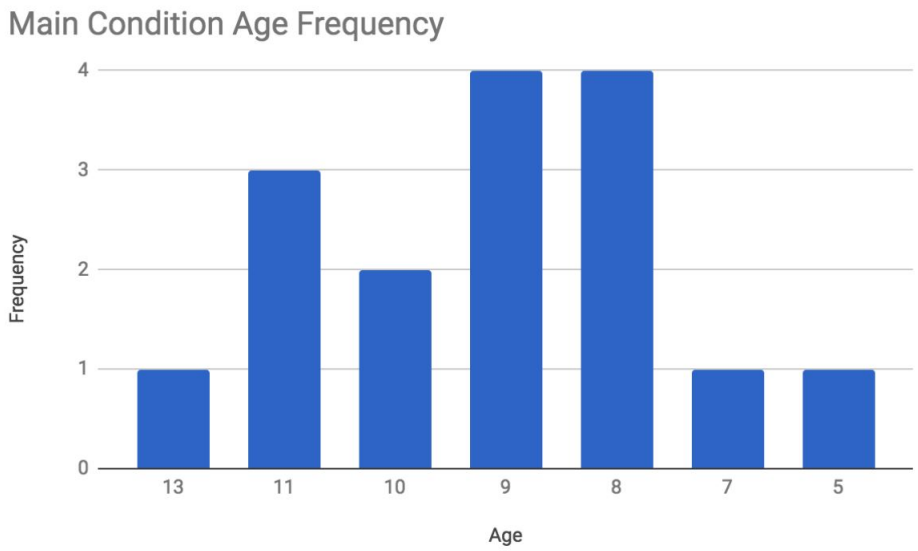
This section of the results will present the results of the descriptive statistics and inferential tests within the three experimental conditions.

15.1.1 Main Condition

The main purpose of the test was to see if the game experience influenced the participants desire to continue playing. The participants rated how much they agreed with the sentence "I want to continue playing the game" on the VAS from 0 (i.e. strongly disagree) to 100 (i.e. strongly agree). The independent variable of the Main Condition is the Game component and the AR component, were the dependent variable is the responses of the Game ESQ. In general, responses from a Likert Scale is considered as ordinal variables, but as the scale is increased using the VAS it can be considered as interval variables.

The Main Condition consists of 16 participants (N = 16), male (N = 10), female (N = 6). The average age of the participants was 9.125 (Median = 9) (target group 6 to 12). The age distribution can be seen on Figure 15.1.

Figure 15.1: Main Condition, Age Frequency.



The heatmap for the Game Component is presented on Figure 15.2. The highest activity has occurred in eastern area of the level, whereas the fields and farmer areas in the west have the lowest activity with some characters being untouched. In general there has been high activity at all the desired places, such as the town square (center) and the jousting area (east), except the religious part (north-west) which lacks activity.

Figure 15.2: Heatmap for the player behaviour in the Game component.

Table 15.2 shows the participants' Game ESQ responses as a function of test levels. The sample size (N), mean of the responses (M), median of the responses (Mdn), standard deviation (SD), standard error (SE) and Interquartile range (IQR) are presented. The descriptive statistics of the levels are presented separately and then combined (total) in all samples.

Table 15.2: Descriptive statistics for Main Condition as a function of test levels.

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
Pre	16	87.50	17.99	4.50	100	28.50
Between	16	81.75	27.91	6.98	100	31.50
Post	16	81.50	24.38	6.10	87.50	22.50
Total	48	83.59	23.44	3.38	99.50	28.50

On table 15.2 the mean differs between the three levels. The mean decreases 6 attitude levels from Pre to Post. The same behaviour can be seen in the median which decreases 2.5 attitude levels from Between to Post. The standard deviation differs from Pre to Between, as does the standard error. The IQR decreases from Between to Post to 22.5.

All the samples are positively skewed and all samples failed to reject the null hypothesis of the Shapiro Wilks test for normality, therefore the data is assumed non parametric. The Friedman's ANOVA test was used to allocate differences in the sum of ranks between the three levels.

The Friedman ANOVA rendered a Chi square value of 0.139535 which was not significant (p = 0.932611). The three levels failed to reject the hypothesis of equal sum of ranks. Therefore no significant difference in the participants' desire to continue playing among the three levels was found in the Main Condition. As no significant difference was found, there was no need to conduct further Post Hoc (e.g. the non parametric Wilcoxon Signed Rank Test) inferential tests.

The results of the Friedman test fail to reject the null hypothesis of the study, stating that the game experience has no effect on the participants' desire to continue playing.

15.1.2 Sub Condition A

In order to allocate if the chronological order of how the components were presented to the participants had an effect on their desire to continue playing, such a division was made in the samples. The VAS was used as the measure (i.e. the same as in the Main Condition). The independent variable of this condition is playing the Game component first and the AR component second. The dependent variables are again the responses from the Game ESQ.

The sub condition consists of 8 participants, male (N = 4), female (N = 4). The average age of the condition is 9.63 (median = 9).

Table 15.3 shows the participants' responses of the Game ESQ as a function of the three levels. The descriptive statistics is presented for each level and together in a total.

Table 15.3: Descriptive statistics for Sub Condition A as a function of test levels.

	N	M	SD	SE	Mdn	IQR
Pre	8	81.88	21.05	7.44	86	31.25
Between	8	72.75	36.09	12.76	85	50.00
Post	8	75.63	30.36	10.73	87.5	51.00
Total	24	76.75	28.76	5.87	87.5	32.00

The mean decreases 9.13 attitude levels from Pre to Between and then increases 2.88 attitude levels to Post. The median follows the same overall behaviour as the mean, but the increase and decrease is much smaller. The standard deviation also fluctuates between the levels as does the standard error. The IQR is much higher in Between and Post.

The Between sample and the Post sample failed to reject the null hypothesis of the Shapiro Wilks test for normality, therefore the data was assumed non-parametric. The Friedman ANOVA will be used to allocate differences between the samples. One of the assumptions of the Friedman ANOVA is that the samples need to include a minimum of 12 participants. The authors use the test to find a difference well knowing that the power of the measure is decreased dramatically. In order to validate a significance, Post Hoc tests need to be conducted, with a Bonferroni corrected significance level at 0.05 / number of samples.

The Friedman ANOVA rendered a Chi square value of 0.086957 which was not significant (p = 0.957453). The three levels within the sub condition failed to reject the hypothesis of equal sum of ranks. Therefore no significant difference in the participants' desire to continue playing among the three levels was found in Sub Condition A. As no significant difference was found, there was no

need to conduct further Post Hoc inferential tests.

The results of the Friedman test fail to reject the first sub null hypothesis of the study, stating that playing the Game component before the AR component has no effect on the participants' desire to continue playing.

15.1.3 Sub Condition B

The VAS was used as the measure (i.e. the same as in the Main Condition). The independent variable of this condition is playing the AR component first and the Game component second. The dependent variable is again the responses from the Game ESQ.

The sub condition consists of 8 participants, male (N = 6), female (N = 2). The average age of the condition is 8.63 (median = 8).

Table 15.4 shows the participants' responses of the Game ESQ as a function of the three levels. The descriptive statistics are presented for each level and together in a total.

Table 15.4: Descriptive statistics for Sub Condition B as a function of test levels.

	N	M	SD	SE	Mdn	IQR
Pre	8	81.88	21.05	7.44	86	31.25
Between	8	72.75	36.09	12.76	85	50.00
Post	8	75.63	30.36	10.73	87.5	51.00
Total	24	76.75	28.76	5.87	87.5	32.00

The mean decreases 5.75 attitude levels from Pre to Post. The median stays the same in both Pre and Between, then it decreases 6.5 attitude levels. The standard deviation is almost the same across the levels, so is the standard error. The IQR is higher in Between and Post, than in Pre.

All samples in this sub condition failed to reject the null hypothesis of the Shapiro Wilks test for normality, therefore the data was assumed non-parametric. The Friedman ANOVA will be used to allocate differences between the samples. The authors are again aware of the participant minimum assumption. We will use the test to find a difference well knowing that the power of the measure is decreased dramatically. In order to validate a significance, Post Hoc tests need to be conducted, with a Bonferroni corrected significance level.

The Friedman ANOVA rendered a Chi square value of 0.400000 which was not significant ($p = 0.818731$). The three levels within the sub condition failed to reject the hypothesis of equal sum of ranks. Therefore no significant difference in the participants' desire to continue playing among the three levels was found in Sub Condition B. As no significant difference was found, there was no need to conduct further Post Hoc inferential tests.

The results of the Friedman test fail to reject the null hypothesis of the study, stating that playing the AR component before the Game component has no effect on the participants' desire to continue playing.

15.2 Difference between the levels of Sub Condition A and Sub Condition B in participants' desire to continue playing

In order to allocate differences between the two conditions, inferential tests were conducted. All three levels for Sub Condition A are compared with the levels from Sub Condition B. The descriptive statistics for each included sample can be seen on Table 15.3 and Table 15.4.

As we try to compare both between and within subjects, a mixed model inferential test was needed. Only one of the six samples included in this test have rejected the null hypothesis of the Shapiro Wilks test and therefore an aligned rank transform operation was needed in order to use the Two Way Mixed Model ANOVA. The aligned rank transform was conducted using the ARTool presented by Wobbrock et al. (2011). The aligned rank transform procedure processess the samples such that little statistical efficiency is lost when using a parametric ANOVA on non-parametric data.

The Two Way Mixed Model ANOVA rendered a mean square value of 2.8356E50 which was not significant (p = 0.540409). Therefore no significant difference was found in participants' desire to continue playing between conditions. As no significant difference was found, there was no need to conduct further Post Hoc (e.g the within subjects Wilcoxon Signed Rank Test and the Mann Whitney U test for between subjects) inferential tests. But as the statistic efficiency was lowered, the Post Hoc test were carried out, but no significant differences were found between the two conditions.

As an addition a Two Way Mixed Model ANOVA was used to investigate if the gender of the participants has an effect on the participants' desire to continue playing. Because the samples do not follow a normal distribution, the aligned rank transform procedure was used again.

Table 15.5 shows the participants' responses of the Game ESQ as a function of the three levels and gender.

Table 15.5: Descriptive statistics as a function of test levels and gender.

Gender		N	M	SD	SE	Mdn	IQR
Boy	Pre	10	86.00	20.12	6.36	100	30.50
	Between	10	81.00	31.74	10.04	100	30.50
	Post	10	82.70	22.66	7.17	88.5	29.50
Girl	Pre	6	90.00	15.19	6.20	99.5	28.2
	Between	6	82.67	22.86	9.33	92	38.00
	Post	6	79.50	29.16	11.91	86.5	33.00

The Two Way Mixed Model ANOVA rendered a mean square value of 2.222222 which was not significant (p = 0.960550). Therefore no significant difference was found in participants' desire to continue playing between genders. As no significant difference was found, there was no need to conduct further Post Hoc inferential tests.

15.3 Association between player behaviour variables and the self reported measures

This section will allocate associations between several player behaviour measures and the self reported results from the Game ESQ. The evaluation of the player behaviour results will be two

fold. First the player behaviour results will be compared with the responses from the Game ESQ for both the AR component and the Game component. Second, the results will be compared with the response items from the Expanded ESQ which relate to the activities and affect in the Game component (i.e. Sensing, Solving, Exploration, Absorption, Positive affect).

15.3.1 The association between targets found in components and the Game ESQ

The participants had to locate targets in the Game component and AR component. Its therefore interesting to see if the amount of targets found has an impact on the participants' desire to continue playing, as these results will provide a better understanding of the designed difficulty. This association analysis will be split into two tests. First a test for association between the targets found in the Game component and the ESQ responses after the participants had played the Game component, then the same procedure was conducted for the AR component.

Game Component

Table 15.6 shows the targets found in the Game component by the participants and the responses from the Game ESQ. The descriptive statistics are presented for each sample.

Table 15.6: Descriptive statistics for association between targets found and Game ESQ.

	N	M	SD	SE	Mdn	IQR
Targets Found	16	1.69	1.25	0.31	1.50	1.00
Game ESQ	16	80.06	28.15	7.04	93.50	31.50

The participants found on average 1.69 clues in a playthrough (Median = 1.5). The mean of the responses on the Game ESQ after playing the Game component is 80.06, with a median of 93.5.

As both samples failed to reject the null hypothesis of the Shapiro Wilks test of normality, the samples are assumed non parametric. Therefore the Spearman rank-order correlation test for association was conducted.

The Spearman rank-order test rendered a correlation coefficient at 0.447197 (Spearman's rho) which was not significant at p = 0.082430. No significant association was found between the number of targets found in the Game component and the responses from the Game ESQ.

AR Component

Table 15.7 shows the targets found in the AR component and the responses from the Game ESQ. The descriptive statistics are presented for sample.

Table 15.7: Descriptive statistics for association between targets found and Game ESQ.

	N	M	SD	SE	Mdn	IQR
Targets Found	16	3.81	1.76	0.44	5.00	2.50
Game ESQ	16	83.19	24.00	6.00	88.50	23.50

On average the participants found 3.81 targets, with a median = 5. The mean of the responses of the Game ESQ was 83.19 (median = 88.5).

As both samples failed to reject the null hypothesis of the Shapiro Wilks test of normality, the samples are assumed non-parametric. Therefore the Spearman rank-order correlation test for association was conducted.

The Spearman rank-order test rendered a correlation coefficient at -0.219205 (Spearman's rho) which was not significant at p = 0.414679. No significant association was found between the number of targets found in the AR component and the responses from the Game ESQ.

15.3.2 The association between appropriate player behaviour data and the relative items from the Expanded Game ESQ

This section will investigate the associations between the player behaviour data and response Items 1, 2, 3, 4, and 5 after playing the Game component. The association will be presented in a chronological order from response item 1 to 5. The response items were measured using the VAS on a 0 to 100 scale. Where 0 resembled an attitude of "strongly disagree" and 100 resembled an attitude of "strongly agree". The response items are measured between and post experience.

Response Item 1

The first response item is related to the Solving activity. The sentence which was presented for the participants stated *"It was fun to figure out where the things were hidden"*. The related player behaviour measures are *targets found* (TF), *average camera size* (ACS), *touches per second* (TPS) and *average time to find target* (ATTFT).

Table 15.8 shows the player behaviour data collected after the Game component as a function of Response Item 1. The descriptive statistics are presented for the sample.

Table 15.8: Descriptive statistics for player behaviour data as a function of Response item 1.

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
Response Item 1	16	76.19	31.17	7.79	90.50	35.50
TF	16	1.69	1.25	0.31	1.50	1.00
ACS	16	6.74	1.29	1.34	7.08	2.46
TPS	16	0.32	0.15	0.04	0.34	0.23
ATTFT	16	182.16	67.18	67.18	171.75	141.42

The mean of Response Item 1 is 76.19, with a median at 90.5. The IQR is fairly large for Response item 1 at 35.50. The participants had an ACS at 6.92 (the minimum probable size is 2.5 and with a maximum at 10). The mean of TPS is at 0.32 with a standard deviation at 0.15. The mean ATTFT is at 182.16 with a high standard deviation at 67.18.

As the Response Item 1 sample failed to reject the null hypothesis of the Shapiro Wilks test, four non-parametric correlation tests were conducted. All player behaviour samples except TF rejected the null hypothesis Shapiro Wilks test, an example of the normal distribution histogram of TPS can be seen on Figure 15.3.

Four non-parametric Spearman rank-order correlation tests were conducted between the four player behaviour samples and the Response item. The results from the tests can be seen on Table 15.9.

Figure 15.3: Histogram for TPS as a function of frequency.

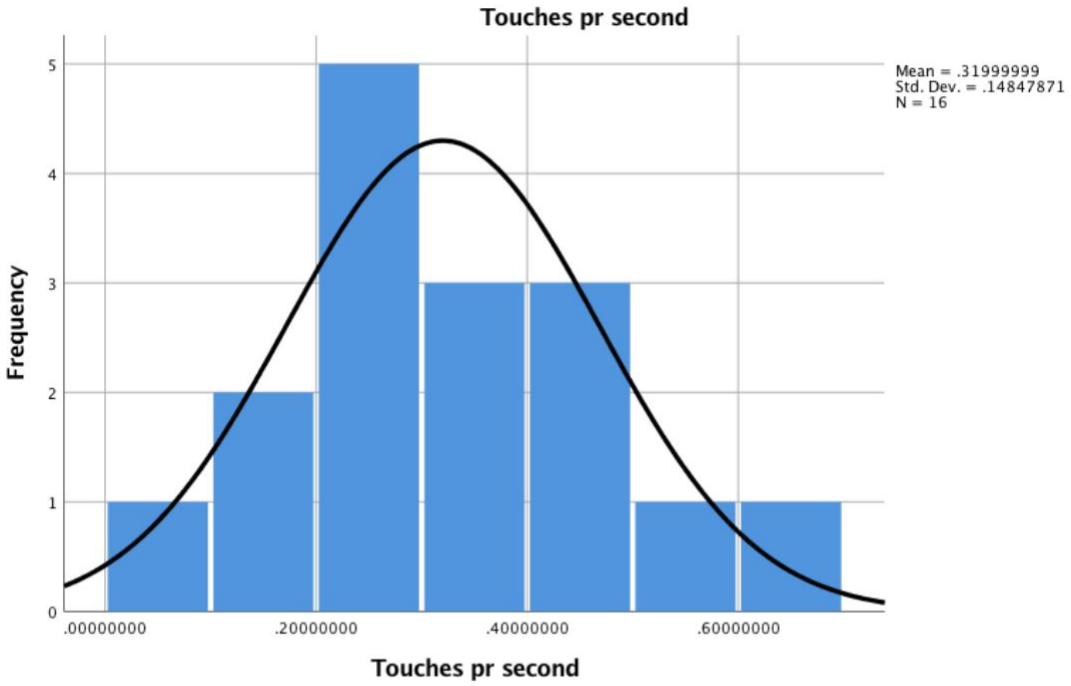


Table 15.9: Results from the Spearman rank-order correlation test as a function of Response item 1.

	Correlation Coefficient (Spearman's rho)	**Significance (p value)**
Item 1 & TF	0.322374	0.223324
Item 1 & ACS	-0.251766	0.346885
Item 1 & TPS	0.528095	0.035492
Item 1 & ATTFT	0.251126	0.386477

The Spearman rank-order tests rendered no significant correlation between three of the four player behaviour measures, but a significant association at a medium strength was found between Response item 1 and the TPS (rho = 0.528095, p = 0.035492). This means that there is a positive relationship between the two variables, indicating the larger Response Item 1, the larger TPS.

Reponse Items 2, 3, 4 and 5

The same procedure as conducted in the above association test was used for the rest of the response items (e.g if the assumption of normality and homogeneity of variance are met by the samples, the parametric Pearson correlation test will be used instead of the Spearman rank-order). Table 15.10 (previous page) presents each response item (with related activity or affect), with the sentence presented for the participants and with their related player behaviour measures.

Table 15.10: Reponse Items 2, 3, 4 and 5.

Response Item 2 **Exploration**
"I want to continue exploring the game" TF, ACS, TPS
Response Item 3 **Sensing**
"I liked the drawings and the sounds"
ACS, TPS
Response Item 4 **Absorption**
"I did not have a hard time focusing on the game" (turned)
TF, ACS, TPS
Response Item 5 **Positive affect**
"I had fun while playing"
TF, TPS

Table 15.11 shows the descriptive statistics for Response Item 2, 3, 4, and 5. As the descriptive statistics for TF, ACS and TPS are shown in Table 8 they will not be presented here.

Table 15.11: Descriptive statistics for Response Item 2, 3, 4 and 5.

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
Response item 2	16	83.50	21.99	5.50	96.00	31.25
Response item 3	16	81.81	17.78	4.45	81.00	28.25
Response item 4	16	67.06	31.73	7.93	67.50	39.25
Response item 5	16	77.19	33.34	8.33	96.50	33.25

The means of the four items are fairly equal, except for Response item 4 which is 14.75 attitude levels lower. The standard deviation for the means also changes a lot between item, with Response item 4 and 5 being almost equal.

Three correlations were found using the Spearman's rank-order correlation test among the response items and player behaviour measures. A correlation was found between Item 2 and TF (rho = 0.533355, p = 0.033373), indicating a positive relationship at a medium strength between the two. This result indicates that the more targets the participants found, the higher the score they reported when agreeing with the sentence *"I want to continue exploring the game"*. Item 2 also correlated with TPS (rho = 0.714717, p = 0.001862) with a large strength. This indicates a positive relationship between the two variables.

Lastly, there was found a correlation between Item 3 and TPS at a medium strength (rho = 0.542674 p = 0.029855). This result indicates a positive relationship between the participants' attitude towards the aesthetics and their degree of interaction in the Game component.

Further investigation of the player behaviour measurement also showed a correlation between TF and TPS at a medium strength (rho = 0.536200, p = 0.032267). The correlation shows a positive relationship between the two, indicating that if TPS becomes larger, so does TF.

Inferential tests (e.g the independent t-test or Mann Whitney U test, based on parametricity) were also conducted on the player behaviour samples between Sub Condition A and B, but no significant differences were allocated.

15.4 Investigation of the association between the Expanded Game ESQ and the Game ESQ

In order to investigate if the Expanded Game ESQ items have associations with the Game ESQ, a correlation test was conducted. The response items were measured between experience and post experience. The responses from pre experience and post experience are collected into five samples, one for each item. The responses from the Game ESQ pre experience and post experience are collected into one sample.

Table 15.12 shows the participants' responses as a function of the response item and the Game ESQ. The descriptive statistics are presented for each sample.

Table 15.12: The descriptive statistics for the Expanded Game ESQ and the Game ESQ.

	N	M	SD	SE	Mdn	IQR
Response item 1	32	77.44	28.36	5.01	86.00	33.75
Response item 2	32	82.88	26.24	4.64	97.50	27.50
Response item 3	32	83.19	16.23	2.87	83.50	25.50
Response item 4	32	61.81	33.31	5.89	64.50	58.00
Response item 5	32	77.00	30.25	5.35	91.50	33.25
Game ESQ	32	81.63	25.78	4.56	88.50	29.00

The mean of Item 4 is the lowest of all items. The highest median is found in Item 2 at 97.5. The standard deviation is lowest in Item 3 as is the standard error. The standard deviation is highest in Item 4. The IQR differs across the items with Item 4 as the highest and Item 3 as the lowest.

As all the samples are positively skewed and fail to reject the null hypothesis of the Shapiro Wilks test, non-parametric testing was needed. Each Item will be correlated with the Game ESQ using the Spearman's rank-order correlation test. The results from the test can be seen on Table 15.13.

Table 15.13: Spearman's rank-order correlation test results for each Item associated with the Game ESQ.

	Correlation Coefficient (Spearman's rho)	Significance (p value)
Item 1 & Game ESQ	0.248751	0.169798
Item 2 & Game ESQ	0.588211	0.000399
Item 3 & Game ESQ	0.440738	0.011578
Item 4 & Game ESQ	0.113317	0.536898
Item 5 & Game ESQ	0.322651	0.071689

Two out of the five Items indicated an association with the Game ESQ. The responses from Item 2 (*"I want to continue exploring the game"*) had a positive relationship with the responses from the Game ESQ at a medium strength (rho = 0.588211, p = 0.000399). The same was the case for Item 3 (*"I liked the drawings and the sounds"*), which also had a positive relationship with the responses of the Game ESQ.

15.5 Differences within participants' desire to return to the museum

As well as asking about the participants' desire to continue, the study also investigated how the game experience influenced the participants' desire to return to the museum. The participants responded on how much they agreed with the sentence, *"I want to visit the museum again"*. The response was measured using the adapted Again-Again table with the VAS on a 0 to 100 scale. Where 0 resembled an attitude of "strongly disagree" and 100 resembled an attitude of "strongly agree". The desire to return was measured in three levels, pre experience, between components and after the experience.

Table 15.14 shows the participants' Again-Again responses as a function of test levels. The descriptive statistics of the level is presented separately and together in a total of all samples.

Table 15.14: Descriptive statistics for Again-Again as a function of test levels.

	N	**M**	**SD**	**SE**	**Mdn**	**IQR**
Pre	16	95.56	12.26	3.07	100.00	0.00
Between	16	90.13	12.70	3.17	98.50	20.50
Post	16	92.94	12.74	3.18	100.00	9.50
Total	48	83.59	23.44	3.38	99.50	28.50

The mean decrease 5.43 attitude levels from Pre to Between, then it increases 2.81 to post. The median is the same in Pre as in Post at 100. The standard deviation is very equal across the levels, so is the standard error. The IQR is very small at all levels, especially in Pre were it is 0.0E0, indicating that almost all participants have answered very high as the median is 100.

The histograms and qq-plot show that all three samples are positively skewed. All three samples failed to reject the null hypothesis of the Shapiro Wilks test for normality, therefore non-parametric inferential tests are needed. The Friedman's ANOVA test was used to allocate differences in the sum of ranks between the three levels.

The Friedman ANOVA rendered a Chi square value of 7.085714 which was significant at (p = 0.028931). The three levels reject the hypothesis of equal sum of ranks. A significant difference was found among the three levels. Further Post Hoc tests were needed. The non parametric Wilcoxon Signed Rank Test was used between the samples to allocate the difference.

The results of the Wilcoxon Signed Rank Tests indicated no significant difference between the samples. Therefore they fail to reject the hypothesis stating that the game experience has no effect on the participants' desire to return to the museum.

15.6 Investigation of the association between the Adapted Again-Again table and the Game ESQ

In order to investigate the relationship between the two measurements of engagement an association test was conducted. All the answers from Pre, Between and Post from each measurement were grouped into two samples, one for the Game ESQ and one for the adapted Again-Again table.

Table 15.15 shows the descriptive statistics for the samples as a function of the measurements.

Table 15.15: Descriptive statistics for Game ESQ and Again-Again.

	N	M	SD	SE	Mdn	IQR
Game ESQ	48	83.58	23.44	3.38	99.50	28.50
Again-Again	48	92.88	12.50	1.80	100.00	10.50
Total	48	88.23	19.26	1.97	100.00	19.75

The mean is 9.3 attitude levels higher in the Again-Again than in the Game ESQ. The mean is almost identical at 100 for the Again-Again and 99.5 for the Game ESQ. The standard error is higher in the Game ESQ than in the Again-Again.

Both samples are positively skewed and fail to reject the null hypothesis of the Shapiro Wilks test. The sample distribution for the Game ESQ responses can be seen on Figure 15.4, and on Figure 15.5 the responses from the Again-Again responses are presented.

Figure 15.4: Game ESQ responses as a function of frequency.

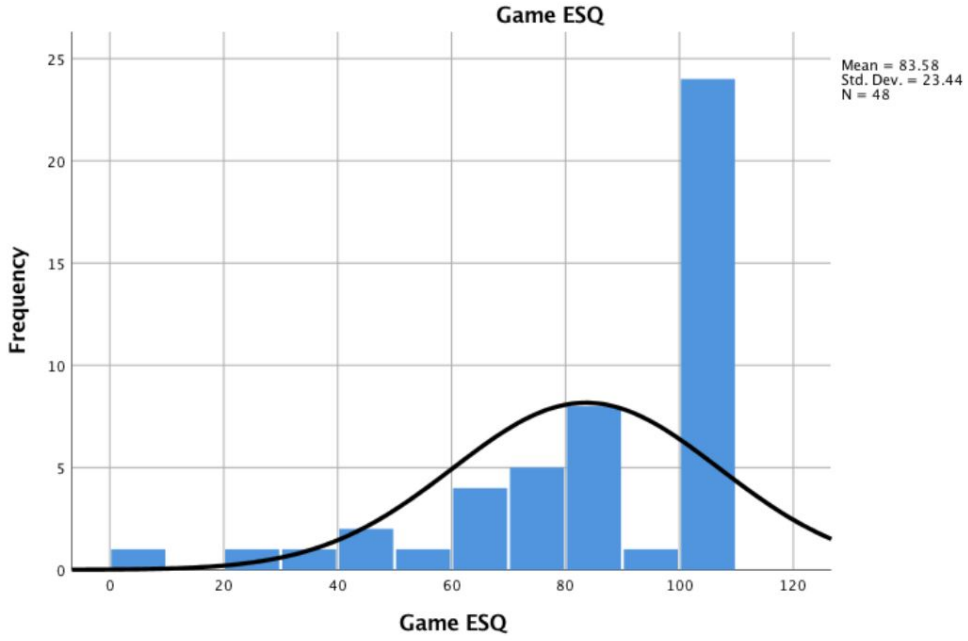
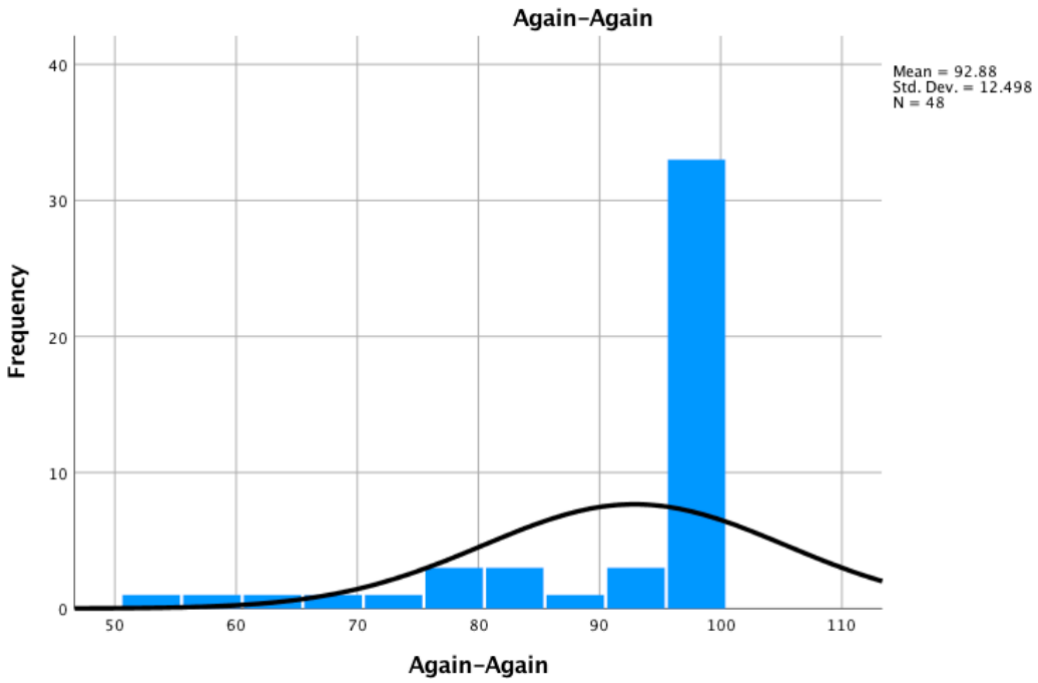


Figure 15.5: The Again-Again responses as a function of frequency.



A non parametric correlation was needed and therefore the Spearman's rank-order correlation test was conducted on the two samples.

The Spearman rank-order correlation tests rendered no significant correlation between the two samples (rho = 0.172400, p = 0.241302). This indicates that no association can be made between the to samples and measures.

A summarization of the results will be presented along with a discussion of how they connect with the final problem statement in the next chapter.

16. Discussion

The discussion chapter will summarize the findings derived from the experimental test. The chapter will discuss how the findings relate to the final problem statement. The discussion will be divided into the following sections: a summary of the findings, a discussion of the findings, a comparison of the findings in relation to other studies, a method discussion, a design discussion, and a plan for future evaluation and implementation.

16.1 Summary of findings

The main experiment measured the participants' desire to continue playing at three levels: pre, during, and after the game experience. No significant difference was found between the three levels. In order to investigate the specific elements of the game experience, the participants were divided into two conditions, based on which component they tried first. But no significant difference in the participants' desire to continue playing was found between the three levels and between the two conditions. When investigating the means of the three levels in the main condition, the desire to continue playing decreases from pre experience to post experience. But when looking at the medians of the samples it is clear to see that an increase in the participants' desire to continue playing would be impossible to measure through non parametric inferential tests. The pre experience median is at 100, which only allows for the possibility to measure a decrease.

While participants played the Game component we measured their behaviour. Several associations were found between the self reported measures and the player behaviour variables. First, the association between the responses from the Game ESQ and the number of targets found was investigated, but no associations were found between the two samples, for both components.

Further investigation found that several of the response items from the expanded Game ESQ could be associated with different behaviour variables. The first response item sought to measure the participants' level of engagement when performing the Solving activity (i.e. locating the targets). We found a positive relationship between the response item and the behaviour variable, touches per second (TPS).

The second response item was designed to measure the participants' desire to explore the game world (i.e. the exploration activity). A positive relationship was found between the response item and the number of targets found (TF) and TPS behaviour variables. Lastly, a positive relationship was found between response item 3 and the TPS behaviour variable. Response item 3 sought to measure the level of engagement when sensing the aesthetics of the game (i.e. the Sensing activity).

Further investigation of the relationship between the behavioural variables found a positive relationship between the TF and TPS variables.

In order to validate the expanded Game ESQ as a measurement of engagement, we correlated the responses of the questionnaire with the responses of the Game ESQ. We found that two of the response items had a positive relationship with the responses from the Game ESQ, namely Item 2 (i.e. Exploration) and item 3 (i.e. Sensing).

An adapted version of the Again-Again table was used to measure the participants' desire to return to the museum, but no difference between the three levels was found. As with the Game ESQ, the means decreased from pre experience to post experience. As the Again-Again table had been used by other studies to measure the level of engagement in participants, the authors wanted to allocate a possible association between the Game ESQ and the Again-Again table, but no association were found between the responses.

16.2 Discussion of findings

Directly related to the results of the Main condition is the part of the final problem statement which seeks to investigate how the game experience has affected the participants' desire to continue playing. The study was not able to measure any difference between the three levels of the experiment, mainly because of the very positive scores of the pre experience Game ESQ, which asked the participants to which degree they wanted to begin the game. The digital VAS was used in order to decrease the possibility of a ceiling effect in the baseline, but it failed to limit the effect. The median was valued at 100, which leaves no room for increases and therefore it resulted in the ceiling effect. The possibility for an effect to be measured was still possible between the post and between components questionnaires (i.e. during and after the experience). No difference in the responses was found.

When analyzing the results, the mean scores of the Game ESQ were measured using one response item and the sample size was small (N=16). The two factors make the test prone to outliers. This was further validated, as almost all samples were found to be positively skewed and therefore did not follow the normal distribution. This leads to a high effect on the means from low and high responses. In order to normalize the samples in future studies, the sample should be drawn from more participants and the number of response items in the Game ESQ should be increased.

A future study could include the response items from the expanded Game ESQ which showed a positive relationship with the Game ESQ. The positive relationship between the response items and the Game ESQ could indicate that the items measure aspects of the same construct (i.e. engagement). The relationship between the items and the Game ESQ needs further validation, this could be done through a repetition of the experimental test, using different participants, together with a larger sample size. Is should be noted that response item 3 rendered a correlation significance value ($p = 0.000399$) below 0.01, which indicates that there is an increased chance of a Type 1 error (finding an effect which does not exist).

The experiment also sought to measure if there was a different effect in the participants' desire to continue playing based on the order in which they played the Game and AR components. The study found no difference between the two combinations. There can be several factors for this.

One of the apparent factors could be the length of the experiences. The participants played each component for 5 minutes, which can prove to be too short for a playthrough to measure an effect change, but most of the participants found all the targets in the AR component, so having a longer playthrough may not be beneficial to solve the problem. Another factor can also be the sample size, as the compared samples only consist of eight participants. The small sample size makes the results more prone to Type I and Type II errors. A future study should be conducted with a longer period to experience the two game experience components.

The evaluation of the player behaviour variables presented several different findings. The player behaviour variables are case relative, meaning that touches per second as a measure of player behaviour makes sense in our case, but maybe not if you were to develop a game like The Museum Mystery (Monkey, 2016a) where the goal is to pick the right answer on the screen. Response Item 1 (e.g. Solving) had a possible association with touches per second (TPS).

TPS is measured when the participants “taps”/"press" the screen. We define the taps as searches or investigations. The player taps an object in order to get information about the possibilities of that object, if it is interactable, if it can move or if it is one of the five targets. The association between the item and TPS is not an indication of causality based relationship. The positive relationship describes the behaviour of the samples within the population, if response item 1 increases, so does TPS.

In order to conclude how our Solving activity performs, more information about how they interacted with the UI and how they interpreted the text hints is needed. TPS was also found to be associated with Response Item 2 (i.e. Exploration), Response Item 3 (i.e. Sensing) and targets found (TF). An association found for items 1 and 2 with TPS can indicate that a success criteria of the design was reached. We want the players to explore the world, so the fact that the participants who had an engaging time doing so, actually investigated the world the most, can validate the design approach we used.

The association between TPS and TF can tell something about the game’s ability to award the player who explores the world the most, which also validates our design approach.

It should be noted that Response Item 2 rendered a correlation significance value ($p = 0.001862$) below 0.01, which indicates that the association between the item and TPS can be the fault of a Type I error.

Response Item 2 also had a positive relationship with TF. Meaning that the participants who found it engaging to explore the world also found the most targets. Again the association provides us with information about how the players were awarded by the game for their willingness to explore.

All these indications and associations need further evaluations. A study with different participants and a larger sample size could validate the associations further. In order to find out if there is a causality relationship between the variables and the self reported measures, an experiment should be conducted, with the purpose of isolating the two variables from other factors.

From the data already collected in each playthrough, new variables of player behavior could be measured such as the distance the camera moved in a playthrough. As the variable also indicates the degree of exploration, there may be a correlation between the variable and the self reported attitude measure of Item 2. Another measure we could calculate could be the areas of the heatmaps to see if the explored area differs between conditions.

Future studies into how these player behaviour variables influence the player experience could prove to be valuable for the case of developing the present game.

The findings from the adapted Again-Again table also proved to be positively skewed and pre experience responses derived a median of 100. The measure included only one question, making

the mean of the responses prone to outliers. That both the adapted Again-Again table and the Game ESQ proved to derive the same outcome, may indicate that a limitation can be found in the method by which they were measured. The findings from the two measurements could have been influenced by many factors, such as question formulation, the participants' understanding of the VAS and the test environment.

How these factors could have influenced the findings, together with the limitations of the pilot test will be discussed further in the Method Discussion section 16.4. To further study the adapted Again-Again table we correlated the results with the Game ESQ, but no association was found. The scores of both scales were positively skewed indicating that in general, the participants were willing to return to the museum and to continue playing the game. A reason for the lack of association between the measurements can be due to the skewed sample distribution. As the skewness in the samples forces non-parametric testing, which is more prone to produce Type II errors (not finding an existing effect). Another reason for the results can be a difference in numbers of influencers for each measurement. An unequal number of influencers can have a negative effect on an association, together with the small sample size.

16.3 Findings in relation to other studies

Van Dijk, Lingnau, and Kockelkorn (2012) argue that using multiple measurements to measure the same construct, further validates the results of a study. Van Dijk, Lingnau, and Kockelkorn (2012) correlated the results of the Again-Again table with the Smileyometer and found a strong correlation between the two. The present study was interested in the Again-Again table as a proposed measure of engagement. The present study correlated the results of the adapted Again-Again table with the Game ESQ, as other studies have used them separately when measuring the same construct, in this case, engagement. The present study found no evidence of an association between the two measurements. There could several reasons for why the two do not correlate. A reason could be, that the two measurements are designed to measure different constructs. The Basic Game ESQ was designed to measure an aspect of engagement, namely the desire to continue playing a game. The Again-Again table was designed to measure Endurability, more precise the two aspects returnance and remembrance (Read, MacFarlane, and Casey, 2002).

The ESQ has before been used to evaluate the components of interactive narratives as a construct of engagement (Schoenau-Fog, 2012; Schoenau-Fog, Louchart, et al., 2013).

Schoenau-Fog, Birke, and Reng (2012) use the Basic Game ESQ as a measurement in an iterative design method. They found that the measurement helped them locate a faulty implementation (i.e. bugs) as it revealed itself in the Basic Game ESQ responses between iterations. The present study expanded the method and applied it to four test iterations, together with several additional questions in order to guide the design. In addition, the present study followed the guideline of using the same participants for the iterations in order to limit the effect of different player preferences. The Basic Game ESQ helped to get an overview of the direction of which to pull the design by adding a small part of new elements into the game at each iteration. The present study then expanded into player behaviour variables in order to locate association, with future focus being to find causality relationships between components of engagement and the behaviour of the player. To further validate both the player behaviour data and the Game ESQ we could look into how the acquisition of psychophysiological data (e.g. galvanic skin response (GSR), electroencephalography (EEG), and cardiovascular measurements) relates to the measurement.

In another study conducted by Schoenau-Fog and Bjoerner (2012), a method for mapping player engagement in an interactive experience was developed. The Engagement Mapping Method (EMM) was developed through a literature review and sought to allocate the causes of why players want to

continue. They found that the causes could be categorized into six broad types, namely intellectual, physical, social, sensory, narrative, and emotional engagement causes. A future study could investigate the causes for engagement in the present game experience. As the game focuses on three main activities, namely Solving, Exploration and Sensing, it could be interesting to see how they relate to the intellectual and sensory causes for engagement. The EMM has the possibility to provide an overview of how strong each cause is in the game experience, which could provide further information on the limitation and possibilities of each present activity.

16.4 Method Discussion

One of the limitations of the experimental design was the lack of qualitative data. The decision to leave out qualitative data was taken in order to increase the period in which the participants played the game experience components. It is hard to estimate the length of the test when participants have unlimited time to answer an open-ended question.

Had we collected qualitative data in addition to each question, we could have gained insight into several other fields of interest such as which targets were the most fun to find, which part of the world did the participants find enjoyable to explore and so on. Leaving out the qualitative part of the experiment is not viable over many tests. The qualitative data could also have helped us evaluate if the participants understood the proposed questions. More qualitative data and a more in-depth demographics section could also help to locate the factors which may have influenced the findings from the Main Condition. Questions such as *"Have you been to the museum before?"* and *"Have you been in the Middle Ages and Renaissance exhibit before?"* could have provided insight into the personal context of the visitors and which type of visitor they were. This could have answered the question of why the participants were so eager to try the game.

In a future study, a more qualitative approach can be followed in order to evaluate the achievement aspect of the OA3 Framework. During the design iterations, several indications of the Completion achievement being a factor for engagement were found. Some participants for the iteration evaluations mentioned a desire or need to open all the windows and search all the haystacks. This could relate to the concept of *Conation*, which describes the determination, perseverance, and tenacity which a player exhibits when playing an engaging game (Schoenau-Fog, 2014). A more qualitative approach could maybe provide insight into why and if the Completion achievement is present in the design of the game. The future experiment could ask the participants how much they want to continue and why, after each target is found. This could together with a follow up interview provide a deeper knowledge into how the game relates to the achievement component of the OA3 framework. The Completion was also found by Schoenau-Fog (2011b) to have the greatest impact on players' desire to continue.

16.4.1 The VAS

The pilot test (iteration 4) was used in order to investigate if the participants could understand how to use the VAS. The test suggested that the participants understood the measurement and how to use it. In the experimental test, the participants and their guardians (e.g. parents) were presented with a verbal and visual presentation of the measure. The results from the final experiment indicate that the scale may have been misunderstood. Most of the participants have placed their mark at either end of the scale, mainly to the positive end. The idea of using the scale was to provide the younger part of the target group with a more visual scale in order to assess their desire to continue or return.

Observations observed by the test conductor provided insight into why the scale failed to produce

a more desired outcome. The conductor observed several times that parents affected the answer of the children when helping them with the questionnaire. This was observed mainly in the pre experience questionnaire, especially in the adapted Again-Again table's first question which stated "I want to visit the museum". Parents indicated that the children themselves had chosen to visit the museum.

The test conductor also observed an interaction behaviour, we will define as the *swipe effect*. Many of the children swiped the mark right or left when answering the question. This could indicate a design flaw in the application implementation of the scale. Interestingly, this was not observed in the pilot test. One apparent factor could be experience with the scale. One limitation of using the participants from the iteration test for the pilot test, was the experience they gained during the iteration period. The participants of the iteration tests have filled out questionnaires several times over a period of two months, and may have grown accustomed to the scales. Another factor which could have influenced the responses from the questionnaire can be age. Bjoerner (2015) argues that a small difference in age can have a large effect on the child's ability to understand and complete questionnaires. The average age of the children used in Iteration test 4 was 12.75, where the average age of the children in the final experiment was 9.13.

It could have been beneficial to try out several measurements of collecting the attitude of children throughout the iteration tests. The measurements could have included the IMI, the Smileyometer, and the Colored VAS scale. This could have led to the allocation of an appropriate measurement for the final experiment. Future iterations should include several different measurements in order to allocate the best method for the future.

16.4.2 Natural environment

The natural environment of the experiment may have had an impact on the participant's perception of the Game component. The Game component was meant to be played off site (Online) and not at the museum. In order to have the same participant playing both experiences, we tried to simulate the Online environment by having the participants play the game in the foyer of the museum, more precise at an area with sofas. The physical context of the museum plays a role and can have tributed many distracting factors such as other visitors and museum announcements.

Future studies may have more success if they have the possibility of having the participants play the game at home before they visit the museum, this would also be a better representation of the natural environment desired for the game experience.

The natural environment may also have influenced the results of the adapted Again-Again table. The experiment took place on a Saturday. The day was chosen based on the museum informing the authors that Saturday was the day in which most children visited the museum (e.g. when not visiting as a school class). In the period of the test, the National Museum had just released a new activity called "The Boredom Button" (Nationalmuseet, 2018a) the release of the new activity had resulted in an increase in visitors at the museum (Stockmann, 2018). The initiative was directed at children in approximately the same age group as the present study, and when talking with the participants after the experiment, we noticed that many of the children came because they wanted to try that experience. The release of the button could have made a shift in the visitor type we expected to meet, which was the tag-along visitor. With the new experience, many of the children came as experience seekers visiting the museum to try the Boredom Button activity.

16.4.3 Question formulation

A ceiling effect was found throughout the responses of the questionnaires. Besides reasons such as the swipe effect, parent influence, and lack of experience with scales, the reason might be found in the formulation of the pre experience question and its relation to the personal context

of the participant. The questions state: how much do you agree with the following sentence, and the sentences are “I want to begin the game” (Game ESQ) and “I want to visit the museum” (Again-Again). The questions imply a degree of comparativity to the present activity performed by the participant. If the participant is already engaged in another activity, they may be reluctant to change and therefore answer with a low score. But if the participants are not engaged in another activity, they may be eager to try something new.

The participants were asked right after paying for their ticket at the museum, because of this they were not already engaged in an activity. In comparison, if the participants were asked in the middle of their stay at the museum, they might be engaged with an exhibition, because of the influence of the physical and sociocultural contexts throughout their stay. Had we asked participants who had been at the museum for a while, the responses in the pre questionnaire may have been different, as they were then provided with a directly compared activity.

The limitation of such method is then that the experience they had before, would then be the influence of our baseline. But that may have proven to be an easier influence to isolate, compared to asking participants when they begin their stay at the museum, as the influence in that scenario is the comparative activity which was experienced before the museum visit, which can vary a lot depending on the participant. Some participants may have arrived directly from their home and others may have come from the theater or such.

It can be argued that the game experience should reflect all of these scenarios. When the game is released it is impossible to influence when they play the online component, which should lead them to the museum in order to play the on site component or the other way around. Qualitative data in regards to the personal context of the visitors could have proven useful in order to answer why they were so eager to play the game or visit the museum. This could also provide further understanding of which visitor types each participant belongs to.

16.5 Design Discussion

The state of the art analysis in museum games brought forward four activities which frequently occurred in the games, namely Solving, Sensing, Exploration, and Socializing. The Socializing aspect is left out in the present study, but is definitely an activity which needs further investigation in order to create a community around the game. Future studies could look into how a level creation mode could be made. The mode could then feature a small part of the map, where players themselves could hide different targets and then share the level with friends and see if the friends could find the targets. This mode could also be able to solve two of the mayor game design limitations we face, namely replayability and content creation.

The games LaunchBall and Rugged Rovers followed the same recipe of experimentation (design) and then testing, a game recipe which was found popular among children (Lankes et al., 2017). Rugged Rovers was designed with the purpose of educating children about the scientific process, more precise the design process of an engineer. The formula of experimenting and then testing is derived from the scientific approach of engineering. The learning goal then becomes a result of play. The present study used meetings with exhibition related employees in the museum in order to formulate the player experience. The present player experience purpose was to evoke a sense of discovery and exploration in the player. The purpose was derived from the mediation approach of the museum (and it is very similar to the experience visitor’s feel when engaging with the "Boredom Button"). Further investigation into how the game experience can connect with the mediation approach of the museum could help the experience to seamlessly blend into the physical and virtual context of the museum.

16.5.1 SGDA & OA3 frameworks

The SGDA framework was used to define the purpose of the game and to provide an overview of what to include into the game. The framework was originally meant as an assessment framework in order to analyze the quality of a serious game. The SGDA framework lacks depth as a game mechanics design framework, which is one of the reasons why the present study used the OA3 framework together with the SGDA. The SGDA provided us with an overview of what to include in the game and how the included components should relate to the purpose, then we expanded on that by using the OA3 framework to dive deeper into the different components of the SGDA, mainly the *MECHANIC* component. The OA3 framework provides more depth into the mechanics design gameplay loop. In the present study, we choose to focus on the *MECHANIC, AESTHETICS/GRAPHICS* and *FRAMING* components, while touching lightly on the *FICTION/NARRATIVE* and *CONTENT/INFORMATION* components. Future studies could look into how we further connect the AR component with the exhibition artifacts and how the narrative of the game is going to facilitate stories from the *Middle Ages and Renaissance* exhibition. Such a study should also investigate how to evaluate learning objectives in an effective manner. This could be done using the Structure Of the Observed Learning Outcome (SOLO) taxonomy (Lucander et al., 2010). The taxonomy assesses learning outcome in five stages, the Prestructural, Unistructural, Multistructural, Relational, and Extended abstract. Questions related to the learning goals can then be designed to evaluate the five stages and based on the responses an assessment of the outcome can be conducted. The purpose of the game could be a learning goal, which in our case could be to educate children about the different societal structures of the Middle Ages (i.e. poor, common, rich, and religious).

This could be done in a confirmative study comparing a control group and a group who play the AR component, to see if a difference in gained knowledge has occurred.
The EDD framework and the iterative design process by Fullerton (2008) proved useful and in alignment with how the OA3 can be used to evaluate iterations.
Using the OA3 framework and the Basic Game ESQ in order to iterate on the design gave us great insight into faulty design decisions (e.g. difficult targets). Understanding of how gameplay can be categorized, which the OA3 framework provides, eases the development of an engaging game experience as the loop can be evaluated step-by-step (via its components). The OA3 framework also proved useful as a tool for assessing digital game mechanics, both in context with museums and commercial games, further expanding the SGDA.

16.5.2 Difficulty

The participants found an average of 1.6 targets in the five-minute period when playing the Game component. The participants were presented with all five targets, meaning that they knew how many they had to find in order to complete the game. As the mean decreased from pre to post in the Game ESQ, it could indicate that participants did not get the feeling of completion. This could be fixed by extending the period in which they play the Game component, so all five targets could be located. Future studies should look into how much time there should be between locating targets while still providing a satisfying player experience. To do this a player adaptive approach could be implemented which provides a subtle hint if the time since a target has been located exceeds a "satisfying experience" threshold.

As we discuss the difficulty further, we see some patterns in regards to which targets were found first and why. Figure 16.1 presents a histogram of targets found by all the participants in the experimental test, ordered by UI presentation.

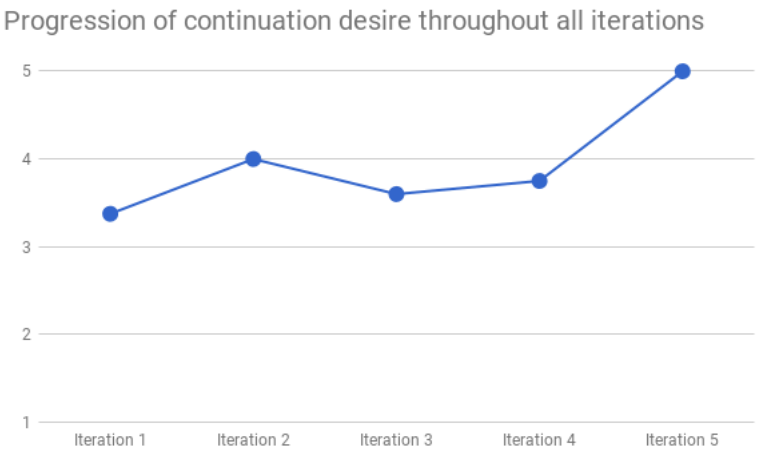
Figure 16.1: Frequency of targets found, ordered by the UI presentation.

Figure 16.1 indicates that the players located the targets in the order in which the UI presented the targets (from left to right). The most frequently found target is the Guard. This was expected as it was designed as a low difficulty target. The Helmet was not classified as one of the difficult targets, such as the Monk. Even though the Helmet was presented as the second target in the UI order, most participants did not find the target. The difficulty was designed dependent on five variables, distance, blend, obscureness, text hint, and thematic dissonance. The fact that the Helmet was hard to find, can indicate that the difficulty variables are not equally weighted (which was expected). In this case, it can indicate that obscureness influences the difficulty more than the thematic dissonance variable, which was intended to make the Monk target difficult to locate. Further investigation into how the variables affect the difficulty could prove useful in order to create a satisfying player experience. The fact that the player has searched for the targets using the UI order, provides us with the possibility of making the first target from the left into a tutorial which introduces the knowledge and process needed to locate the rest of the targets.

16.6 Future evaluation and implementation

We sought to find a design approach in order to create an engaging experience. Even though we did not find a difference between the three levels, we did see an overall increase between the five iterations in the participants' desire to continue playing the game. see Figure 16.2.

Figure 16.2: Progression of continuation desire throughout all iterations.



We found that the OA3 framework could expand the SGDA framework as a design and assessment tool.

We evaluated the purpose of the game which was that the game should hook the players, and draw them to the museum in an engaging manner. We evaluated the purpose through the adapted Again-Again table, which showed that the children still wanted to visit the museum after playing the game.

The next step for this study will be to investigate how the achievement component of the game experience should be designed and evaluated through an iterative design process.

In order to conduct such an investigation, many limitations of this study and the game experience need to be further researched. A qualitative study into the reasons why children revisit museums should be conducted. On the basis of the results from the study and the present study, a plan for how the progression system (e.g. unlock levels online, by playing on site) should be designed can be planned. This also requires a more interactive AR component which utilizes the physical context of the museum in a higher degree, by increasing exhibit and artefact exploration. The main driver behind the progression system is the Completion achievement, in order to evaluate if children find the achievement compelling, an iterative design process should present and evaluate several different solutions, including features which support the Socializing activity, such as the player level creation mode. The iterative design process could, in addition, include a measurement interpretation study which seeks to find an adequate scale for the Game ESQ and the Again-Again table. Further research into how the player behaviour variables can be used unobtrusively to evaluate the experiences in context with engagement, can make for a method to rapidly iterate the design, therefore studies into the causality relationship between the measurements should be conducted.

Together with the design related evaluation, research into which degree the AR component should facilitate learning or support it, should also be carried out. The AR component has the possibility to include many of the museums, affiliated with the National Museum. How such possibilities can converge into an engaging and purposive game experience is a demanding design challenge.

17. Conclusion

This thesis explored how an engaging on site and online game experience could be designed and evaluated for children, through an iterative design process.

Through the development process, five design iterations guided the design of a mobile game experience developed as a case study for the National Museum of Denmark. The study combined research in the field of museum and player experiences in order to evaluate each iteration.

The final game experience consisted of two components, a mobile game in which the players explore a medieval town to locate characters and objects, and an augmented reality experience in which the visitors discover hidden characters and objects in the *Middle Ages and Renaissance* exhibition of the National Museum.

The OA3 framework from the player engagement concept of Continuation Desire was used to assess the design of state of the art games and to evaluate the iterative design process in order to reach a satisfying design. The Mechanic component of the SGDA framework was expanded using the OA3 framework adding an understanding of how purposive gameplay should be designed.

The relation between the museum experience measurement Again-Again table and the ESQ was investigated and should be further researched in the future.

The final experiment was conducted at the National Museum and the participants' desire to continue and return to the museum was measured at three levels: pre, during, and post experience. 16 participants in the age group of 5 to 13 played the Game and AR components. Due to a ceiling effect in the pre experience questionnaire, no difference between the levels could be measured. Overall the continuation desire among participants increased through all the iterations, as more and more content and tweaks were added to the game experience.

The thesis also compared player behaviour variables to the results of the self-reported measurements and found several interesting associations, which should be tested in case of a causality relationship.

Future studies should focus on evaluating the Achievement component of the OA3 framework, especially the completion aspect. Future studies should explore how new methods for measuring children's desire to continue playing can be evaluated through an iterative design method.

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V

Appendix

18. Questionnaires

18.1 Pre Experience Questionnaire

Køn/Gender
Dreng/Boy (Checkbox)
Pige/Girl (Checkbox)

Alder/Age
Alder/Age (Text field)

Game ESQ
DK: Jeg har lyst til at komme på museum i dag.
ENG: I want to visit the museum today.
Meget Uenig 0-100 Meget Enig (VAS)

Again-Again
DK: Jeg har lyst til at begynde spillet.
ENG: I want to begin the game.
Meget Uenig 0-100 Meget Enig (VAS)

18.2 Post Game Component Questionnaire

Game ESQ
DK: Jeg har lyst til at fortsætte med at spille.
ENG: I want to continue playing.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Solving)
DK: Jeg synes det var sjovt at finde ud af hvor tingene var gemt.
ENG: It was fun to figure out where the things were hidden.

Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Exploring)
DK: Jeg har lyst til at fortsætte med at udforske spillet.
ENG: I want to continue exploring the game.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Sensing)
DK: Jeg kunne godt lide tegningerne og lydene.
ENG: I liked the drawings and the sounds.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Absorption)
DK: Jeg havde svært ved at holde fokus på spillet.
ENG: I had a hard time focusing on the game.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Positive affect)
DK: Jeg havde det sjovt mens jeg spillede.
ENG: I had fun while playing.
Meget Uenig 0-100 Meget Enig (VAS)

Again-Again
DK: Jeg har lyst til at komme på museum igen.
ENG I want to visit the museum again.
Meget Uenig 0-100 Meget Enig (VAS)

18.3 Post AR Component Questionnaire

Game ESQ DK: Jeg har lyst til at fortsætte med at spille.
ENG: I want to continue playing.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Solving)
DK: Jeg synes det var sjovt at finde ud af hvor tingene var gemt på museet.
ENG: It was fun to figure out where the things were hidden.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Exploring)
DK: Jeg har lyst til at fortsætte med at udforske museet med spillet.
ENG: I want to continue exploring the museum with the game.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Sensing)
DK: Jeg kunne godt lide tegningerne og lydene.
ENG: I liked the drawings and the sounds.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Absorption)
DK: Jeg havde svært ved at holde fokus på udstillingen og spillet.

ENG: I had a hard time focusing on the game.
Meget Uenig 0-100 Meget Enig (VAS)

Expanded Game ESQ (Positive affect)
DK: Jeg havde det sjovt mens jeg spillede i udstillingen.
ENG: I had fun while playing.
Meget Uenig 0-100 Meget Enig (VAS)

Again-Again
DK: Jeg har lyst til at komme på museum igen.
ENG: I want to visit the museum again.
Meget Uenig 0-100 Meget Enig (VAS)