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#museumgroupie

Playful photography at the museum

Bachelor thesis in Software Engineering and Computer Science



#museumgroupie

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Gothenburg, Sweden 2018

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Abstract

This bachelor thesis aimed to develop an application which encourages documentation through photography at Universeum. Furthermore, the application aimed to support social interaction and enable sharing of the photographs. The project was carried out in collaboration with Museum 2020. The application was developed for Universeum, a museum and science centre in Gothenburg, Sweden.

In order to motivate visitors to photograph at Universeum, gamification methods including feedback, reputation, rewards and progress have been used. Two prototypes were designed, tested and evaluated before the final application was implemented. The testing results indicated that by using the application the participants interacted together and photographed more at Universeum. However, these results must be interpreted with caution and further testing is required.

Keywords: application, Universeum, museum, photography, gamification, user experience, group, social interaction.

Sammandrag

Denna kandidatrapport hade till syfte att utveckla en applikation som uppmuntrar dokumentation genom fotografering på Universeum. Utöver detta skulle applikationen främja social interaktion samt möjliggöra delning av foton. Projektet utfördes i samarbete med Museum 2020. Applikationen utvecklades för Universeum, ett museum och vetenskapscentrum i Göteborg, Sverige.

För att motivera besökare till att fotografera på Universeum har spelifieringsmetoderna återkoppling, rykte, priser och framgång använts. Två prototyper har designats, testats och evaluerats innan den slutgiltiga applikationen implementerades. Testningen indikerade att genom att använda applikationen har testpersonerna interagerat och fotograferat mer på Universeum. Dock måste dessa resultat tolkas med försiktighet och ytterligare testning krävs.

Nyckelord: applikation, Universeum, museum, fotografi, spelifiering, användarupplevelse, grupp, social interaktion.

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Finally we would like to thank all our test participants who patiently tested the prototypes and application and gave us valuable feedback to improve our prototypes.

Amanda Jonsson, Emilia Vestlund, Joel Sundqvist, Maja Nyberg, Raha Dadgar,
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Glossary

Design pattern - A design pattern is a template for how to solve a problem in user interface design.

Design guidelines - A set of recommendations for a good practice in design. The guidelines' purpose is to provide instructions for developers and designers to use when adopting specific principles, for instance consistency and intuitiveness.

Application - The Application refers to the final prototype developed in this thesis.

NoSQL - A schema-less database that provides the functionality for storage and retrieval of data.

JSON - JavaScript Object Notation.

UID - UID stands for a unique identifier. All UIDs refer to Firebase UIDs in this thesis.

Swiping - The action to draw the fingers across a touchscreen to activate a function.

Tapping - To tap the touchscreen with your finger to activate a function.

SDK - Software developer kits.

API - Application programming interface.

BaaS - Backend as a service.

IDE - Integrated development environment.

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1

Introduction

This bachelor thesis project was carried out in collaboration with Museum 2020, which is a project initiated in 2016 at the Institution of Applied IT in Gothenburg, Sweden. Museum 2020 focuses on the digitising of society and their implications for public institutions, for example museums. Their purpose is to explore how public institutions can continue to be knowledge nodes in a time when media and society are becoming more and more digitised [1].

The initial project proposal for #museumgroupie was to develop a mobile application which supports documentation of museum visits and enables sharing of created content locally and on social media. The documentation was suggested to be in form of a “Groupie”, which refers to taking a photo of yourself together with other people, thereby the name #museumgroupie. The *Application* developed in this thesis incorporates the groupie phenomenon and group activities, but does not limit photography to only groupies.

One of the collaboration partners of Museum 2020 is Universeum; a science centre and museum located in Gothenburg, Sweden. With over half a million visitors annually, Universeum is the most visited science centre in Scandinavia and one of Sweden’s most popular attractions [2]. Their mission, to be a “public arena for lifelong lessons where children and adults can explore the world through science and technology” [2], and the presence of interactive elements, makes it an ideal organisation to work with when developing the *Application*.

In order to design and develop the *Application*, it was necessary to study rapidly growing photo- and social network applications such as Instagram, which has over 800 million monthly active users. Instagram is owned by the largest social media network in the world, Facebook, and plays a big role on the internet today. The American entrepreneur, author and internet personality Gary Vaynerchuk, goes as far as calling social media “a slang term for the current state of the internet” [3]. The development of the *Application* of this thesis will be influenced by Instagram, Snapchat and other social media applications, but the intention of this *Application* is not to be used *instead* of these, but to *complement* them.

1.1 Background

This section will give a background in form of related applications and investigations of how one of these applications are used in museum contexts. Furthermore it will discuss the technical aspects of developing an application and storing data.

1.1.1 Snapchat

Snapchat is an application of increasing popularity. The international science project *World Internet Project*, follows the proliferation of Internet in the world and their 2017 report shows that 80% of the Swedes up to 25 years of age are using Snapchat [4].

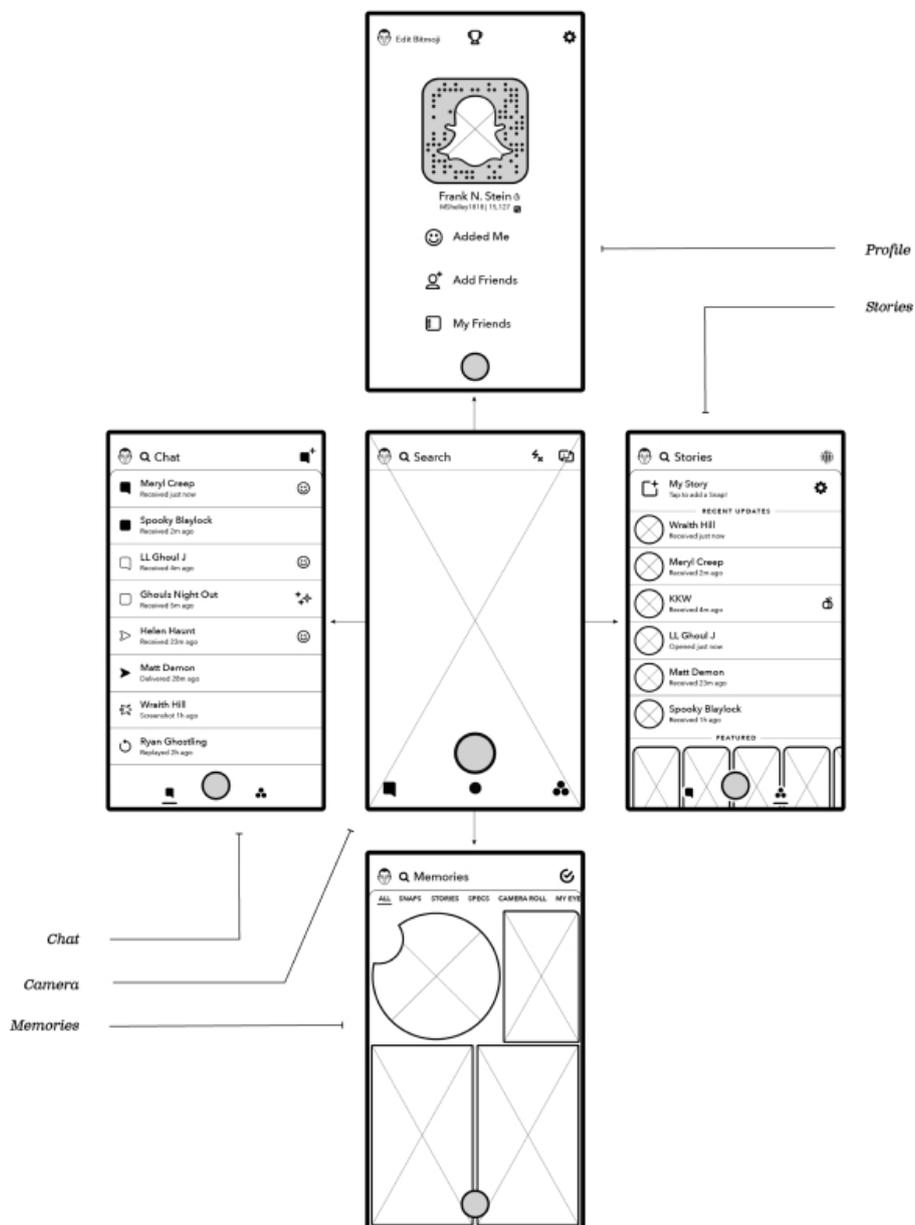


Figure 1.1: User Interface of Snapchat.

As seen in Figure 1.1 [5], Snapchat opens directly into the camera. It serves as a “homepage” in that it lets users navigate to the chat service to the left, or the storytelling platform to the right. The profile service is located above the camera, and the memories below. Switching between views is done by *Swiping*, and there is an additional navigation bar below the camera button to navigate between the three horizontal views by *Tapping* [5].

1.1.2 Instagram

Instagram is a photo and video sharing application which enables users to upload photos and videos [6]. Photos shared on Instagram are not necessarily taken with Instagram’s camera. They can be taken with the device’s own camera application, or any other application.

There are similarities between the *Application* and Instagram. They are both photo-based applications with sharing features. The main difference is that the *Application* of this thesis will be focusing on sharing within the visiting group rather than on a social network like with Instagram, and that the *Application* will be guiding users into what to photograph. Although Instagram in the museum context is an emerging field of study, and few studies have been conducted which one can make generalised claims from, literature can give hints on user behaviour, goals and issues that may apply to the *Application* as well.

In an influential thesis by Suess, the reasons for using Instagram at Art Exhibitions was investigated. One of the conclusions drawn was that Instagram is often used for sharing these kind of experiences. Suess also mentions different motivations for sharing. For example, users are encouraging their audience to see it for themselves. The investigation also shows the connection to aesthetic experience, in how users make observations and interpretations of the art, and expresses this with their photos [7].

1.1.3 What Are People Photographing?

In another article related to Instagram content created at museums and science exhibitions, Budge investigates what people are photographing at the museum. 390 pictures were studied, where 47% contained objects only. 28% of the photos contained people and objects [8]. Not all museums allow photography, and it is common to have regulations regarding the use of flash. After Italy state museums allowed photography for personal use, the art historian and blogger Alexandra Korey was curious to see what people were taking photos of, now that they could. In a blog post from 2014 she declares findings from a survey of photos hashtagged or geotagged Uffizi on Instagram. This investigation is not one to draw conclusions from, but she made one interesting note: people are actually photographing the artwork and not only taking selfies. Regarding the artwork photographs, there was a trend of photographing details rather than whole artworks. Details could be interesting frames of paintings for example. Korey also showed examples of photographs showing the

chaos when visitors tried to take pictures of the most famous artworks [9]. This kind of playful behaviour commonly occurs among teenagers according to Rowland et al. A study on teenagers playful photo taking behaviour during group visits to touristic events resulted in findings supporting the idea of “humans [...] being innately playful”. The application tested allowed members of a closed group to take photographs that were automatically pushed to a shared repository and accessible to all members. Design features such as instant sharing of the photos to social media, and anonymous annotation of photographs were found to further encourage the playful behaviour. Furthermore it was found that the use of these anonymous annotations, and the potential to share these images, lead to playful teasing that was sometimes on the verge of bullying. The study also indicated that their application may distract the users from fully engaging in the event [10]. This potential of distraction should be considered when developing an application for this area of use.

1.1.4 Cross-platform vs. Native Application Development

There are numerous different platforms that can be used in software development. All these platforms vary from each other and the software developers who want to reach a wide audience need to develop their application for all platforms separately. A cross-platform allows the developers to implement the application for a number of different platforms at the same time, which results in developers avoiding repetition of code. A cross-platform is a single code base which can be executed on several different platforms [11].

Native application development implicates that the developers implement the application using one specific platform and its frameworks and tools. Native applications are often faster, have broad functionality and a user interface that is more suitable for the specific platform. The disadvantages are the cost to implement the application for multiple platforms and the time it takes to implement several code bases [11].

A cross-platform provides application development using HTML, JavaScript, CSS and native shells while native application development requires a platform-specific language, for instance a native iOS application is coded in Swift or Objective C [11].

1.1.5 Backend as a Service

The *Application* will need to collect data in both text and photo format. This data therefore must be stored in a database. Backend as a Service or *BaaS* is a cloud computing service model which enables developers to connect applications to backend cloud storage while also providing features such as user management, push notifications and integration with social networking services. The connection between the application and the cloud storage is possible through *SDKs* and application programming interfaces *APIs*. Different features are provided similarly with the use of *SDKs* and *APIs* [12].

BaaS gives developers very little control of hosted code and in practice, can be less

secure [13]. Applications which use *BaaS* may also become bound to their *BaaS* provider, making it difficult to migrate the database in the future. However using *BaaS* would significantly decrease backend development time, increase scalability and provide the application with ready to use features such as user management, authentication and search.

1.2 Purpose

The purpose of this bachelor thesis is to develop an application which encourages documentation through photography at Universeum. Furthermore, the application should support social interaction and enable sharing of the photographs.

1.3 Task

Considering the purpose, the task can be further detailed. The functionality of the application which is going to be developed can be shaped in various ways. Therefore a more detailed description of the task was defined. The task definition of this project is to fulfil the purpose by fulfilling the three sub-tasks defined as following:

- Applying group work to encourage social interaction.
- Providing the ability to share photos within the group.
- Applying gamification methods in order to motivate photography hence encouraging documentation at the science centre.

The sub-tasks were established during the start up phase of the project and build the foundation of the functionality in the application.

In addition to the sub-tasks the application should be adapted to the specified target group. Depending on the target group, the application design and set up regarding gamification and group activities should vary, and therefore the application needs to be well adapted to the chosen target group. Based on the task description, requirements should be established as seen in Chapter 4.

1.4 Scope

The intended area of use for the Application is Universeum in Gothenburg, and the content has been related to current exhibitions (Spring 2018). Even though the *Application* is limited to be used at Universeum, it was developed so that a few adjustments would make it relevant for use at other museums and exhibitions as well.

The typical context of use is a school class visiting Universeum. Targeting visitors between 9 and 25 years of age, the application has been designed to fit their previous experience regarding mobile applications. The group aspect of the *Application* was designed with an optimal group size of 2-5 users in mind, however, no

limits are set regarding number of group members. This choice of flexibility was due to considering the target groups possible sensitivity to group affiliation, and the prototype status of the *Application*.

A native iOS application was created, meaning that it was limited to be used on iPhones. This choice was made considering available technology within the thesis group and simplified development and testing. Since the thesis group had no previous knowledge of iOS development, this choice also granted the opportunity to learn Apple's native programming language Swift and was therefore attractive.

1.5 Social and Ethical Aspects

In the planning stage, decisions were made regarding which social and ethical aspects to consider in the thesis. With a recent scandal where Facebook was accused of sharing personal data with a political consulting firm who allegedly used the data to influence voter opinion [14], privacy issues have gained increased attention in media and politics. It is important to be transparent about what kind of data is collected and to what purpose. Setting up a privacy policy would be of great importance to the *Application* since the content created might be of interest to collect. It might be valuable to analyse the photos taken with the *Application* to see what the users are photographing and how this differs from photos taken with for example Instagram. Since the *Application* is not available on App Store and is still of prototype status, privacy policies are considered future work for now.

Universeum does not have policies regarding photography except the fact that it is forbidden to take photos of animals using flash. This was reflected in the *Application* where the camera's flash function is disabled. In case of adapting the *Application* to another museum, it would be of importance to confirm that the authenticity of their information is preserved. The museum's preferences should be incorporated with the functionality of the *Application*. For example, the possibility to use flash, or which objects the users are guided into photographing. The potential problem of other visitors appearing in photos without their consent was considered, but since the *Application* does not promote users to photograph people outside of the group, the problem was considered negligible.

2

Theory

This section introduces the theory of agile software development, more specifically Scrum. It presents a few factors software developers should have in mind when designing and implementing for mobile platforms. Further, it describes the concept of gamification and states three different types of evaluations.

2.1 Agile Development Using Scrum

Agile software development is an umbrella term for a number of system development methods which can be applied to software development. Agile software development is characterised by dividing and completing the project in small sections [15].

Scrum is an effective agile software development method. It is used in the development of a product, to make the development iterative and incremental. One of the advantages of Scrum is that the development team will react to change, in an effective and immediate way. The development is divided into cycles which are called sprints [16]. These sprints are a fixed amount of time, which can range from three days up to one month. The first step in Scrum is to create the product backlog. This is a prioritised list with functionality that the product will have. This list consists of user stories but can also have items of engineering improvements. The Scrum team will also estimate how much time the user stories will take to implement.

At the beginning of every sprint in Scrum, there is a sprint planning where the team decides what is going to be achieved during the sprint. The team members select a user story from the product backlog which they are going to work on during the sprint. A daily scrum is held during the sprint, which is a daily meeting that is very short. All team members should answer three questions; what they have done since the last meeting, what they will plan to accomplish to the next meeting and if they have any problems. When the sprint is completed a sprint review is held. This is an informal meeting where the team discusses what was done during the sprint. The product backlog can be modified based on the conclusions made by the team. After the sprint review, the team will have a sprint retrospective. This is where the team evaluates how the sprint went and discuss further improvements. The evaluation can be about the team, the process and the tools the team uses [17], [18].

In Scrum, there are three different roles; the Scrum Master, the Product Owner and the Scrum Team. The Scrum Master is the coach of the team and assures that the

different events, such as sprint planning and sprint review is performed and that the Team understands the idea of the different events. The Scrum Master also assures that the different events do not breach the time-limits. The Team is supported by the Scrum Master to be self-organisational, cross-functional and develop high-value products. The Product Owner serves as the connection to the customer, makes decisions about the product and presents the project vision to the Team. The last role is the Team itself, which is responsible for developing the product [18].

In summation, Scrum is a great tool to use in software development. It makes the implementation iterative and the product will be responsive to change.

2.2 Mobile Usability and Design Patterns

Mobile devices have transformed the way people live and do their everyday activities. The ability to perform various tasks on mobile devices has increased substantially in the recent years. With the increased usefulness of mobile devices, the usability has come to expand. Therefore mobile usability has become more and more important to study. When looking at mobile usability models, the most common factors are effectiveness, efficiency and satisfaction. Other attributes like cognitive load sometimes tend to be overlooked despite their impact on the success of an application [19].

Some challenging constraints with mobile devices are poor connectivity and limited output options. These constraints also affect usability of mobile platforms. Thereby, it is difficult to measure the usability with just the factors effectiveness, efficiency and satisfaction. Other challenging limitations are for instance the small screens, short sessions and the fact that only one window can be visible at a time. However, these limitations can also present unique opportunities [19].

In order to produce a user interface with a high level of usability, *design patterns* can be used. The *design patterns* can be seen as guidelines to design a more "familiar" application that is thereby easy to use [20]. However, since there is a large number of *design patterns*, it is not always clear which pattern is the best choice. The patterns capture a common structure among all different user interfaces, and thereby the users can use their previous knowledge to understand the new interface.

In addition to *design patterns*, *design guidelines* can be used. Apple has specific guidelines for designing applications for the Apple platform. These guidelines concern visual components, for example buttons, icons, text size and font, but also user interaction aspects like audio and gestures [21].

To make a familiar interface that will be easy to use, both *design patterns*, guidelines and inspiration from other similar applications will be applied in the design stage of this project.

2.3 Gamification

Games can help motivate people in otherwise non-game scenarios and engage users in high level interaction. Gamification “involves the incorporation of game elements into non-game applications or domains. [...] [including] the use of elements from games to gamify things such as systems or activities.” [22]. In a conference paper on this topic, Basten writes about gamification and how software teams use this method for collaborative experiences, sharing knowledge and learning [23]. Gamification is when non-game contexts applies game-related elements and has become more and more popular since it was first discussed in 2010. Basten describes how gamification can be used to turn repetitive tasks into a playful experience and thus make users more engaged. He also points out that gamification can help improve companies usability, trust and customer motivation. Some common game elements used for gamification are feedback, goals, badges, point systems, leader-boards and user levels.

In order to perform tasks, people tend to have intrinsic and extrinsic motivation. Intrinsic motivation moves people to perform tasks because they are fun or because of personal gain. An example of extrinsic motivation is a task a person performs because of rewards, prizes or to avoid a negative consequence. Some systems use game elements to motivate users to perform tasks in these environments. Gamification is about using game elements to motivate users. Game elements can be supported by points, for example a user can obtain a number of points and win a badge or improve their status on a leader board [24].

An example of gamification is Livemocha, which is an online language learning community. It uses peer-based reputation that allows users to evaluate both learning and teaching contributions of other users. Livemocha helps users improve their reputation and also evaluates other users’ assignment by giving them better reputation. Reputation is considered an extrinsic motivator since a reward is involved, but Livemocha also lets the users be moved by intrinsic motivation since they are learning and improving their own skills [24].

2.4 Theory of Evaluation

In an influential book about Interaction Design, Preece et al list three categories of evaluation. These categories and common methods are briefly described below [25].

Controlled Setting Involving Users

A controlled setting could be a laboratory or any place where it is easy to monitor the users’ activities and observe certain behaviours. Common methods are user tests and experiments. In this type of evaluation, data is often collected using a combination of methods; observation, interviews and questionnaires for example, and user tests are increasingly done remotely or in natural settings instead of only in laboratories. This approach has been widely and success-

fully used to evaluate desktop applications where participants can be seated in front of the application to perform a set of tasks.

Natural Setting Involving Users

The main method for this category is field studies, which aims to evaluate people in their natural setting. Since there is little control over users' activities, this method is often used to help identify opportunities for new technology or establish requirements for a new design.

Any Setting Not Involving Users

In this category, experts analyse the interface in order to identify obvious usability problems. Common methods are heuristics and cognitive walk-throughs. These methods can be used in all stages of the design process. They can also be used to complement user testing. In a heuristic evaluation, the experts use guidelines in form of usability principles called heuristics to evaluate user-interface elements such as menus, navigation structure and other graphical user interaction objects.

There are pros and cons of each type of evaluation; Lab-based studies are good for finding usability issues while field studies are good for studying how the technology is used in its intended setting. As mentioned, user tests are increasingly done remotely or in natural settings, which will be embraced in the evaluation of the *Application* in this thesis, Section 3.2.2.

3

Methods

This section describes the different methods used in this project and how the theories have been used. First, the prototyping methods used are introduced. Subsequently, how these methods were used for testing the prototype and the *Application* are described. Finally, a review of the different application development methods used in this project is presented.

3.1 Prototyping Methods

Paper prototyping is a method used for testing, designing and improving user interfaces [26]. The method can be implemented in a variety of ways, however the fundamental idea is to create mock-ups in order to conduct usability tests on the mock-ups. The purpose of the tests is to evaluate the design and navigation of the mock-up. A representative user gets to interact with a paper version of the interface for the facilitator to identify flaws and improvements. Instead of spending time implementing a complete application, paper prototyping promotes creativity and the opportunity to test several different ideas early in the development process [26]. It gives developers and designers feedback early in the development process, thereby the application can be better adapted to the aimed user.

Marvelapp is an application which transforms mock-ups into interactive experiences [27], a so called computer based prototype. It lets the users add transitions between different sketches to resemble an actual implemented application without writing any code. The Marvelapp prototypes can be shared online, thereby the aimed user or product owner can give actionable feedback immediately.

Paper prototyping and computer based prototyping do not significantly affect user feedback, in other words the same feedback would be given using either computer based prototypes or paper prototypes. However, according to Sefelin, Tscheligi and Giller, remarkably many test participants tend to prefer computer based prototyping to paper prototyping because it gives them more freedom when exploring a system. They do not cause unnecessary work for the facilitator and feel less observed [28].

In this project, paper prototypes were first created to brain storm ideas and work out a concept. Thereafter, the paper prototypes were refined and implemented in Adobe Illustrator, to later on create a computer based prototype using Marvelapp.

3.2 Methods for Testing Prototypes

In order to evaluate the prototype and the application, user tests in both controlled- and natural settings were performed. Three different test sessions were held, two for the different prototypes and one for the *Application*.

3.2.1 Test of Prototype

Testing of the first two prototypes goes under the category of “Controlled setting involving users” in Section 2.4. The first prototype was tested using a very brief usability test. Friends and family tested the prototype. The purpose of this test was to obtain feedback on usability aspects of the early prototype. Participants were asked to perform a few use cases while a group member sat beside to observe difficulties. When the participants had completed all use cases they were asked to give feedback verbally on usability aspects.

Testing of the second prototype was conducted at Universeum. A poster and flyers were prepared with information about the project. Visitors passing by and identified as likely to be part of the target group were invited to test the prototype.

During the test session, nine use cases were tested:

- Join a group.
- Do the first mission with the boat icon.
- Do some of the tasks and preview the picture you took.
- Finish the mission.
- Name the person who took the other picture.
- Do not redo the mission.
- Navigate to the album to see all the pictures you have taken.
- Find out who is in your group.
- Change group.

The participants were supplied an iPhone to test the prototype and the facilitator asked the participants to perform the different use cases while someone else in the group took notes. Afterwards, all participants filled out a questionnaire, seen in Appendix C. Ten people participated in the test, but only nine of them filled out the questionnaire. Feedback from the questionnaires was used to detect usability issues with the design in order to further improve the design.

Even though this test was performed in the natural setting at Universeum, this test session focused on usability issues and the flow of the prototype. The reason for this test session to be held at Universeum was to easily reach the target group and to demonstrate our work for the personnel at Universeum.

3.2.2 Test of the Final Prototype

The implemented prototype was tested at Universeum. Four volunteers attended the user test session. This test did, compared to the prototype tests, not only focus on usability aspects. For this session, interest laid in how the *Application* was used in its natural setting; how the users interpreted the tasks and how they communicated during their visit. Thus, a “Controlled setting involving users” type of evaluation was executed in a natural setting as mentioned in Section 2.4. Few instructions were given about how to use the *Application*.

Participants tested the *Application* in pairs. Due to lack of time, the group could not launch the *Application* on App Store, hence the test duo borrowed the group members mobile phones. Accompanied by an observer, the duo tested the *Application* in its natural setting by trying to complete all of the *Applications’* missions during their Universeum visit. The observation was then complemented with a questionnaire to be filled out after the visit.

3.3 Application Development Methods

During the development of the *Application*, agile software development was applied. The *Application* was implemented in small sections. Requirements were added and removed during the process and the design was changed according to these requirements. The *Application* is a prototype and is responsive to change, which is characterised by agile development.

The Scrum methodology was applied during the implementation of the *Application*. A product backlog was created with specified epics, which are greater user stories. The epics were broken down into smaller user stories. The user stories were estimated on a scale of one to ten, where the use cases assigned with ten were the most challenging. The sprints were often one week long, occasionally they were two weeks long due to size of use cases. At the beginning of every sprint, there was a sprint planning meeting, generally on Mondays, to determine what was going to be accomplished during the sprint and the group members were assigned use cases.

At the end of the sprint, a sprint review was held, where all group members described their sprint progress. Depending on the outcome of the sprint review, the sprint backlog was modified, for instance more use cases were added or use cases were divided into even smaller ones.

The implementation was divided into three areas which were backend, frontend, and design.

4

Establishing Requirements

This chapter presents the requirements study which was done in order to establish requirements for the *Application*. To establish requirements, a literature study was done, Universeum's mission was studied and observations were made at the science centre. The results of the requirement study is also presented in this chapter. These results are the final requirements which the *Application* is based upon.

4.1 Literature study

Museums are ideal environments for collaborative activities as collocated settings are ideal for group work [29], [30], [31]. Group work implicates two types of work: task work, which is performed individually and is independent, and team work which is interdependent work. Team work is vital for general group performance and coordinates task work [29], [32], [33]. A good example of group work is collaborative photography which is defined as a group of people taking photos together [34]. According to the study [34] collaborative photography consists of three main steps: assigning photo spots, taking photographs at the assigned spots and reviewing photos. The study also revealed that group interaction support and space awareness are important factors in collaborative photography.

According to the study [35], most museum visitors do not share their experience with people who have not visited the museum. Visitors who share their experience, mainly share emotions verbally and seldom use any material to support storytelling. As mentioned in [35], one reason may be the absence of interaction design for sharing content in a simple and playful manner at museums. By providing visitors with an easy to use interactive tool, a virtual photo book, the study showed that sharing could be significantly enhanced. Playfulness, which has been recognised as an attribute that can positively affect the experience of using a system [36], can additionally encourage users to use the application in different ways [37]. Numerous studies have examined how to add playfulness in non-game applications [38], [39], [40], [41]. The studies have focused on incorporating playfulness through navigation, layout, audiovisual manipulation and achievement systems.

Interactive tools such as Letspic can also improve visitor attendance and increase interest. Another example of such a tool is the multimedia visitor book [42]. In the multimedia visitor book study, visitors who used the tool [42] were more interested and felt more involved in the exhibitions. The multimedia visitor book was even

able to help visitors communicate with each other and escape from a monotonous experience. These ideas will further be explored as requirements are established.

4.2 Universeum

Universeum's mission as an organisation is to be a "public arena for lifelong lessons where children and adults can explore the world through science and technology"[...] [Universeum strives to] "create experiences which empower creativity and innovation, increase knowledge and simulate critical thinking. With science as the foundation and engaging pedagogy Universeum challenges people to enrich their lives and to be an advocate for a more sustainable world" [2].

Universeum, which has aimed to inspire and awaken interest for science and technology in young adults from the beginning, has recently started to focus on transforming people and challenging them to act for a more sustainable future [2]. This transformation will occur through explorations and experimentation and will strengthen creativity and critical thinking in order to challenge visitors to engage for a sustainable world.

During a conversation with Christian Sandberg, a Universeum representative, the importance of exploration and experimentation was emphasised. By experimenting and exploring at the science centre, children could become more interested in science and become inspired to pursue a carrier in science later in life. Sharing experiences is also important for Universeum. When visitors share their experience, they awaken interest and curiosity in other people, explained Christian. This is valuable as Universeum constantly works towards attracting more visitors. The science centre also focuses on creating a dynamic experience that attracts both new and returning visitors.

4.3 Observations

The observations were done by four group members at Universeum during popular visiting hours. The observations were done unobtrusively since the goal was to observe visitors' behaviours in the science centre without interrupting them. Specific questions which can be seen in Appendix H were prepared prior to the session, and the observers gathered information by answering these questions after the session. In addition to answering questions, the observers took notes during the session.

The observation session revealed that the target group used their phones while in Universeum. How much the phones were being used differed from person to person, however, the majority of the target group used their phones only to take photographs. The photographs were mostly taken with the device's own camera application or with Snapchat. All photography was initiated by the photographer and no objects in the science centre directly promoted photography.

The animals at the science centre were photographed the most, but visitors were seen taking photos of themselves as well. For example, parents were seen taking pictures of their children. Photographing animals with a flash was prohibited.

During the session a guided tour for children was also seen. While the tour guide used a learning aid during the tour, no digital learning aids were seen being used. Some complementary digital devices such as screens and games were seen throughout Universeum, however, these devices were not very popular amongst visitors.

4.4 Application Requirements

Based on the literature study, Universeum's mission and observations done at the science centre, requirements were established for the prototypes. These requirements concerned the design and functionality of the *Application*. Since after each design iteration the prototype created was evaluated for further improvement, the requirements were also updated or clarified accordingly in order to improve the prototype. Appendix J and K show the first and second version of the requirements respectively.

The following is a list of the final requirements. Based on these requirements the final prototype was created.

Final Requirements

1. The *Application* should include photography based missions for users to accomplish.
2. Missions should be designed to be done in groups.
3. Each mission must consist of tasks which can be done individually.
4. Tasks should be described clearly and should be rather simple to do.
5. Photography Missions must include most or all sections of Universeum.
6. Once all tasks in a mission are completed, a visualisation which consists of all the pictures taken for the mission should be viewed.
7. All *Application* users must belong to groups.
8. Users should be able to create a group or join a group.
9. Users should be able to easily invite friends to their group at all times.
10. Users should be able to see their group members.
11. Users should be able to leave the group.
12. While completing a mission, users should be able to see who the photographer of a certain picture is.
13. All task and mission pictures should be saved in a gallery.
14. Users should be able to save pictures to their phone at all times.
15. All group members should be able to see all the pictures in the gallery.
16. The *Application* must provide visual feedback for every completed task.
17. The *Application* should have a short startup time.
18. Icons and images used in the application must be relevant.

19. The *Application* must be designed in a way so that missions could be easily adjusted for different environments or occasions.

The photography missions were created to gamify photography or in other words gamify documentation of Universeum visits. To accomplish missions, users would need to take photographs collaboratively. Through these photographs users would document their visit together. The missions were designed to be done in groups to encourage social interaction and group work. As mentioned in Section 4.1, group work must consist of both individual work and team work, thus, to insure group work, missions included tasks for individuals to complete.

Since Universeum focuses on exploration, the missions were designed for all or most sections of the science centre. The visualisation generated after a completed mission served as an achievement system and was added to incorporate playfulness as well as emphasise the gaming aspect. To highlight the social aspect of the *Application*, all users belonged to a group, therefore the ability to create a group, join a group or invite friends to a group was granted.

The pictures taken for the missions were to be saved in real time to a gallery which all group members had access to. This was done so that experiences could be shared quickly within the group. All pictures could be saved to the phone's photo gallery at all times so that users could easily save their memories. Since the *Application* was to be primarily used during a visit to the science centre, it was important that the start-up process did not take a long time so that users could quickly start exploring and photographing. It was also necessary for icons and images to be clear and relevant to avoid confusion.

The requirements established at this phase were implemented during the development process and serve as the foundation of the application.

5

Design Iteration One

The following chapter describes the first iteration of the design process. The complete process consists of two significant design iterations where the design together with the functionality are established. The second design iteration is the result of evaluating and testing the prototype generated in the first design iteration, and it is described in Chapter 6.

5.1 Functionality

An application was to be created based on the requirements established in Section 4.4. An application with such functionality could be designed in various ways therefore brainstorming sessions were held in the start up phase of the project. During these sessions the functionality, design and target group of the application were discussed.

By specifying functional requirements as described in Chapter 4, ideas were developed. With inspiration from already known photography applications such as Instagram, the first prototype was created. The target group was determined to be people between the ages of 19 to 25. To incorporate the gamification aspect, missions were created for the user to perform. Each mission would consist of several sub-tasks.

It was determined that the application should have the functionality to take pictures, either while doing a mission or simply for the sake of taking a picture. The tasks in each mission should be visible and distinctly shown for the user to get an accessible overview. Thereby it also had to be clear which tasks were accomplished and which were not.

All photographs taken would be visible in albums and it should be possible to save the pictures to the local library. To include the social aspect, each album could either be private or shared with other users. The administrator (creator) of the album would be able to remove album members; however, all users should be able to leave an album as well as add another member.

The application would require a login, with an email address and password, in order to identify the different users.

5.2 Sketches and Prototype

The first ideas were sketched on paper and discussed by the group. The paper sketches were further elaborated into digital sketches created in Illustrator, as seen in Appendix A and Figure 5.1. The intention was to create a prototype that appeared familiar to users who use other photography applications. The prototype was thereafter created by using Marvelapp and the digital sketches.

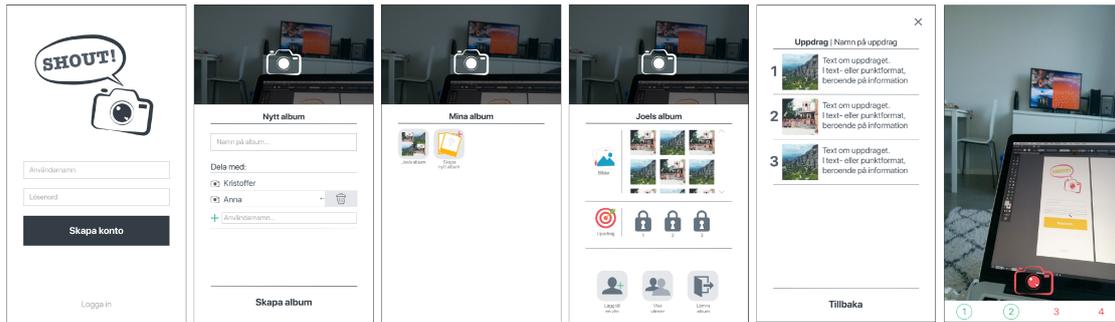


Figure 5.1: The digital sketches created in Adobe Illustrator.

5.3 Testing and Evaluation

The prototype was tested by people in the target age group. The test exposed how difficult and challenging the design was. Remarkably many did not understand that the albums were collaborative. In other words the group aspect was not clear enough. The flow in the prototype was difficult and poorly adapted to the actual usage context, hence the prototype had usability issues. The test participants did not understand the flow of the prototype. Furthermore, they had issues understanding where to click, what each click or swipe would actually result into and how to generally navigate in the prototype.

After evaluating and discussing with the supervisor, additional requirements were set. The design of the application should be reconsidered due to the usability issues exposed in the testing. The application should also have an easier set up and the start up time should be minimised. Museum visitors would presumably not wish to spend too much time setting up a new application to use it when they are already at the museum. The prototype therefore had to be better adapted to the purpose of the application. This resulted in a second design iteration, described in Chapter 6.

6

Design Iteration Two

The results from design iteration one revealed major issues in design and functionality, hence a second design iteration was enforced and is described in this chapter.

6.1 Functionality

The core functionality would largely remain the same with some minor changes. The requirements established for this design iteration can be seen in Appendix K. The first critical task was to minimise the startup and setup time. By not requiring the user to create a login, but instead instantly start using the application, the startup time would be minimised. The second important task was to emphasise the social interaction aspect. Instead of having groups assigned to albums, groups would be created at the start. The groups would be the same for all missions.

6.2 Sketches

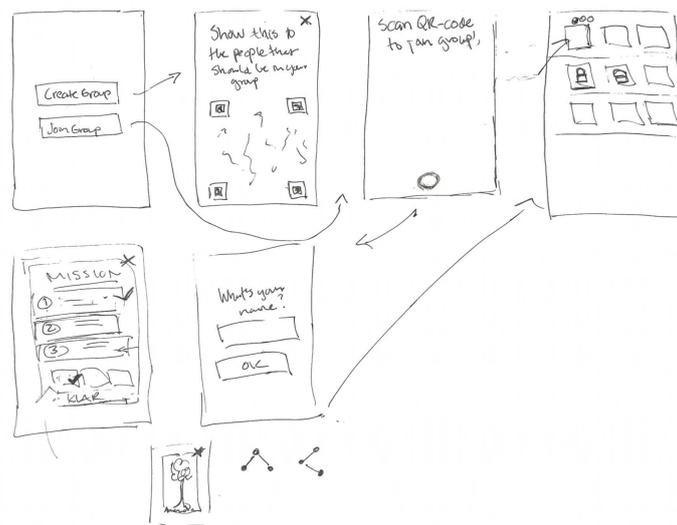


Figure 6.1: The paper sketches of the second prototype.

While sketching the design of the second prototype, seen in Figure 6.1, the target group was discussed. Considering that many school classes visit museums during

school hours, as seen in the observation in Appendix H, the target group was extended to the age span of 9 to 25. The design and flow were thereafter adapted to the new target group, with inspiration from photography applications which the target group uses.

Because of the fact that more than 80% of people under the age of 25 in Sweden use Snapchat [4], the flow in Snapchat was a source of inspiration to the prototype for a more familiar experience, described below. This was because the target group is likely to be familiar with the navigation and flow in Snapchat. However, Snap Inc. states in their Terms of Service that no person under the age of 13 is allowed to use their services, including Snapchat. A minor section of the target group, between ages of 9 and 12, would therefore perhaps not be equally comfortable with the flow in the prototype. For that reason, the prototype and design had to be adapted to the target group in several other ways described in the next section.

The navigation of Snapchat is described in Section 1.1.1. In Figure 1.1 the Camera-, Stories- and Chat view can be seen. The navigation between the Group, Mission and Album view in the *Application* is inspired by the navigation of Snapchat's Camera-, Stories- and Chat view. The *Application* views can be seen in Appendix G. Switching between these views can be done by either *Swiping* or *Tapping* the navigation bar seen in Figure 6.2.



Figure 6.2: Screen shot of the tab bar.

6.3 Prototype and Design Patterns

The change of target group resulted in a more colourful prototype for a more playful experience as seen in Figure 6.3. Detailed views can be seen in Appendix B. The icons, buttons and tasks should be easy to understand and straightforward, for a more intuitive design suiting the entire target group.

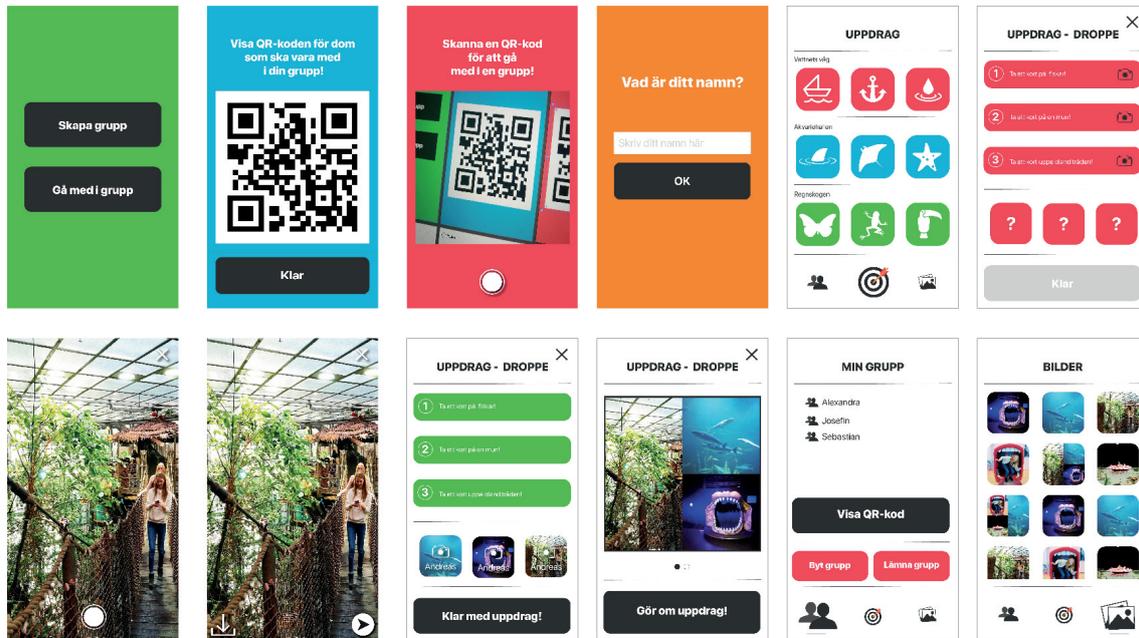


Figure 6.3: The digital sketches based on the sketches in 6.1.

The start up phase was minimised by not requiring a login and simply joining a group by scanning or producing a group-specific QR-code. The first four screens in Figure 6.3 represent the start-up phase and is designed in accordance with the Clear Entry Points pattern [20]. The pattern requires only a few task-oriented and descriptive entry points into the interface. Creating an interface that is easy to use would give the user confidence and immediate gratification.

The missions as well as the photographs and visualisations are presented in a grid on each respective screen. This is referred to as the *design pattern* Grid of Equals [20]. Grid of Equals can be used to distinctly declare that all items in the grid have equal importance. It gives the screen a neat, ordered and calm appearance.

The color scheme was created with inspiration from Universeum’s website for a more unified and playful design. To create an intuitive and well-understood design, the Prominent “Done” Button pattern is used [20]. The pattern was visualised by placing a big and well-labeled button in the end of the visual flow, for example the buttons “Klar”, “Ok” and “Klar med uppdrag!” in Figure 6.3.

In line with Apple’s Human Interface Guidelines, all artwork in the prototype was high-resolution images [43]. Agreeing with the guidelines, the icons were correspond-

ingly designed to achieve simplicity with recognisable illustrations [44]. Furthermore, the round corners of the icons were implemented programmatically as advised by the guidelines.

6.4 Testing of the Marvelapp Prototype

The prototype was thereafter tested at Universeum, as described in Section 3.2.1. The answers to the questionnaire can be found in Appendix D.

The observations and testing exposed some minor usability issues. For example, some participants clicked on the icons with question marks instead of the task icons with numbers and camera icons. Another issue was the group aspect. The participants did not understand that the missions should be performed in groups.

The feedback and results from the testing was taken into consideration when implementing the final version of the prototype. The usability issues regarding which icon to press was solved by making it possible to press both icons for the same action. The final prototype, the *Application*, is described in the next chapter.

7

Final Prototype

The final prototype has almost the same design as explained in Chapter 6. There are only small differences, for instance the order of the first views, some colours and the placing of some buttons. In Figure 7.1 the different views are shown. In Appendix G all views are shown, as well as the navigation. This chapter describes the *Application* and the results of testing the *Application*.

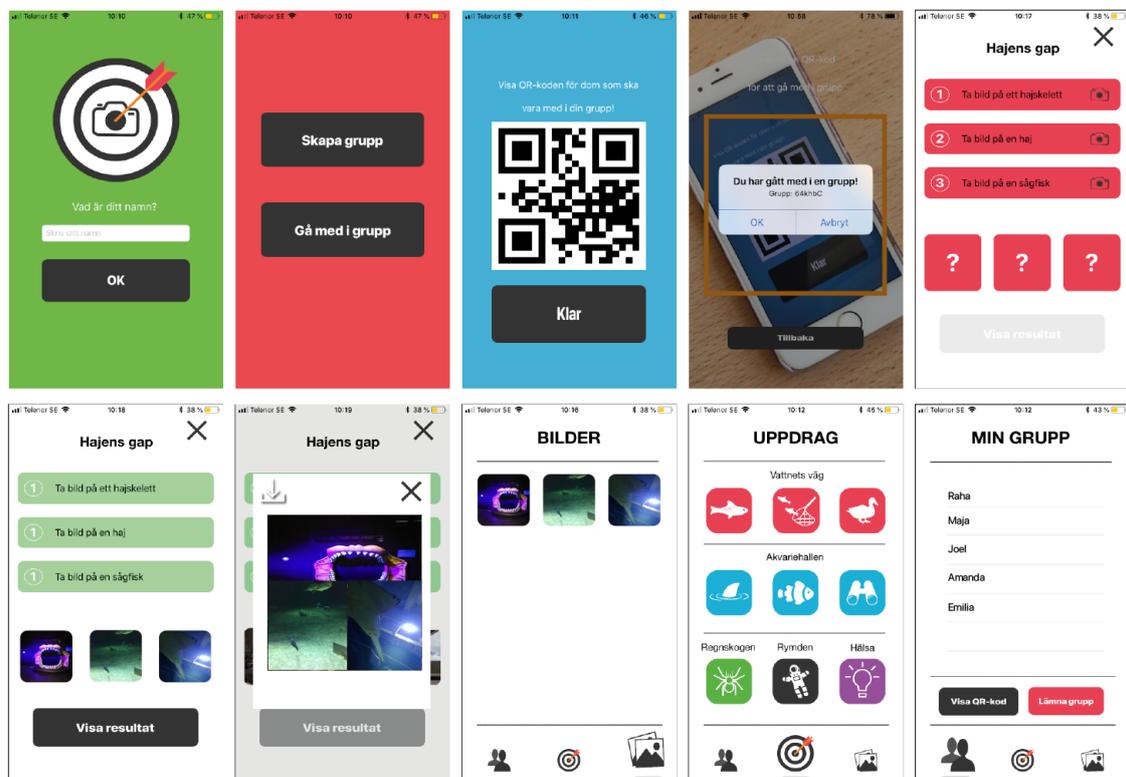


Figure 7.1: Screen shots of the final prototype, the *Application*.

7.1 The Application

The first time the *Application* is opened the user will type their name in the name field and then press the “OK”-button. After pushing the button the user gets a choice, either join a group or create a group. Depending on what alternative the user chooses, they will get different views. If the user wants to create a group, a QR-code will be generated which other users can scan to join that group. This implicates that if the user chooses to join a group, a QR-scanner will show so that the user will be able to scan the QR-code.

After either joining or creating a group the Mission view, seen in Figure G.5, appears. The user can choose to do any of the nine missions, each containing up to three different tasks. When clicking on a mission, a detailed view of that mission will appear. The tasks will be marked with the colour red, indicating that they are not accomplished. When the user presses one of the tasks, the camera view will appear. The user will be able to take a photo and review it. When satisfied with the photo, the button in the bottom right corner is pressed to accept the photo and send it to the mission. The photo will appear in the Detailed Mission view and the task will become green as seen in Figure G.7.

This procedure is repeated for all tasks. When all tasks are accomplished, the tasks will become green and the photos will be placed in the image views. The “Show result”-button will be enabled and get a darker grey colour, to visualise that the button is clickable. When the “Visa Resultat”-button is clicked the visualisation is generated. Depending on how many tasks the mission has, there will either be a collage or a sticker on the photo. The *Application* is gamified through visualisations which reward completed missions. Other gamification aspects are feedback and progress which allow the user to see the progress of the mission with the change of colour from red to green when a task is completed. Another gamification method used is reputation. Since the missions are supposedly performed in a group, a user who completes more tasks acquires a better reputation within the group.

From the Mission view, the user can navigate to the Album view as seen in Figure G.9, and to the Group view shown in Figure G.10. The navigation can be done using the navigation bar at the bottom by *Tapping* the icons, or by *Swiping*. The user can view all the photos taken by the group and all the visualisations generated. The user can also see all the group members, show the QR-code again or leave the group.

The missions are adapted to different parts of Universeum. There is a recommended path the visitors at Universeum can follow and the missions follow that path.

7.2 Testing of the Final Prototype

The final prototype was tested at Universeum, as described in Section 3.2.2. The questionnaire can be found in Appendix E and the answers in Appendix F. In Ap-

pendix I the observations are described.

The questionnaire answers and observations show that the social aspect was clearer compared to the results from testing the Marvelapp-prototype described in Section 6.4. The participants understood they were to perform the missions in groups and helped each other, or interacted with the personnel at Universeum, when there were difficulties; for example when they could not find the specified animal to photograph. The majority of the participants believed that they took more photos with the *Application* than they would have done without it, and there were indications of learning aspects as they for example learned what species a certain fish was.

Overall, the feedback was positive from the participants. One participant expressed there was an aspect of competition when performing the missions. Another participant compared the different missions and tasks with quests in other games, and found them similar. One negative aspect was the fact that some animals at Universeum were difficult to find, and therefore some sub-tasks were time-consuming and difficult to perform. The feedback regarding the graphical user interface was positive. The participants understood how to use the *Application*; where to click and how to proceed.

8

Implementation and Technical Aspects

Part of the project was to implement the final prototype as an application in iOS. This chapter will discuss which platform, programming language and frameworks were used in implementing the *Application*. First the frontend will be discussed to give insight on the views and controllers. The backend will then be discussed in more detail to explain the data structure and nontraditional choices along the way.

8.1 Frontend

The frontend of the *Application* was implemented as a native iOS application with the platform Cocoa Touch using the *IDE* XCode and the programming language Swift. The reason for this was mainly because all members of the thesis group used Apple devices, which simplified development and testing. In the considering of using a cross-platform, it was realised that the most cross-platforms use JavaScript, HTML, and CSS. Even if there was little knowledge in both swift and Javascript it was preferable to learn a new native programming language.

In XCode, Storyboards and View Controllers are used to manage classes and views. A Storyboard in XCode manages many views and the *Application* has two Storyboards: Main Storyboard as seen in Figure 8.1 and Introduction Storyboard as seen in Figure 8.2. A View Controller works as a node between the frontend and the backend of the *Application*.

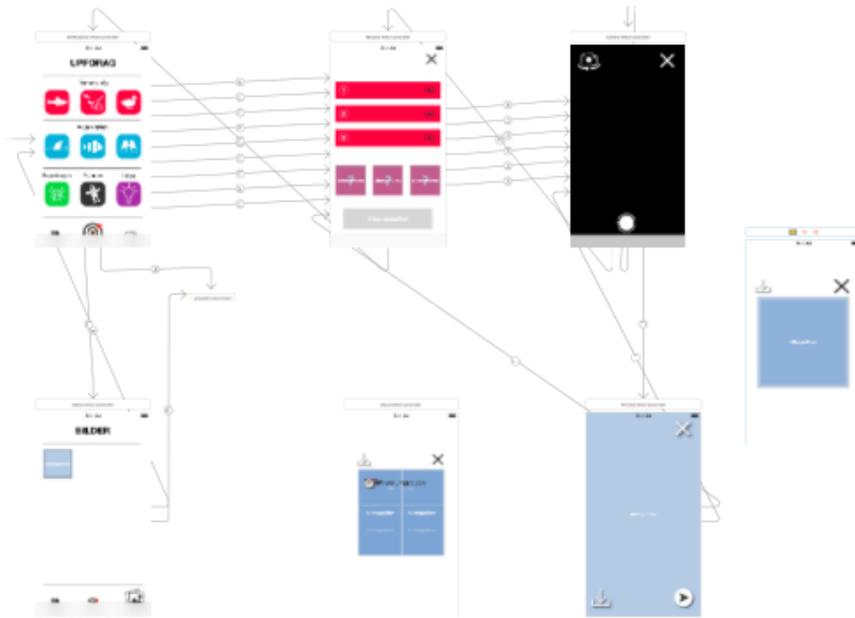


Figure 8.1: The Main Storyboard.

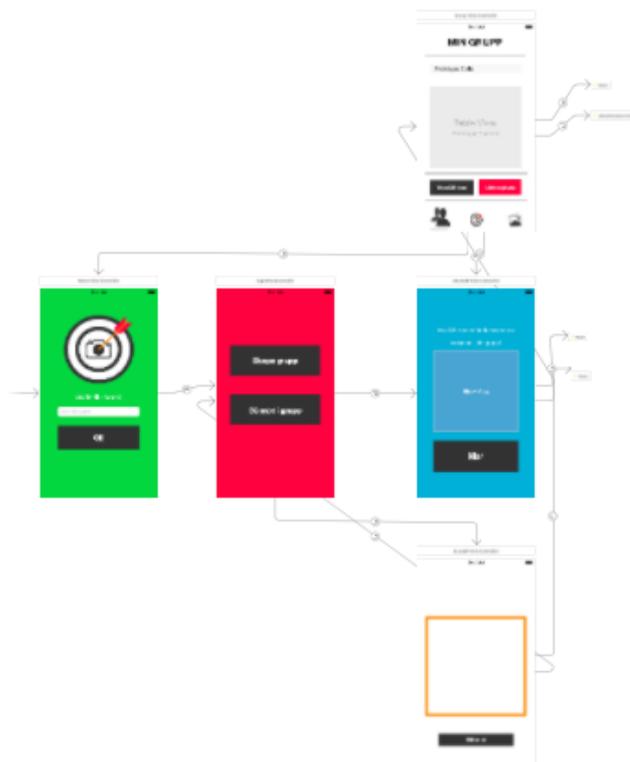


Figure 8.2: The Introduction Storyboard.

8.2 Firebase Backend

Firebase is a mobile and web application development platform which provides developers with tools and frameworks to develop high quality applications in a short amount of time [45] and can be used as a BaaS. Firebase offers various products for application development, testing, user engagement and growth. In this development process, the Realtime Database, Authentication and Cloud Storage from Firebase were used.

8.2.1 Anonymous Authentication

Firebase Authentication enables applications to identify users in order to securely save user data and support the same personalised experience over all of the user's devices [46]. With Firebase Authentication, users can be identified by emails and passwords, phone numbers and through popular federated identity providers such as Google and Facebook. These identification methods all require user information which is gathered either directly from the user or via the identity providers. However, Firebase supports another kind of authentication called Anonymous Authentication, which identifies an anonymous user without any user information or credentials from third party websites.

Anonymous Authentication is traditionally used to enable anonymous users to try an application securely before they create accounts. Since it provides data security without forcing users to create accounts, this authentication method is used as the only method to identify users in the *Application*. By only using Anonymous Authentication the *Application* can identify users without forcing them to create accounts. This supports the *Application's* design and short startup time requirement established in Section 4.4.

8.2.2 Cloud Storage

Firebase Cloud Storage supports storage for user generated content such as photos and videos. The files uploaded to Cloud Storage are stored in the Google Cloud Storage bucket, and are accessible through both Firebase and Google Cloud [47].

All users of the *Application* acquire a folder in the Cloud Storage containing photos they have taken. This folder is created as soon as the user takes their first picture. Each time the user takes a photo, the photo is stored in their folder along with the size of the file, the time and date the photo was taken and information about the storage location. This information is later used to retrieve data.

8.2.3 Realtime Database

The Firebase Realtime Database is a *NoSQL* cloud-hosted database. Data is stored in *JSON* objects and synchronised in real time to every connected client [48]. The

Application uses the Realtime Database to store information such as the user's name, group and references to photos stored in the Cloud Storage. The text description of all missions are also stored in the database. According to the Firebase data structuring guide [49], flat data structures are encouraged as such structures make the process of retrieving data easy and more secure. Following the guidelines, the data is structured as flat as possible, with a three nesting level maximum. In order to create a flat data structure the data was divided into three separate paths: Groups, Posts and Text. The Groups path would include information about all groups created and group members. The Posts path would hold references to photos taken by all users. The Text node would hold all text required for missions. To implement this structure, three first level nodes were created as seen in Figure 8.3.



Figure 8.3: Three first level nodes in the Firebase Realtime database.

The Groups node consists of groups created with the *Application*. The groups are represented by unique string identifiers. Each group consists of group members which are represented by their Firebase *UID*. Group member nodes hold user name information. Figure 8.4 shows the expanded Groups node.

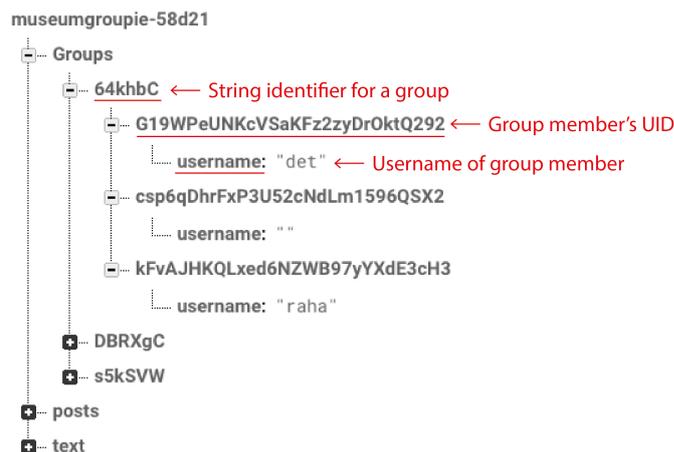


Figure 8.4: Groups node in Firebase Realtime database.

The Posts node consists of users who have taken photos. These users are represented by their *UIDs* as seen in Figure 8.5. Each time a photo is stored in a user's Cloud Storage folder, a reference to that photo is created for the corresponding user *UID* in

Posts, connecting the Cloud Storage to the Realtime database. With this connection, pictures stored in the Cloud Storage can be accessed through the Realtime database.



Figure 8.5: Posts node in Firebase Realtime database.

The Text node has a completely flat structure which can be seen in Figure 8.6. Children of this node are identified by unique IDs which correspond to a specific task or mission title.

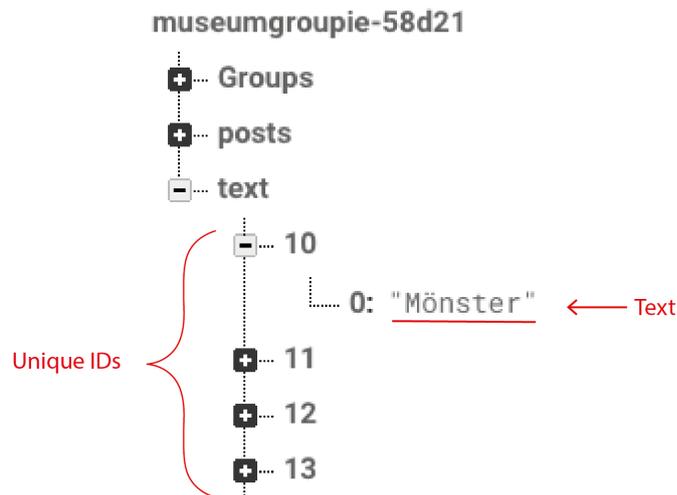


Figure 8.6: Text node in Firebase Realtime database.

9

Discussion

The purpose of this bachelor thesis was to develop an application which encourages documentation through photography at Universeum. Furthermore, the application aimed to support social interaction and enable sharing of the photographs. The report has hereunto shown the process of generating the suitable requirements, design and functionality by using computer based prototypes. The purpose was fulfilled by creating the application described in Chapter 7 which is an application where the users join groups to perform missions together. All missions include sub-tasks with separate photography instructions. The *Application* was tested at Universeum by four people. The outcome of the testing and fulfilment of the task will be discussed in this chapter, together with observed limitations and possible future work.

9.1 Task Fulfilment

The task as defined in Section 1.3 included three sub-tasks: applying group work to encourage social interactions, enabling sharing of photos within the group and applying gamification methods to motivate photography. In this section, the fulfilment of each sub-task is discussed.

9.1.1 Group Work and Social Interaction

The observations from the final test sessions revealed strong indications of group work within participants. Group work, which as defined in Section 4.1 consists of both task work and team work, was seen between participants. This is evidenced by the fact that pictures were taken individually but at the same time, participants worked together as a team to find the photography subjects to accomplish missions. Signs of collaborative photography were also seen since participants followed the three main steps of collaborative photography defined in Section 4.1. These signs are further indications of group work since collaborative photography is considered as group work.

According to the observations and the questionnaire seen in Appendix I and Appendix E, the *Application* promoted social interactions. Group members interacted with one another to accomplish missions as predicted. In addition to the predicted group interaction, observations revealed signs of social interactions between group members and Universeum employees which were not predicted.

This observation was not too surprising because it is natural for participants to ask questions regarding the whereabouts and appearance of photography subjects and serves as further validation for the *Application*'s ability to promote social interactions.

To accomplish all missions, participants explored all sections of Universeum together. The observations showed that while some groups explored the science centre using the *Application* in a way which it did not interfere but complemented their exploration, others completely focused on achieving the missions, paying very little attention to the science centre otherwise. The credibility of these results can be questioned since the participants were at the science centre with the intent to test the *Application*, and therefore may have naturally just focused on completing their task. However, these results raise an important concern, which is whether the *Application* could draw too much focus to itself. As mentioned in Section 4.2, Universeum works towards providing an environment where visitors can explore and experiment. An application which engages users to a point where attention is mainly focused on a screen rather than the science centre, would therefore conflict directly with Universeum's mission as an organisation. It is therefore vital to think about the amount of engagement such an application may acquire before implementing it in its intended context. This finding is inline with the previous findings of Rowland et al presented in Section 1.1.3.

9.1.2 Motivating Photography Through Gamification

As pointed out in Section 2.3, reputation moves users by both intrinsic and extrinsic motivations when combined with learning. Reputation is used in the *Application* since the missions are done within the group and group members increase their reputation by completing tasks and missions. The visualisations are unlocked when a mission is accomplished. This rewards the entire group and gives every group member better reputation. As mentioned in Section 7.2, the testing at Universeum showed that the participants learned what species a certain fish was. This, however, is not a strong indication of learning. If possible future testing of the *Application* reveals stronger indications of learning, there is reason to believe that the users will be motivated, not only extrinsically but intrinsically, to use the *Application*.

Participants of testing sessions expressed their belief that they took more photos with the *Application* than they would have done without it as described in Section 7.2. However, due to few test participants, no conclusions could be drawn regarding if and how much the *Application* motivates users to taking photographs. The fact that the *Application* is guiding users into what objects to photograph was appreciated, mostly due to its "quest like nature, like in a game" as seen in Appendix F expressed by one of the participants. This indicates that the gamification of the *Application* is at least perceived by the users.

9.1.3 Sharing Photographs

As pointed out in Section 1.1.3; when Instagram is being used in the museum context, it is often in order to share the experience and encourage the audience to visit the museum for themselves. As previously mentioned, photos shared on Instagram are not necessarily taken with Instagram's camera. They can be taken with the device's own camera application, or a collaborative application like the one developed in this thesis.

When asking the participants whether they would share the photos taken with the *Application* on social media, they were hesitant and it depended on the likeability and uniqueness of the photo. As indicated by previous studies [9], [10] mentioned in Section 1.1.3, people enjoy showing their personality through photos. Therefore allowing room for creativity within photos may increase the likeability, which can be an important motivator for sharing pictures on social media, such as Instagram. It is thereby important to allow room for creativity within the predefined missions created in the *Application*.



Figure 9.1: Alternative photo from the bird-watching mission. Instead of simply taking a picture of the bird in the task, the test participant used a monocular present at Universeum to find the bird shot the picture through the monocular lens.

The testing showed participants interpreting the tasks differently, taking different photos of the same subject. As seen in Figure 9.1, one participant was creative within the bird-watching mission, using the monocular to photograph the bird. Another interesting find was when participants tried to build a bird using interactive tools present at Universeum, and photograph this bird instead of the real one. The room for interpretation of tasks were not intentional in the design, but could be a way to stimulate creativity. However, due to limited test participants, no conclusion could be drawn regarding whether the missions in the *Application* allowed for creativity sufficiently.

9.2 Limitations

The *Application* is a prototype and not a finished product, which means there are some limitations and weaknesses regarding its functionality. For example there are several bugs, but the two extensive ones are that there is a delay while the taken

photo shows up and that the *Application* crashes due to memory issues. The delay depends on that the photos are retrieved from the database. Approximately three to four missions can be performed before the *Application* crashes due to memory issues.

Additionally, the connection between the database and the front-end is not flawless. There are issues in the way that the database methods are called from in the front-end, which causes problems. Another issue is that the code has not the ultimate structure, which may cause problems in understanding the code and how the different parts of the *Application* are connected.

Another weakness lies in the presentation of the visualisations. When a mission contains two or three tasks the visualisation is a collage. The images in the collage do not get cropped but instead, they expand to match the view where it is placed and thereby get the wrong dimensions.

In addition to the previously mentioned limitations, the limitation of time is significant for this project. The process of developing the design and determining the functionality is a considerable part of the project. Both prototypes were tested and evaluated, which resulted in a well adapted design for the target group, but was by that also time-consuming. Thereby, there was an insufficient amount of time remaining for implementing the *Application*. All group members were unacquainted with the language Swift and Firebase, and therefore had to learn and do research before implementation. Because of the time limitations, there were a few remaining use cases left in the product backlog and the *Application* was not submitted to App Store.

Further limitations involve the testing of the *Application*. It was difficult to find participants who were willing to take part in the testing because the testing had to be performed at Universeum. Additionally, the testing took approximately one hour for each participant, which was far too much time for several of the approached people. Because the *Application* was not submitted to App Store, it was only available through the four phones which the group possessed. Thereby, only four participants could test the *Application* simultaneously.

9.3 Data Uncertainty

Although all prototypes created were tested by the intended target group, a rigorous testing process was not conducted. This was due to limitations mentioned in Section 9.2. Since the testing process was not rigorous the observations and results from the test sessions must be interpreted with caution. It is important to acknowledge that all findings are based on a highly limited number of test participants. It is also important to note that all participants who took part in the final prototype's test session had the same background, were approximately the same age and personally knew some of the thesis group members. Therefore even though participants were asked to give honest answers to the questions asked, the reliability of these answers are uncertain and confirmation bias is likely. Thus it is important to further test

the *Application* with more test participants and test cases before it can be actually used at Universeum.

9.4 Future Work

Since the *Application* is a prototype, it can be further developed regarding both technical- and conceptual aspects.

The *Application* was adapted to Universeum, but could be modified to suit other museums by adjusting the missions according to its exhibitions. Some museums have guided tours, to which the missions could be adapted to. The *Application* was not developed to be used in the context of guided tours, and possible incorporation was left for future work.

Additionally, the missions can be further improved. As discussed in Section 9.1.3, it is important to design the missions with the intention to allow room for creativity. An investigation could be done on how to create creative missions with learning aspects. This should be done by working closely with the museum of interest. Regarding learning aspects, the results from the testing at Universeum, seen in Appendix F, showed that the participants for example learned what species a certain fish was. This might imply that the *Application* can be used for learning, if the missions are adapted accordingly. An alternative to adapting the tasks in each mission for a better learning experience could be adding information with the visualisations. The information could for example be connected to the specific mission and thereby give information directly in the *Application*.

There are improvements that can be made regarding the implementation of the *Application*. For example, a mission can only be done once. This could be modified so that missions can be done several times, if desired. Another area of improvement is image recognition. At this point, the *Application* is not able to determine whether the photos taken actually fulfil the specified task. This could be achieved by using image recognition. If the picture taken did not fulfil the task, a pop-up dialogue asking to redo the task could be shown.

The *Application* is an iOS application and can only be used on iPhones. In the future, the *Application* could be implemented for Android as well or a cross-platform can be used to implement for several platforms. The *Application* is only designed for iPhone 6,7 and 8. On older iPhones, that have a smaller screen, the design will not be compatible with that screen size. Future work could include a design supporting all screen sizes.

The prototype was tested on the target group regarding the design before its implementation. The design has therefore been evaluated and improved. The functionality was not tested before the implementation and has therefore not been evaluated as thorough as the design. An evaluation and test session concentrating on functionality could therefore be conducted in order to investigate the functionality.

10

Conclusion

The *Application* developed is a collaborative tool which by using gamification methods may encourage photography at Universeum. In order to develop the *Application*, requirements were established based on the literature study, Universeum's mission and observations at the science centre. Two prototypes were designed, tested and evaluated before implementing the iOS *Application*.

The task was to develop an application that supported group work, motivated photography using gamification methods and enabled sharing pictures taken within the group. The data collected from the test sessions suggests that the *Application* supports group work as defined in Section 4.1, and sharing photos within the group is made possible through the shared group album where all photos taken by group members are saved in real time. The current study was limited by few test participants. Thus, no definite conclusion can be made about whether the *Application* motivates taking photos. Nevertheless, test results showed that the majority of the participants took more photos with the *Application*.

The thesis revealed that the concept of predefined missions comes with challenges. Balancing the attention required by the *Application*, the likeability of the photos taken and creativity were proved to be significantly important factors. In conclusion missions should thereby be created with consideration to these factors. The findings of this thesis add to a growing body of literature on how interactive tools can shape museum visits of the future.

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A

The First Prototype

The sketches of all produced views in the first prototype as well as its elemental navigation are presented in this appendix.

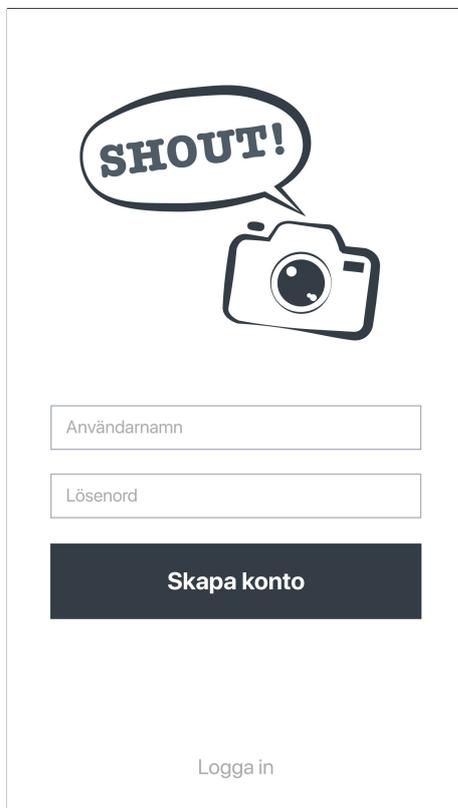


Figure A.1: The sketch of the start screen, where the user signs up or logs in.

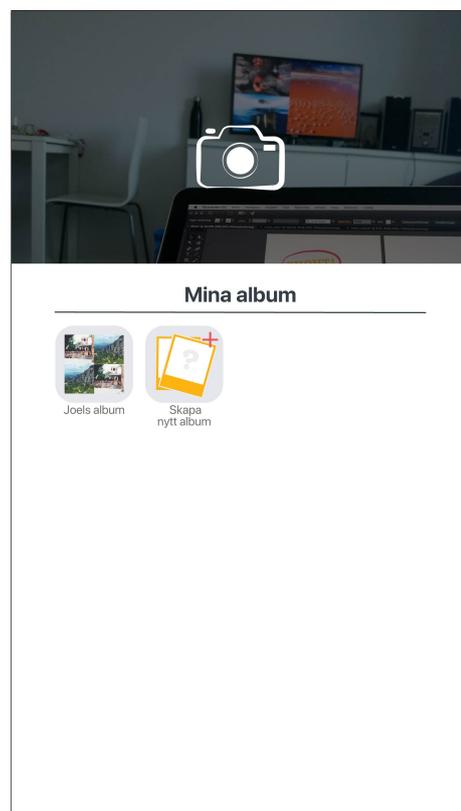


Figure A.2: The sketch of the album view, displaying all existing albums as well as the possibility to create a new album and access the camera.

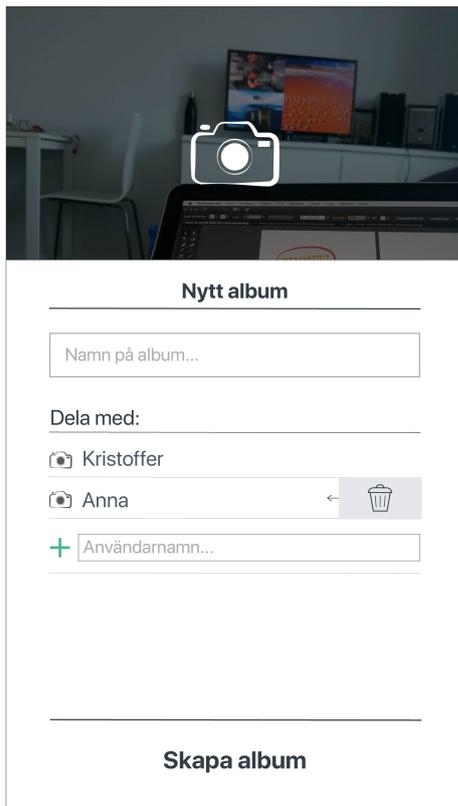


Figure A.3: The sketch of the view where the user sets a name for the new album, as well as adding other users to the album and access the camera.

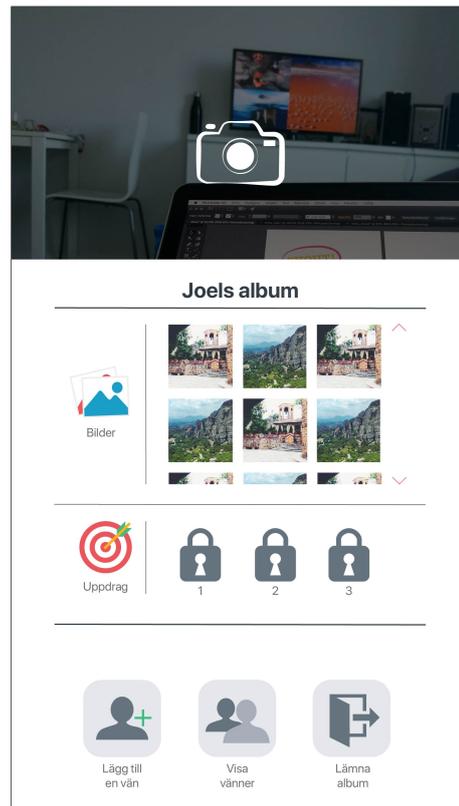


Figure A.4: The sketch of one specific album presenting all pictures and missions. It also displays the opportunity to access the camera, add users, show users and leave album.

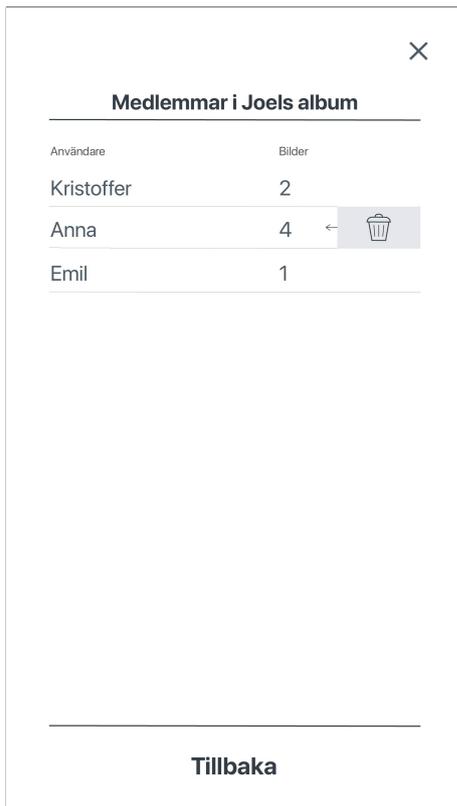


Figure A.5: The sketch of the view where the user can see all members of one album. If the user is the administrator of the album, he or she also has the opportunity to remove users from the album.

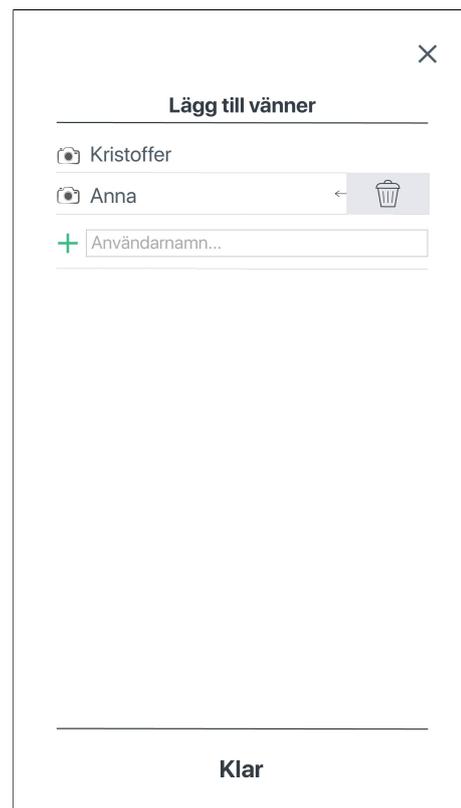


Figure A.6: The sketch of the view where the user can add other users to the album. The opportunity to remove users is also displayed if the user is the administrator of the album.



Figure A.7: The sketch of the view where all tasks of the chosen mission are displayed.

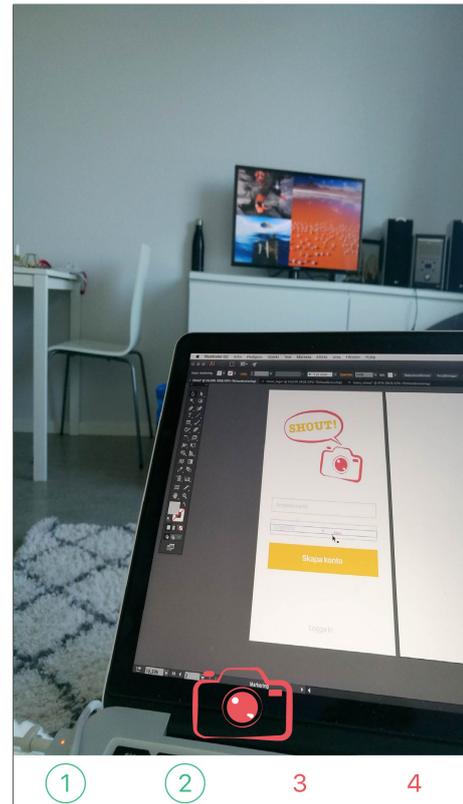


Figure A.8: The sketch of the camera view, where the user can take pictures. The progress of the mission is also visible in the bottom bar where accomplished tasks turn green.

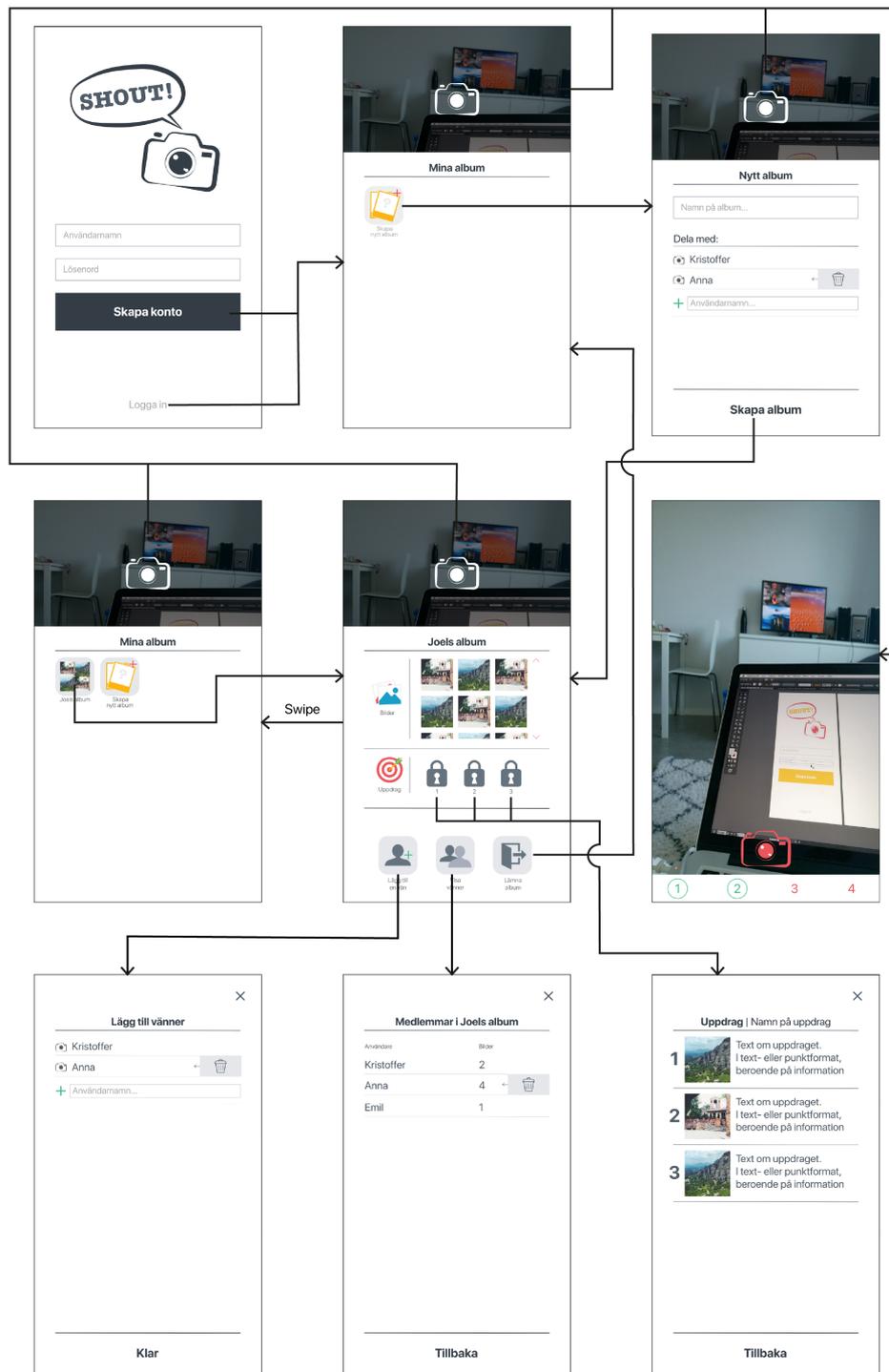


Figure A.9: The sketch of the navigation of the first prototype. All the views including the symbol “x”, return to the previous view when the symbol is pressed. The buttons “Klar” and “Tillbaka” respond similarly.

B

The Second Prototype

The sketches of all produced views in the second prototype as well as its navigation is presented in this appendix.



Figure B.1: The sketch of the start screen, where the user either creates a new group or joins an already existing group.



Figure B.2: The sketch of the view that displays a QR-code for other users to scan to join the new group.



Figure B.3: The sketch of the view where the user scans a QR-code to join a group.

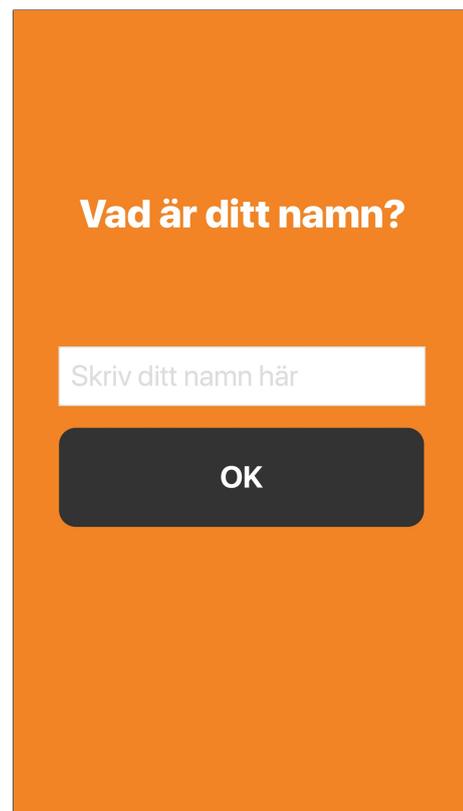


Figure B.4: The sketch of the view where the user enters their name.

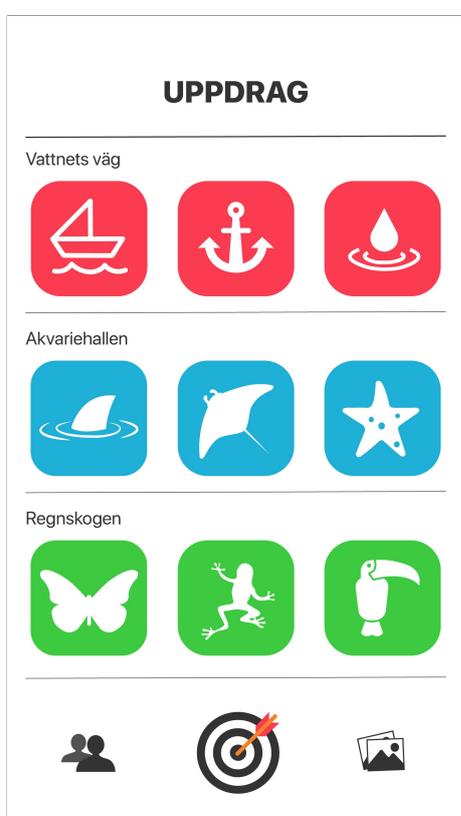


Figure B.5: The sketch of the view which displays all missions.



Figure B.6: The sketch of the view where the detailed tasks of one specific mission are displayed. In this sketch neither of the missions are accomplished.



Figure B.7: The sketch of the view where the detailed tasks of one specific mission are displayed. In this sketch the first and third mission are accomplished.

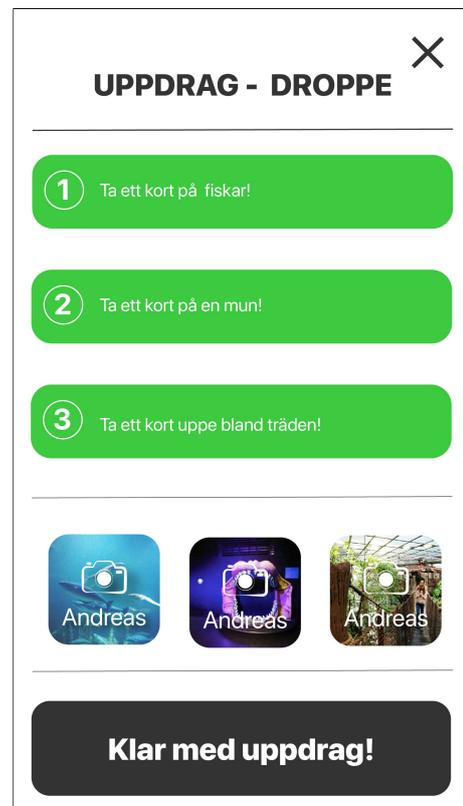


Figure B.8: The sketch of the view which displays that all missions are accomplished.



Figure B.9: The sketch of the view, which is the camera, where the user can take photographs.



Figure B.10: The sketch of the view where the user previews the recently photographed picture. The opportunity to download the picture is also displayed.

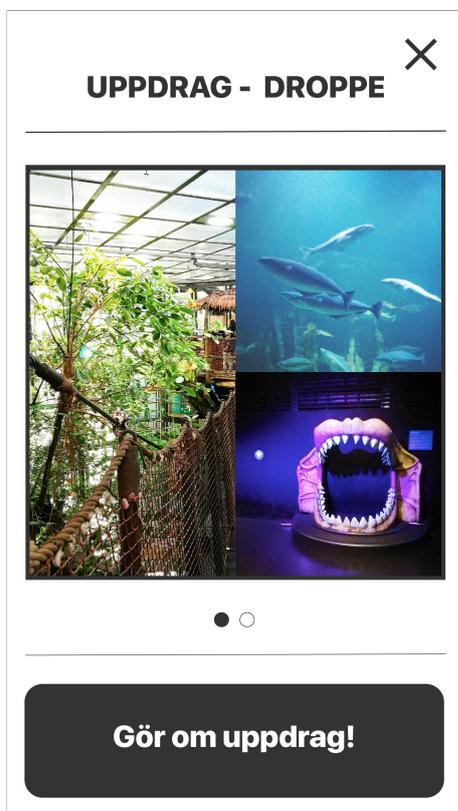


Figure B.11: The sketch of the view where the result of the mission, visualisation, is presented.

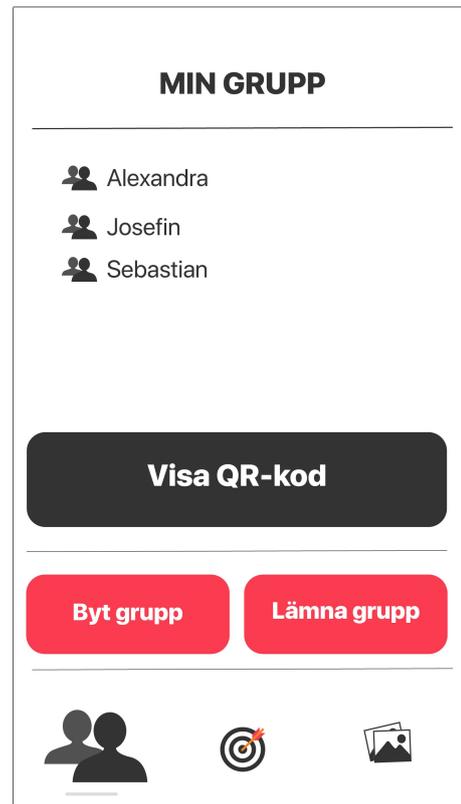


Figure B.12: The sketch of the view where the user can see group members and settings. The settings include the opportunity to leave the group, change group or display the group specific QR-code.

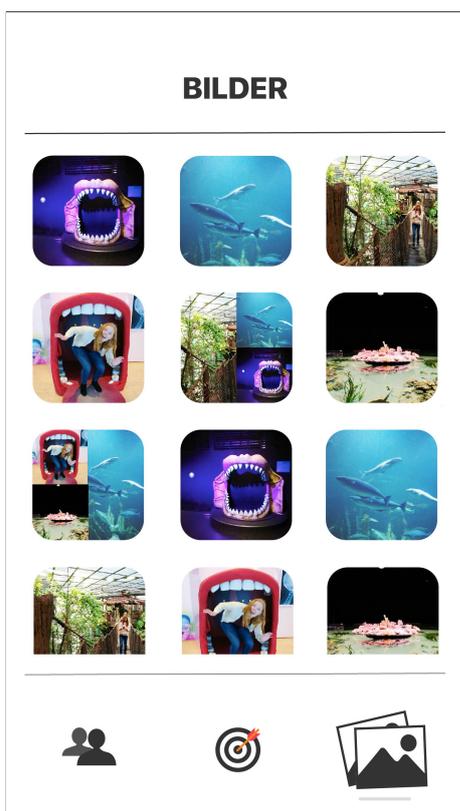


Figure B.13: The sketch of the view which displays all photographs and visualisations created by the group.



Figure B.14: The sketch of the view where the user can preview the photographs in the album.

C

Questionnaire from the First Testing at Universeum

The questions from the first testing is presented in this appendix. The testing was held in Swedish, therefore the questionnaire is written in Swedish. Q1-Q7 represent all questions and A1-A7 represent the answers.

Q1: Var det lätt att hitta till uppdraget?

A1: Ja | Nej | Varför?

Q2: Jag förstod hur man skulle göra för att ta en bild.

A2: Inte alls | Efter ganska länge | Efter ett litet tag | Ganska snabbt | Direkt

Q3: Jag förstod när uppdraget var färdigt.

A3: Ja | Nej | Varför?

Q4: Jag hittade till Bilder-sidan och Grupp-sidan.

A4: Inte alls | Efter ganska länge | Efter ett litet tag | Ganska snabbt | Direkt

Q5: Kan man göra uppdragen tillsammans med andra i gruppen?

A5: Ja | Nej | Vet inte

Q6: Jag tyckte att ikoner och symboler i appen var...

A6: Mindre tydliga | Tillräckligt tydliga | Tydliga | Väldigt Tydliga

Q7: Jag tyckte att appen var lätt att använda.

A7: Inte alls | Sådär | Lätt | Väldigt lätt

D

Answers to First Testing at Universeum

This appendix presents the result of testing the digital prototype at Universeum. Nine children and teenagers tested the application. Q1-Q7 represent the questions from the questionnaire seen in Appendix C. The questionnaire was written in Swedish, therefore the answers are written in Swedish. The answers are presented in bar charts for clarification.

Q1: Var det lätt att hitta uppdraget?



Figure D.1: Diagram of the answers of question 1 in the questionnaire.

Q2: Jag förstod hur man skulle göra för att ta en bild.



Figure D.2: Diagram of the answers of question 2 in the questionnaire.

Q3: Jag förstod när uppdraget var färdigt.

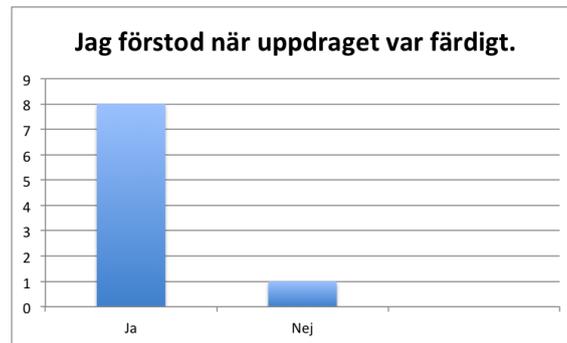


Figure D.3: Diagram of the answers of question 3 in the questionnaire.

Q4: Jag hittade till Bilder-sidan och Grupp-sidan.



Figure D.4: Diagram of the answers of question 4 in the questionnaire.

Q5: Kan man göra uppdragen tillsammans med andra i gruppen?



Figure D.5: Diagram of the answers of question 5 in the questionnaire.

Q6: Jag tyckte ikoner och symboler i appen var...



Figure D.6: Diagram of the answers of question 6 in the questionnaire.

Q7: Jag tyckte appen var lätt att använda.



Figure D.7: Diagram of the answers of question 7 in the questionnaire.

E

Questionnaire from the Second Testing at Universeum

The questions from the second testing session are presented in this appendix. The testing session was held in Swedish, therefore the questionnaire is written in Swedish. Q stands for question and A stands for answering alternatives. In the form, there was a chance to write a comment after each specific question.

Q1: Var det tydligt att uppdragen gjordes i grupp?

A1: Ja | Nej | Kanske

Q2: Vad pratade ni om när ni testade applikationen?

A2: Uppdragen | Universeum | Annat

Q3: Hade ni delat bilderna på andra sociala medier?

A3.1: Ja | Nej | Kanske

A3.2: Varför/varför inte?

Q4: Hade ni visat bilderna för andra personer, exempelvis vänner?

A4.1: Ja | Nej | Kanske

A4.2: Varför/varför inte?

Q5: Vad tycker ni om att det var specifika saker man skulle fotografera?

A5: Bra | Mindre bra | Okej | Dåligt

Q6: Hade det varit bättre att få välja själv vad man skulle fotografera?

A6: Ja | Nej | Ingen skillnad | Vet inte

Q7: Tog ni fler bilder med applikationen än ni hade gjort utan den?

A7: Ja, fler bilder | Nej, färre bilder | Samma antal bilder | Vet inte

Q8: Jag förstod lätt var någonstans jag skulle klicka för att göra nästa steg.

A8: (Inte alls) 1 2 3 4 5 (Direkt)

Q9: Vilket mönster har en Abborre?

Q10: Har ni lärt er något annat?

F

Answers to the Second Questionnaire at Universeum

The answers from the questionnaire presented in Appendix E is presented in this appendix. The questionnaire was written in Swedish, therefore the answers are written in Swedish. Q1-Q10 represent the questions and T1-T4 represent the four different testers and what they answered.

Q1: Var det tydligt att uppdragen gjordes i grupp?

T1: Ja. Efter första bilden tagits, men var lite oklart om båda var tvungna att fota samma sak först.

T2: Ja. Var inte helt säker i början, men efter en uppgift var det tydligt.

T3: Ja.

T4: Ja. Ibland tog det lite tid att synka så bilder tagna av partnern dök inte alltid upp direkt, enstaka fall dök den inte upp alls vilket löstes genom att göra om gruppen.

Q2: Vad pratade ni om när ni testade applikationen?

T1: Uppdragen. Vi försökte lista ut vart alla grejerna fanns! Man blev lite tävlingsinriktad typ att man ville bli klart med allt.

T2: Uppdragen. Uppdragen, "var ska vi gå för att hitta den här..."

T3: Uppdragen. Typ vad kan det vara, vart ska vi härnäst.

T4: Annat. Båda ovanstående typ.

Q3: Hade ni delat bilderna på andra sociala medier? Varför/varför inte?

T1: Kanske. Hade det varit något extra gulligt så hade jag nog gjort det.

T2: Nej. Brukar inte dela bilder på sociala medier.

T3: Nej. Känns lite skumt.

T4: Kanske. Om man hade fått till en najs bild på något så hade den kanske kunnat hamna på snapchat.

Q4: Hade ni visat bilderna för andra personer, exempelvis vänner?

T1: Ja. Kul att visa bilderna om man ska berätta om det.

T2: Ja. Kul att visa bilder på coola djur.

T3: Kanske. Visa bilder på djuren typ.

T4: Kanske. Ah beror väl på om man får till en najs bild.

Q5: Vad tycker ni om att det var specifika saker man skulle fotografera?

T1: Bra. Det är ju bra för då tvingas man faktiskt leta lite också (så man inte bara fotar random fågel och går vidare). Dock lite svårt om just de specifika grejerna inte finns.

T2: Bra. Bra för det mesta, men när det tog tid att hitta saken var det mindre bra.

T3: Bra. Roligare att hitta djur än i rymden och hälsan (känns lite onödigt).

T4: Bra. Gillade känslan av att det var typ som quest i olika spel.

Q6: Hade det varit bättre att få välja själv vad man skulle fotografera?

T1: Vet inte. Oklart, hänger ihop med svaret ovan. Ska man få välja helt själv måste man vara väldigt engagerad. Tror t.ex små barn inte hade utnyttjat det på önskvärt sätt.

T2: Nej.

T3: Nej.

T4: Nej. Nä då hade man säkert fuskat.

Q7: Tog ni fler bilder med applikationen än ni hade gjort utan den?

T1: Nej, färre bilder. Nu tog jag bara de bilderna som behövdes. Hade jag gått på egen hand hade jag nog tagit fler bilder med min telefon (men då inte med fokus på särskilda arter). Å andra sidan fick jag ta bilder på sånt jag normalt

sett inte tagit bilder på (t.ex spindlar..).

T2: Ja, fler bilder. Ganska lätt att ta egna bilder samtidigt.

T3: Ja, fler bilder. Hade inte tagit bilder annars.

T4: Ja, fler bilder. Aa absolut hade förmodligen inte tagit bilder alls annars.

Q8: Jag förstod lätt var någonstans jag skulle klicka för att göra nästa steg.

T1: 5. Kanske partisk eftersom jag testat tidigare.

T2: 4. Lite osäker i början men det blev bättre. Lite otydligt hur man skulle gå tillbaka efter man hade bjudit in till gruppen.

T3: 5.

T4: 5. Aa bra gui.

Q9: Vilket mönster har en Abborre?

T1: Randig.

T2: Fina ränder.

T3: Randigt.

T4: Randig.

Q10: Har ni lärt er något annat?

T1: Att Doris är en kirurg..fisk?.

T2: Lite vad fåglar har för namn osv.

T3: Väldigt mycket ändå.

T4: Att doris är en kirurg.

G

The Final Prototype

All views from the final prototype described in Chapter 7 is presented in this appendix.

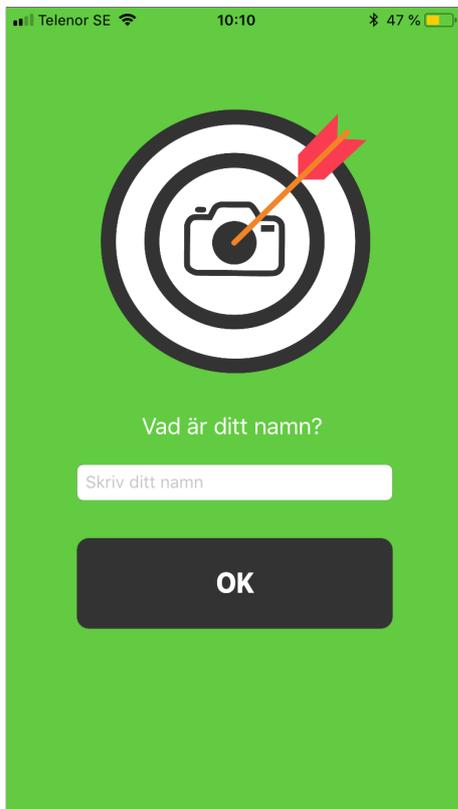


Figure G.1: The Start View. The Start View is the first view in the *Application*, where the user writes their name.



Figure G.2: The Join Group View. The Join Group View is the second view in the *Application*, where the user can create or join a group.



Figure G.3: The Scan QR View. The Scan QR View is the view where the user can scan a QR-code presented in the Show QR View to join a group.



Figure G.4: The Show QR View. The Show QR View is the view where the user can show the group specific QR-code.

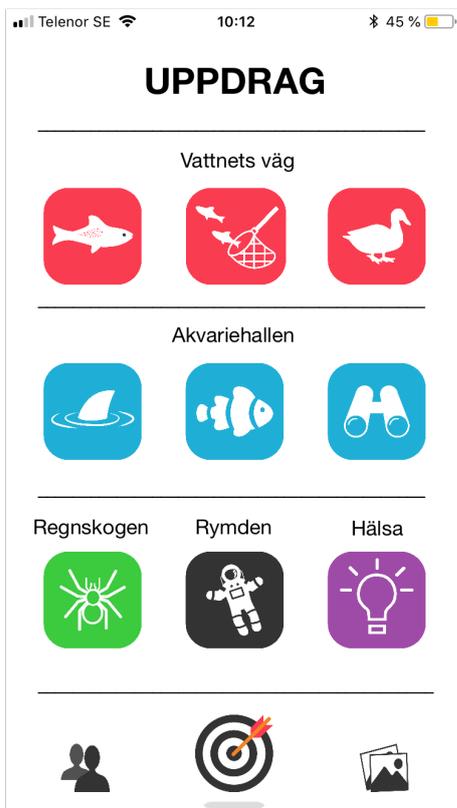


Figure G.5: The Mission View. The Mission view is the view displaying all missions.



Figure G.6: The Detailed Mission View. The Detailed Mission View is the view presenting the sub-tasks of one mission.



Figure G.7: The Detailed Mission View. The Detailed Mission View presenting the sub-tasks of one mission. In this figure all sub-tasks are completed.



Figure G.8: The Visualisation View. The Visualisation View presents the result, visualisation, of the mission.

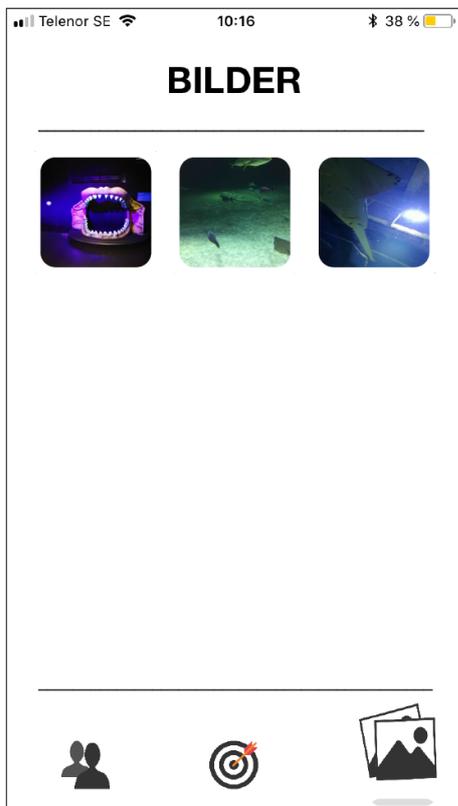


Figure G.9: The Album View. The Album View is the view displaying all photographs the group members have taken.

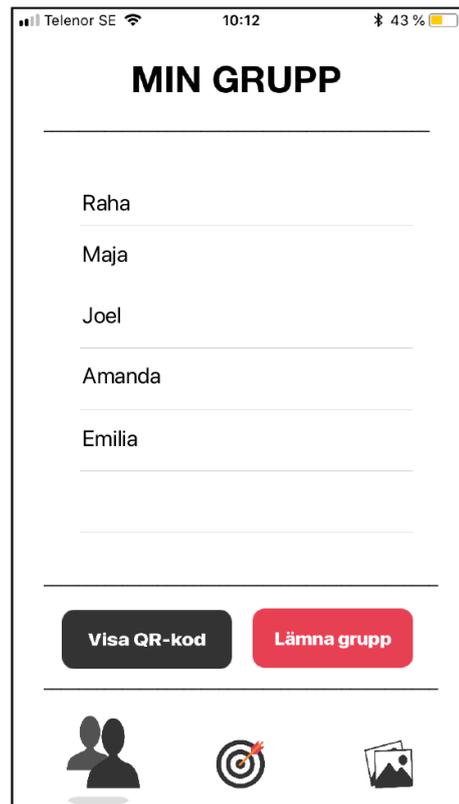


Figure G.10: The Group View. The Group View is the view showing the members of the group, giving the user a chance to leave the group or show the QR-code again.

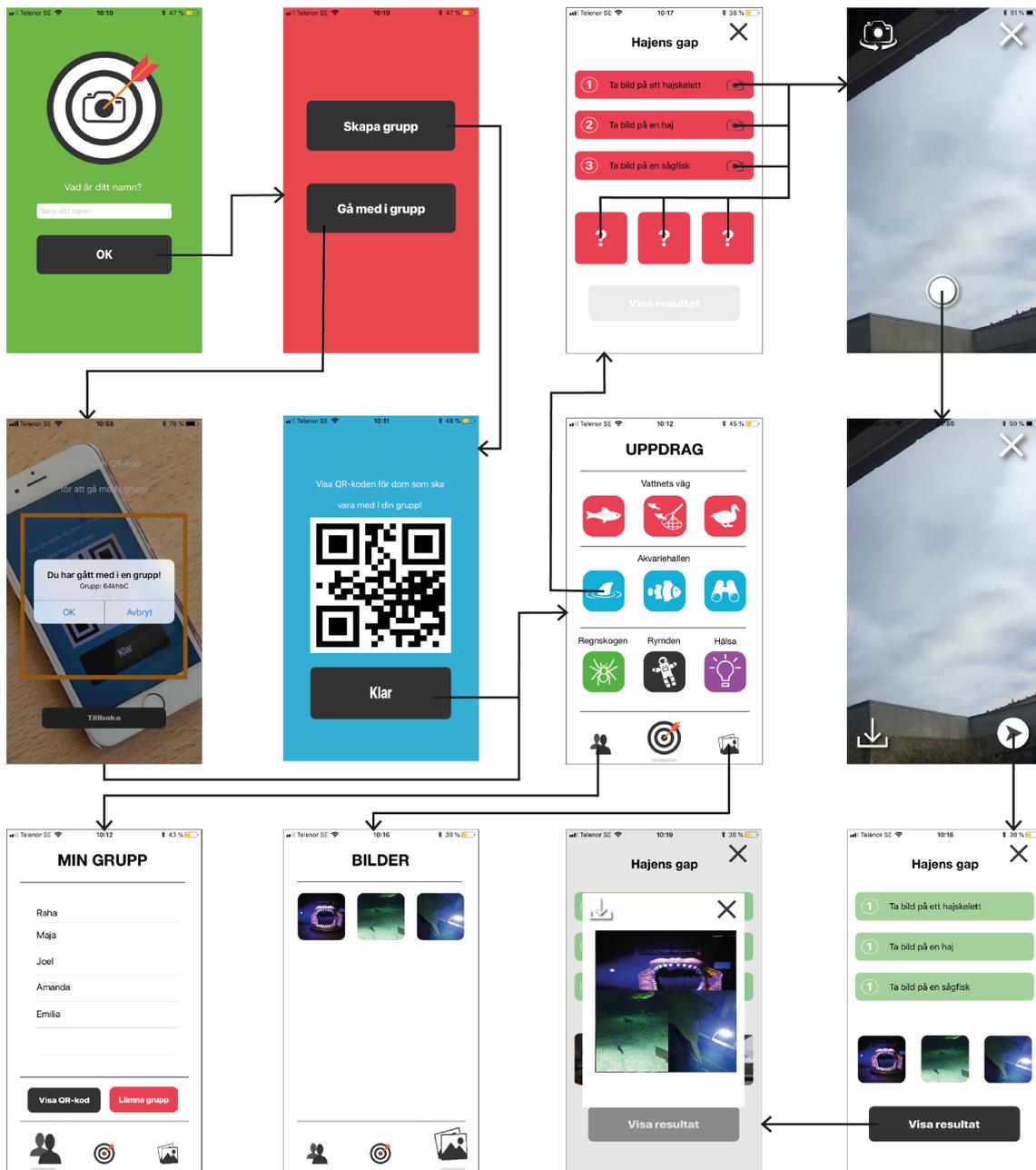


Figure G.11: The navigation of the *Application*. All the views including the symbol “x”, return to the previous view when the symbol is pressed.

H

Observations from Universeum

Observations made while visiting Universeum the first time is presented in this appendix. The observations was made by members of the thesis group.

Where are the most children? Which sections of Universeum?

All over the museum, they want to see everything. Fewest people at “Vattnets väg”.

How many of the children are approximately in our target group?

About 75% of the children. Two school classes, and some children visiting with their grandparents.

What are they doing at Universeum?

They are visiting with their school or grandparents. They listen to guides, take pictures or just walk around exploring the museum.

Are they using their phones?

Approximately 50% of the children use their phone around the aquarium, taking pictures of the sharks. Some children used their phones all the time, just waiting for an object to photograph.

How are they using their phones?

They take photographs. Some children pick up their phone when finding an object to photograph, others have their phone in their hand continuously. They use Snapchat and the standard camera application.

If they are taking pictures, what are they taking pictures of?

The animals (sharks, birds etc) and each other. Parents photographed their children.

Are there any digital devices in the museum?

Screens with games. Devices with buttons that play for example animal sounds when pressed.

How are the digital devices used?

The screens with games are used, but not the other devices.

Are there any tours for the children?

One class participated in a guided tour.

Do tour guides use specific devices?

Microphone with a speaker. Learning aids related to the topic.

Is there any other device that promotes taking pictures in the museum?

Not any digital devices, but props as seen in figure H.1 and H.2.



Figure H.1: Prop at Universeum.

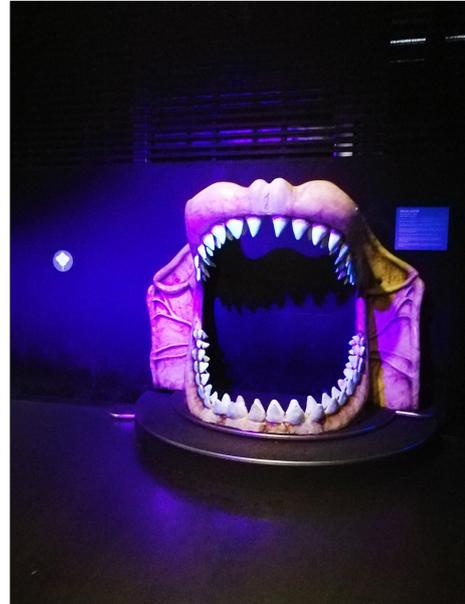


Figure H.2: Prop at Universeum.

Other observations

Taking pictures of the animals using flash was prohibited. Almost all children had phones, mostly iPhones.

I

Observations from Testing the Application at Universeum

This appendix presents the observations which were made during the testing of the *Application* at Universeum, as well as verbal feedback given from the test participants.

Group 1

The test participants discussed the animals.

The test participants interacted with the employees of Universeum to find the animals specified in the missions.

The participants helped and explained to each other when there were uncertainties.

The participants discussed the tasks.

The participants only completed the tasks and did not explore Universeum without their phones.

Group 2

The participants were happy with their sense of accomplishment.

The participants did not only perform the missions, but explored other parts of Universeum as well.

The participants discussed animals.

The participants were impressed with the QR-scanner.

The participants interpreted one task completely differently. Instead of finding the specific bird asked in the task, they assumed they should use the Universeum's interactive screens to "build a bird".

Feedback from both groups

The mission regarding space was boring.

The keyboard should be closed when one can press the button "Klar".

It would be fun to have more missions with animals.

There was an aspect of competition which was nice.

The graphical user interface was intuitive, nice application.

Some animals were hard to find when exploring.

J

The First Set of Requirements

This appendix presents the first set of requirements.

- Camera view.
- Standard camera.
- Mission camera.
- Display task instructions.
- Display number of tasks.
- Be able to see if you have accomplished task or not.
- Confirming pictures for mission.
- Album view.
- Display content (pictures).
- Settings (administration).
- Be able to see all group members.
- Adding group members.
- Deleting group members (Admin).
- Leaving group.
- Saving pictures to local library at all times.
- Sharing pictures in group album at all times.
- Sharing from group album to social media.
- Deleting pictures at all times unless picture is sent to group .
- Sign up view.
- Log in view.
- Username and password .

K

The Second Set of Requirements

This appendix presents the second set of requirements.

- Photography missions designed to be done in groups.
- Each mission must consist of tasks which can be done individually.
- Missions should encourage users to explore Universeum.
- Missions should be described clearly and should be rather simple to do.
- After all tasks in a mission is completed a visualisation including pictures taken should be viewed.
- All users must belong to groups
- Users should be able to create a group.
- Users should be able to easily invite friends to their group at all times.
- Users should be able to leave the group.
- Users should be able to change groups.
- Users should be able to see who is in their group.
- Users should be able to see who the photographer of a certain picture is when completing a mission.
- Users should be able to save pictures to their phone at all times.
- All task and mission pictures should be saved in a gallery for all group members to see.
- All group members should be able to see all pictures taken by the group
- The *Application* should have a short startup time.
- Missions in the *Application* should be designed in a way which it could be easily adjusted for other experiences.