User Experience Design for Children

Developing and Testing a UX Framework

Arvid Bräne
arvidbrane@gmail.com
www.arvidbrane.com
@Kodagrux

Spring of 2016

Master’s Thesis in Interaction Technology and Design, 30 credits
Supervisor: Thomas Mejtoft, TFE, Umeå University
Extern Supervisor: Adrià Verdaguer, North Kingdom

Examiner: Ulrik Söderström, TFE, Umeå University

Umeå University
Department of Applied Physics and Electronics
SE-901 87 UMEÅ
SWEDEN
Abstract

Designing good digital experiences for children can be difficult; designers have to consider children’s cognitive and motor skill limitations, understand their target audience, create something entertaining and educational, comply with national and international jurisdiction, and at the same time appeal to parents. We set out to create a general framework which designers and developers can use as a foundation and testing ground for their digital products in the field of user experience.

The methods used during the thesis include interviews, literature studies, user testing, case studies, personas, prototyping, and more. The results created are primarily user experience guidelines packaged in a Theoretical Framework, user testing conclusions, along with suggestions on improving the current Lego Star Wars: Force Builders application, a few in the form of prototypes.
Keywords: user experience (UX), user interface (UI), interaction design (IxD), graphical user interface (GUI), design, usability, kids, children, minors, teenagers, childhood, guidelines, framework, child centered design (CCD), tablets, smartphones, media, Lego, Star Wars, North Kingdom.
# Contents

1 Introduction ......................................................... 4  
1.1 User Experience ............................................... 5  
1.2 Earlier & Related Work ........................................ 5  
1.3 North Kingdom ................................................ 6  
1.4 Lego Star Wars: Force Builders ......................... 6  

2 Objective .......................................................... 9  
2.1 Problem ........................................................ 9  
2.2 Purpose & Goal ............................................... 10  
2.3 Restrictions .................................................. 10  

3 Method ............................................................ 11  
3.1 Introduction .................................................. 11  
3.2 Research Learning Spiral ................................... 11  
3.3 Literature Study .............................................. 12  
3.4 Interviews ....................................................... 12  
3.5 Best Practice Evaluation ................................. 13  
3.6 Application Review ........................................... 13  
3.7 User Testing ................................................... 14  
3.7.1 Testing with Children ................................... 14  
3.7.2 Testing with Parents .................................... 16  
3.8 Personas ......................................................... 17  
3.9 Prototypes ....................................................... 17  
3.9.1 Lo-Fi ......................................................... 17  
3.9.2 Hi-Fi ......................................................... 18  

4 Theoretical Framework ....................................... 19  
4.1 Definitions ...................................................... 19  
4.1.1 Age Groups ............................................... 19  
4.1.2 Current Technology ...................................... 20  
4.2 Framework ..................................................... 22  
4.2.1 General ..................................................... 23  
4.2.2 Ages 3-5: Preschoolers ................................. 25
Chapter 1

Introduction

Some 30 years ago, before the iPhone, before tablets, before high speed internet, and before powerful home computers, adults stood for a majority of the advanced information technology usage in the world [1, 2, 3]. Most children back then did not have their own laptops, phones or tablets and therefore spent less time than many adults using technology. As a result, digital products and experiences were only designed and developed with one customer segment in mind; adults.

Today the world looks different; yesterday’s high consumers are today’s average users and over three quarters of Swedish children above the age of 9 have their own smartphones and are, in many cases, larger consumers of the Internet than adults [3, 4]. This is due to many reasons, but the first and foremost are technical advances, leading to lower prices and allowing for mass adoption. However, while it might sound alarming that the majority of these children use their phones every day [3] it is important to understand that a smartphone today is capable of a lot of things. 30 years ago, people had more single purpose tools to complete separate tasks; a phone to call with, a TV to watch TV-programs on, a radio to listen to broadcasts on, a camera to take photos with, a calculator to calculate with, and, in the best case, a computer to write on. Today, we can do all those things on one device, anytime, and anywhere thanks to the smartphone.

Technology usage is moving down the ages and as a result companies need to design products and services children are able to use. However, while this might sound like a simple task in theory, designing for children is often very different than designing for adults [5, 6]. Several of design considerations, such as limited cognitive abilities, poor motor skills, individual development, and the lack of prior experience need to be considered in order to create a well crafted, digital experience children want to use.

In this thesis we address and suggest a solution to these problems by constructing a theoretical framework based on current literature and research along with
1.1 User Experience

Interviews with experts in the field of user experience for children. In order to verify the framework’s validity, it was used to evaluate an existing iOS application, Lego Star Wars: Force Builders. The results from the application review were benchmarked against the findings from user testing conducted with children and parents. All these findings were then taken into account and solutions, in the form of prototypes and recommended corrections, were then finally proposed.

1.1 User Experience

The field of User Experience (UX) was first introduced in the mid-1990s by Donald Norman [7] and the term refers to a user’s total response (or experience) from the use of a product, system, or service. Don Norman and Jakob Nielsen from Nielsen Norman Group summarize the definition as:

“User experience’ encompasses all aspects of the end-user’s interaction with the company, its services, and its products” [8].

This means that the total UX of a product or service is affected by a number of factors, such as meeting user needs, simplicity, elegance, and an overall seamless experience that is a joy to use. While the user interface design, interaction design, service design, and visual design are all important, UX is the combined feel for a product or service.

1.2 Earlier & Related Work

A lot has been studied, researched, and written about designing for children. However, most academic research is either feature or technology focused and/or out-dated. A lot has changed when it comes to design trends such as graphic design guidelines for web interfaces [9], while some, such as children’s usability issues with tablets [10], remain current. Large child-related companies, such as Lego [11] and Sesame Street [12] often develop their own design frameworks. However, these are often brand specific and therefore apply only to that company’s specific products.

The Swedish author and educator Ellen Key has written the early (1900) and influential book “The Century of the Child” [13] where she focuses on the upbringing and education of children. In her work, Key describes her beliefs about gender roles, family structure, class, and even child labor. The book has been translated to several languages since, and is by many considered the foundation of the status of the child in Western society.

\footnote{For more information, see \url{https://www.nngroup.com/}}
The Nielsen Norman Group have conducted two studies, one in 2001 and the other in 2010, on children’s behaviors and usability issues when browsing popular websites. A total of 53 websites were evaluated and tested on 90 children (41 girls and 49 boys). Their findings from the two studies, separated by 9 years, are all summarized in the book “Children (Ages 3-12) on the Web” \[14\] together with 130 concrete usability guidelines.

Some more recent work on the relationship between children and technology has been written by Debra Levin Gelman in her book “Designing for Children: Digital Products for Playing and Learning” \[15\]. In her work, Gelman describes how children, in age spans separated by two years, behave and feel at different stages during their youth. Her research consists of user tests, interviews with experts, best practice evaluations, and her own experiences from working with children.

### 1.3 North Kingdom

North Kingdom is an award winning experience design company based in Stockholm, Skellefteå and Los Angeles with approximately 50 employees (2016). They have worked with companies such as Google, Disney, Volvo, Netflix, and Toyota, creating everything from mobile applications to marketing campaigns. North Kingdom describes themselves as:

“We believe that new value can be created wherever people, business, and technology collide. We help our clients harness that value through the creation of experiences, products, and services that play a meaningful role in people’s lives. Through human-centered design, we make the complex simple and relatable, no matter what medium or platform” \[16\].

The author has conducted this master thesis at North Kingdom’s office in Stockholm during the spring of 2016.

### 1.4 Lego Star Wars: Force Builders

Since the summer of 2015 North Kingdom has been Lego’s designated creative collaborator and innovation partner \[17\] and has since then been involved in a number of projects. With the launch of a new series of Star Wars movies \[18\] (late 2015), Lego, in collaboration with Disney, decided to develop a number of games and applications \[19\]. One of these applications, a mobile exploration game, is called Force Builders and is targeted towards children (ages 7 to 12).

\[2\] Available for both iOS and Android
This application encourages children to build with digital Lego pieces while at the same time exploring the Star Wars universe.

The product has been in development since the summer of 2015 by North Kingdom and has had its first release, version 1.0 (used throughout this thesis), during the first half of 2016. The plan is to update the application with relevant content alongside the releases of new Star Wars movies to keep their users entertained. Due to its target age group, the application will serve as a case study for the Theoretical Framework developed during this thesis.

The current application consists of four main views; **Hangar**, **Creative Builder**, **Test Tunnel**, and **Missions**. These can be found in Figure 1.1 and are here briefly described:

**Hangar** The Hangar is the top-level, from which users can navigate to the other sections. Here you see users current ship, the R2D2 menu, the users current Jedi status, and entry-points to the other sections of the application such as Gallery and Photo Booth.
Creative Builder  In the Creative Builder users build and color their own ships. This is done by tapping on a part of the ship that has a blue connection point (later referred to as key-points), choosing a part (such as a wing or a cannon), and then “use the force” by long-pressing on the screen to create and place the part.

Test Tunnel  When the user has built a ship, he/she can test it in the Test Tunnel. Here the ship flies down a tunnel where the user has to use directional swipes, vertical or horizontal, on the screen in order to help the ship avoid obstacles in the tunnel and reach the goal.

Missions  In order to level up, the users have to collect Jedi points by completing short build- and coloring Missions. These missions are based on characters from the Star Wars universe and can be as simple as coloring Han Solo’s ship in black and green.

Future releases of the application will include performance adjustments, user interface adjustments, feature updates, and an addition of a galaxy map allowing the user to visit more planets as more Star Wars films are released. In order to get a full understanding of the application, and this thesis as a whole, it is therefore recommended to download the latest version from Google Play Store or Apple App Store.

Chapter 2

Objective

The following chapter consist of three sections: 2.1 Problem, 2.2 Purpose & Goal, and 2.3 Restrictions. Here we address the main objectives for the thesis along with some basic background and motivation.

2.1 Problem

When a designer tackles the problem of designing a product for an adult target group, he or she can put him or herself in the shoes of the user. Designers can also be potential users of the products they help design. This is not the case when designing for children; designers are adults and are therefore very different from children, both in the way they think and act. They are neither potential users of the product [20, 21, 6].

20 years ago, children were not a large user base for technical products: computers were expensive, hard to use, and made for productivity, not entertainment. Today (2016), this has changed: children use technology everyday, some even more then adults [3, 2]. Due to the large amount of applications on Google Play and Apple App Store, parents have a hard time finding the best applications and games for their children, and therefore often have to rely on external reviewers such as PappasAppar[1] FriKid[2] and TheiPhoneMom[3].

[1] For more information, see http://www.pappasappar.se/
[2] For more information, see http://www.frikids.com/
[3] For more information, see http://www.theiphonemom.com/
2.2 Purpose & Goal

The goal with this thesis is to construct a framework for user experience (UX) designers when creating services for children, specifically between 3 to 12 years old. A majority of the guidelines will be tested and evaluated on a newly developed iOS application (described in Section 1.4) designed for children aged between 7 to 12 years old. Suggestions of suitable solutions to the issues found in the current application’s design will then be presented. The purpose of the findings is to enlighten UX designers about the problems and solutions when designing for children.

2.3 Restrictions

While the goal for this thesis is to provide a framework as abstract and general as possible, some restrictions have been defined due to time limitations:

**Ages** The framework briefly covers children of all ages, although only children of ages 3 to 12 years old will be described in greater detail.

**Background** Any specific differences in backgrounds such as ethnicity, gender, demographics, social economic, etc. will not be considered.

**Technology** The different types of technical devices considered are the ones currently (2016) on the market, and only touch based devices are evaluated in greater detail.

**General** The defined guidelines do not cover specific details during the application development, but should be considered more as a foundation for an abstract mindset when designing for children.

**Digital** While the term *User Experience* encompasses both physical and digital experiences, the main focus for the framework is purely for digital services.
Chapter 3

Method

The Method chapter consist of nine main sections: 3.1 Introduction, 3.2 Research Learning Spiral, 3.3 Literature Study, 3.4 Interviews, 3.5 Best Practice Evaluation, 3.6 Application Review, 3.7 User Testing, 3.8 Personas, and 3.9 Prototypes.

3.1 Introduction

This thesis is structured into two main phases: Definition and Evaluation.

Phase 1: Definition In the first phase, a theoretical framework was defined using material gathered from literature studies, interviews and best practice evaluations.

Phase 2: Evaluation In the second phase, the framework was used as a foundation on which the Lego Star Wars application was evaluated and improvements suggested. This phase uses methods such as prototyping, user testing and personas to suggest improvements in the application.

3.2 Research Learning Spiral

Throughout this thesis, the research learning spiral \cite{Sanders1} was used in order to conduct research. The method was developed by Erin Sanders, a senior interaction designer at Frog\footnote{For more information, see \url{http://www.frogdesign.com/}}, and can be implemented into any part of the design process of a product or service. The method consists of five parts, Objective, Hypotheses,
3.3 Literature Study

Methods, Conduct, and Synthesis, where the first three are for formulating and answering questions, and the latter two for gathering information:

1. Objectives The questions to be answered; what do we need to know?
2. Hypotheses What is believed to be known; what are the assumptions about the users?
3. Methods How should these knowledge gaps be filled; which methods should be used?
4. Conduct Gather data through the selected methods.
5. Synthesis Answer the defined research questions to accept or reject the hypothesis.

The method was mainly used to understand and choose the target group, to construct the theoretical framework (described in Chapter 4), and to synthesize the result from the literature study.

3.3 Literature Study

As a part of phase 1 a broad variety of literature was evaluated, all in the field of UX design for children. The type of literature varied from books, articles, previous interviews, videos, magazine posts to blog posts in order to get a wide understanding of the field. The reviewed research mainly consisted of articles found through Umeå University’s online library\(^2\) by searching using keywords and phrases such as “user experience for children”, “designing for kids”, “children and media”, etc. The conclusion of the literature study covered most areas of design for children, such as visual design, interaction design, experience design, etc. and served as a foundation for the Theoretical Framework (described in Section 4).

3.4 Interviews

Interviews were conducted with experts in the field of UX design, all with experience of designing for children. The goal of the interviews were to gain further understanding of how to design for children, which is why a semi-structured interview method was chosen. The semi-structure model \(^{23}\) allows the interviewer to ask follow-up questions that deviate from the predefined set of structured questions in order to get a more clear and explanatory answer. This structure was chosen since it opens up for discussion and allows for further understanding of the interviewees answer.

\(^{2}\)For more information, see [http://www.ub.umu.se/](http://www.ub.umu.se/)
For the overall structure of the interviews, a method referred to as three connected boxes [24], was used. It consists of three separate parts: Introduction, Body, and Conclusion that are all loosely connected:

**Introduction** Explain the purpose and goal of the interview while introducing oneself and the topic. Clarify how, and for what the information will be used and shared and that the proper permissions are in order.

**Body** This is where the semi-structured, along with follow-up, questions were asked. Probing questions, such as “Tell us more about that” were used.

**Conclusion** Finally, asking if the interviewee wants to add anything relevant, before thanking and finishing the interview.

In total, four, one hour interviews (see Appendix A for the questions) were conducted, all in Swedish. One interview was conducted over Skype while the other three at the Toca Boca office and SVT Interactive office in Stockholm. The interviews were audio recorded in order to eliminate the risk of missing key information while taking notes [23]. A list of the interviewees, along with short descriptions, can be found in Appendix B.

### 3.5 Best Practice Evaluation

As a part of the constructing the theoretical framework, popular applications and games among children were analyzed and evaluated. This was done in order to get a greater understanding of which applications and games are popular among children and why. A total of three applications were chosen and evaluated based on their popularity [3, 2] among children and parents; Minecraft, Toca Boca Tea Party, and the OSMO Application Suite, all of which have won awards. “Why are these popular among children?”, “What is their target audience?”, and “How important is the user interface compared to content?” were all questions that were asked and answered.

### 3.6 Application Review

Using the Theoretical Framework, a meticulous review of the entire Lego Star Wars: Force Builders application was concluded to find any issues with user experience and usability. The review was completed using a similar method as in the Best Practice Evaluation (described in Section 3.5) on both an iPad Air

---

3For more information, see [https://www.skype.com/](https://www.skype.com/)
4For more information, see [https://minecraft.net/](https://minecraft.net/)
5For more information, see [https://tocaboca.com/app/toca-tea-party/](https://tocaboca.com/app/toca-tea-party/)
6For more information, see [https://www.playosmo.com/](https://www.playosmo.com/)
Mini 2 and on an iPhone 6. The issues found (presented in Section 5.2) were later benchmarked with the results found during the user testing.

### 3.7 User Testing

As a part of the evaluation phase, user tests were conducted on both children and parents. These tests were conducted to evaluate current version of the Lego Star Wars: Force Builders application and to confirm or reject the issues found during the Application Review (described in Section 3.6). All tests were conducted using an iPad Air 2 running the latest version of the application in an environment where the participants felt at home. To prevent the loss of important information, tests were video and audio recorded using a camera mounted a tripod behind and above the user. Each test took circa 15 to 30 minutes and all the names of the participants are purposely left out to keep their anonymity.

All of the participants knew of both Lego and Star Wars but had never seen or used the Lego Star Wars: Force Builders application before. After each test, the participants were asked about their experience with the application, what was hard, what was easy, and if it was fun.

#### 3.7.1 Testing with Children

A total of five children participated in the user tests (see Table 3.1), 1 boy and 4 girls, all but two in the target age group for the application. These two participants were used as references for users outside the target group in order to understand their needs. Since all participants had some type of relation to the author, all children felt comfortable expressing their thoughts and insights of the application.

The tests were all loosely structured with five main objectives not known to the child. Rather than telling the participants specifically what to do, they were initially told to explore the application freely on their own. After approximately 20 minutes of gameplay, the children were told to complete any remaining objectives before finishing. The following were the five objectives:

<table>
<thead>
<tr>
<th></th>
<th>Child 1</th>
<th>Child 2</th>
<th>Child 3</th>
<th>Child 4</th>
<th>Child 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>6</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Sex</td>
<td>Girl</td>
<td>Girl</td>
<td>Boy</td>
<td>Girl</td>
<td>Girl</td>
</tr>
</tbody>
</table>

Table 3.1: The five participating children during the user tests, ordered by age.
Figure 3.1: A screenshot from one of the user testing sessions conducted with children. Here three children (one at the top, one on the left, and one on the bottom) are building a ship in the Creative Builder, without any supervision.

- Complete the Tutorial/Onboarding.
- Build at least one ship in the Creative Builder.
- Start and complete at least three Missions.
- Do at least three test flights in the Test Tunnel
- Take a Photo of a ship and view it in the Gallery.

After each participant finished the test they got to play with the application without any supervisor in the room, as seen in Figure 3.1 with the camera still recording. This was done in order to understand what they would do in the application and have problems with when not supervised.

Testing Considerations

User testing with children is in many ways similar to user testing with adults. With that said, it is important to understand that children experience user testing in a different way than adults and require a more playful and fun experience [15]. The following are adjustments that need to be considered when user testing with children:

Hi-Fi Prototypes Testing products and ideas early on in the design process is paramount. However, it is important to be aware that children have a hard
time using and evaluating early prototypes that look more like wireframes than final graphics. In order to get a good and accurate response during testing, a fully interactive, high level prototype complete with sounds is recommended [25, 20].

**Questions** Asking the right questions is always important in user testing. However, with children it is also crucial to adjust the language to their level and to ask open-ended questions. Questions such as “Is this cool?”, “what do you think about...?”, and “what are you thinking right now?” are all good examples [25, 21, 20, 26].

**Pairs** Getting the child to open up can sometimes be problematic if the instructor has no relationship to the user. A good way of overcoming this is to involve someone else, close to the child, in the testing process, such as a friend or a parent [27]. This way the child can interact and explain to his/hers parent or friend his/hers thoughts on the application [25, 21, 26].

**Environment** It is always best to conduct user testing in an environment that the user is comfortable using the product in. For children, this means in their home or at their school where they feel calm and relaxed; not in an office [25, 20].

**Documentation** In order not to miss any details during user testing, documentation is key. The preferred way is using a video camera and screen capture software, however having an assistant taking notes is also a good solution [20, 6].

**Privacy** Whenever conducting user tests with minors without anonymity, permission from their legal guardian is needed. This is especially important if a video camera is used to document the results [25, 26].

**Encourage** Finally, making it clear, before the test, that if the child does not find a feature or does not understand something in the application, it is the applications fault, not the child’s [28, 27]. Encourage the user with positive feedback to build their confidence; even tell them that they are the experts and that you, the supervisor, are there to learn from them [14].

### 3.7.2 Testing with Parents

While parents are not the core user group for the theoretical framework, they play an important role in creating digital experiences for children. Parents and caretakers need to be able to understand the application, both to be able to help children if they get stuck and also for parents to feel comfortable with their children using the product.

A total of 3 parents were tested, 2 male and 1 female, all with children. Like the user tests conducted with children, the parents were also allowed to complete the
tutorial/onboarding. The parents were given four similar objectives:

- Build one ship in the Creative Builder.
- Start and complete one Mission.
- Complete one test flight in the Test Tunnel
- Take a Photo of a ship and view it in the Gallery.

3.8 Personas

In order to understand each age group, personas were created based on descriptions of children discovered during the literature study. Personas are fictional characters that are defined, often on a one to two page basis, to represent the different types of user groups that might use the product or service [29]. The character descriptions include a basic background (such as name, age, gender, occupation, etc.), behavioral patterns (what, how, and why they do what they do), and interests (such as hobbies, music, film, etc.) to get a clear understanding of the user. Including a phantom picture of the user is also a valuable way of "humanizing" the fictional character.

These personas were used to define and identify pain points, values, beliefs, goals, and behaviors which then served as an early testing ground for suggested application improvements and prototypes. There are several benefits of using this method in all stages of the design process; sharing specific user assumptions among team members, benchmarking proposed solutions, and providing a "human face" of the demographics [30].

3.9 Prototypes

In order to evaluate the Theoretical Framework, two types of prototypes were created; low-fidelity (Lo-Fi) and high-fidelity (Hi-Fi). A prototype is often a draft version of the full product, used to test either specific ideas or general user patterns. These prototypes can often help to evaluate if an idea is good or bad before investing too much capital in development [31].

3.9.1 Lo-Fi

In order to quickly visualize ideas of improvement in the Lego application, simple sketches of wireframes were first made using pen and dot grid paper. These were

---

7 A users’ problem, real or perceived.
in some cases later re-created and polished using Sketch\textsuperscript{8} in order to further explore their possibilities. An advantage of using low-fidelity prototypes during the early stages is that the designer can quickly try out different approaches without investing too much time in a single idea using an iterative process.

The sketches/wireframes created of the improved Lego application were never used as a test platform for its users, but were rather evaluated using the personas in mind. Some of the interesting ideas visualized in the wireframes were made interactive using the prototyping application Marvel\textsuperscript{9} allowing for further evaluation.

### 3.9.2 Hi-Fi

In order to fully evaluate the ideas from the Lo-Fi prototypes, high-fidelity prototypes with graphics and full interaction schemas were designed and developed. The graphics were created using Sketch and Adobe Photoshop\textsuperscript{10} and were later imported into Pixate\textsuperscript{11} in order to make them fully interactive.

\textsuperscript{8}For more information, see https://www.sketchapp.com/
\textsuperscript{9}For more information, see https://marvelapp.com/
\textsuperscript{10}For more information, see http://www.adobe.com/products/photoshop.html
\textsuperscript{11}For more information, see http://www.pixate.com/
Chapter 4

Theoretical Framework

The Theoretical Framework consist of four main sections: 4.1 Definitions, 4.2 Framework, 4.3 Best Practices, and 4.4 Conclusion.

4.1 Definitions

This framework is a result of phase 1 and serves as a foundation for phase 2 of the study (defined in Section 3.1) and is based on an extensive literature study, personal interviews with experts, and best practice evaluation. The content is based on a broad variety of media: books, articles, interviews, videos, reviews, presentations, magazines, and blog posts, all written by experienced designers, authors, and researchers in the field of user experience (UX) design for children.

4.1.1 Age Groups

All children develop in different ways; some can walk before they can talk, some can ride a bike before they are able to read, some are interested in sports and others in physics. They are all different. This makes grouping children a difficult task, and at the same time a necessity. There are several solutions for this for the defined age span (3 to 12 years), however we would argue that by age is the most appropriate. Specifically by approximately every 3 (preteens span 4 years) years, after recommendations by experts in the field [14, 32, 21]. Other methods might include by every 1 to 2 years [5], interests, or by children’s IQ.

As mentioned in Chapter 2, this thesis only covers the ages 3 to 12. This is accomplished by dividing the age span into three different groups called preschoolers, school kids, and preteens. In most countries the legal definition of a child, or a
4.1. Definitions

minor, is an individual below the age of 18 years. We will therefore define the different spans, from 0 to 17, and describe their everyday life:

Ages 0-2: Infants & Toddlers From newly born infants to toddlers that just started walking and are able to formulate simple verbal words/sentences. These toddlers and infants are often at home with their parents the first half and then moving on to kindergarten or similar day-care.

Ages 3-5: Preschoolers From toddlers mastering running, climbing and playing to children able to construct advanced verbal sentences and understand the concept of letters. Children in this group are normally all in kindergarten and interact with children about the same age as themselves.

Ages 6-8: School kids From kids just learning how to read and write to children understanding the four basic operations of mathematics. Children in this group are generally in the first to third year of primary school, often around children much older then themselves.

Ages 9-12: Preteens From children getting into sports to preteens who are reading to learn and understand the basic structures of society. Typically children in this age span are in the forth to sixth year of primary school, usually in an environment with both younger and older children.

Ages 13-17: Teenagers From young teenagers to young adults; the whole adolescence period. These minors are somewhere between the later part of compulsory school and upper secondary school.

Age differences among children play a much larger role than among adults, both physically and mentally. The differences between a 2 and 5 year old are far greater than the those between a 42 and 45 year old. As children grow up and get closer to adult hood, age plays less of a role.

4.1.2 Current Technology

According to the Swedish Media Council’s study on media consumption among children in Sweden 2014 [3][2], the most popular media/entertainment/technology platforms that children use today are Smartphones, Tablets, Computers and TV Gaming Consoles and are described briefly below.

Smartphones

Smartphones come in all shapes and sizes, but they have a few things in common; touchscreens (often 3.5 to 5 inches), connectivity (cellular, WiFi, and Bluetooth), comprehensive operating systems (most often Apple iOS† or Google Android‡).

† For more information, see http://www.apple.com/ios/
‡ For more information, see https://www.android.com/
**4.1. Definitions**

*sensors* (such as accelerometer, gyrometer, magnetometer, GPS, microphone, cameras, etc.), *few physical buttons* (often around five), *portable format*, and *limited power* (both computational and electrical).

In 2014, only 13% of children ages 5 to 8 owned a smartphone[2], while a vast majority of these had access to one. This means that children in this segment are likely to play on phones that are not theirs, such as their parents, probably in a stationary position at home. In the age group 9 to 12 on the other hand, 78% of children have their own smartphone[3] and are probably using it as their main mobile platform, often outside their home.

**Tablets**

Tablets have most of the features that the smartphone have except larger touchscreens (often 8 to 11 inches), *often only WiFi*, and are *less portable* (both larger and heavier). Since tablets are less portable they are more likely to be used in a stationary position rather than on the move, often indoors or in cars. While tablets often run the same operating systems as smartphones, they have a bit more computational power and much longer battery life. 2014, around 80% of the children in Sweden had access to a tablet, while only 12% (ages 2 to 4)[2] to 50% (ages 10 to 11)[3] had their own.

**Computers**

There are two different types of computers that children use: stationary desktop computers and portable laptop computers. The similarities between the two are as many as the differences; they run the same *advanced operating systems* (most often Microsoft Windows[3] or Apple OS X[4]), *full size keyboards, speakers*, and *camera with microphone* (however more common on laptops).

The most noticeable differences are *computational power* (laptops run on batteries and therefore have lower specifications such as CPU, GPU, and memory), *non-touchscreens* (laptops are often around 12 to 15 inches, while stationary are generally 20+ inches), *cursor input* (while laptops sometimes have mice, the most common input are touchpads), and *connectivity* (a large majority of stationary computers have internet access, while laptops in some scenarios might not).

While both tablets and smartphones have the possibility of being used while moving, computers do not; even laptops will not be used while moving. Although computer usage has decreased over the last few years due to the mass adoption of tablets, 96% of children ages 9 to 12 have access to a computer in their home.

---

[2]For more information, see https://www.microsoft.com/windows/
[3]For more information, see http://www.apple.com/osx/
4.2. Framework

[3], where 43% have their own. The same numbers are 87% and 9% for children 5 to 8 [2].

**TV Gaming Consoles**

The most common gaming consoles on the market today are the Sony PlayStation [5], Nintendo Wii [6], and Microsoft Xbox [7], all of which have their own controllers, user interfaces, and hardware specifications. While smartphones, tablets, and computers focus on productivity, TV consoles focus mainly on entertainment through games and applications making it a good fit for children. 2014, 87% of children ages 9 to 12 had access to a TV gaming console [3], while the same number is 64% for ages 5 to 8 and 36% for ages 2 to 4 [2].

**Summary**

All these hardware and software platforms have their own guidelines which should be considered and complied with when designing applications for children. While the above are the current technical platforms for entertainment there are a lot of emerging platforms such as virtual reality, smartwatches, and smart-TV systems (such as Android TV [8] or Apple TV [9]) that require unique consideration and basic frameworks of their own.

4.2 Framework

The resulting framework is divided into four sections; the first covers more general guidelines for children of all ages. The latter three describe specific guidelines for the different age groups in greater detail:

**General:** Guidelines that affect children in all three age groups.

**Ages 3-5:** Guidelines that affect preschoolers.

**Ages 6-8:** Guidelines that affect school kids.

**Ages 9-12:** Guidelines that affect preteens.

---

[5] For more information, see [https://www.playstation.com/](https://www.playstation.com/)
[8] For more information, see [https://www.android.com/tv/](https://www.android.com/tv/)
4.2. Framework

4.2.1 General

A majority of the following principles and practices span across all ages, many apply to all types of interfaces, while some are crucial for children [33]. Predicting user behavior among children is difficult due to the difference in how children develop; the best predictor of how well children will use an application is how much previous experience they have had with the platform [28]. It is therefore recommended to stick to conventions where it is possible and to be consistent across the service or product [14, 9].

Purpose & Goal

The main purpose when creating an experience for a child, physical or digital, should always be to create something that is both fun and educational; *play is education* [27, 5, 34]. Most children use applications, services, and products for pure entertainment, unlike adults who often use these for productivity [35, 5]. Incorporating learning as a part of a game will benefit both the child with knowledge and the parent with motivation to allow the child to continue playing [5].

Playing video games and watching TV has long been what parents think children overdo [2]. Therefore the application should not be about creating more screen time, but rather enhancing the time they spend today. Creating omni-channel experiences that extend outside the screen can enforce the digital and overall experience while requiring less time in front of a display [36]. Good examples of these types of experiences are Lego Club [10] (which extend the physical Lego experience to a digital one) and Cubetto [11] (teaching children digital programming using physical objects).

Children, teachers, caregivers, parents, and grandparents are all possible users of child products. However, stakeholders also play a significant role when it comes to application development, so choosing the right revenue model (most commonly free or paid) is important [35, 32, 5]. It is seldom recommended for an application targeted towards children to have any *in-app purchases* [12] due to the risk of accidental purchases. However, if this is the decided revenue model it is important to keep in-app purchases about content (such as more levels, preferably a one-time purchase) and not *virtual currency* (such as character upgrades) and also to require passwords [37, 33, 38]. It is also important not to force these purchases upon the child or the application is likely to be removed by the parents [33, 26].

---

10 For more information, see http://www.lego.com/club/
11 For more information, see http://www.primoys.com/
12 For more information, see https://support.apple.com/en-us/HT202023
4.2. Framework

Feedback & Rewards

In order to create an application that children want to keep coming back to, the overall experience has to be rewarding. Always encourage children and give them positive feedback in connection to progress. Try to balance the challenge level so that it is neither too easy nor too hard, so that they feel like they deserve the praise [5, 34, 39]. Incorporating these types of game characteristics into services not related to games is often referred to as Gamification and is a well researched area [40, 41, 42, 43, 5].

Parents & Safety

While this framework focuses on designing for children, designers need to address the main areas of parental concerns such as safety and service usage. Parents are frequently both caretakers of the target user and application users themselves.

Children across all age spans occasionally experience “stranger danger” (a feeling of danger, associated with adults whom often children do not know) when playing online games or browsing social websites. In fact, two thirds of the parents worry that their child will experience cyber bullying or online harassment [1]. In order to allay these parents it is therefore recommended to keep interaction between users moderated (foul language is censored) or canned (users can only choose between pre-determined messages). This way children can still interact with each other, while parents feel that their children are in a safe zone [5].

It is suggested to always anticipate that parents will be users as well, especially if the application/service is targeted towards the youngest ones. These children sometimes need help in order to fully understand the purpose/goal and controls of an application. Including a feature to show more descriptive texts, and not only relying on illustrative icons, can help parents understand and explain the application [5, 5, 9]. More advanced settings and service information (user agreements, etc.) should be placed out of accidental reach for children, however in a logical and easy to find location for parents. Recommended solutions are in the footer of websites or in the system settings for native applications [14, 9].

Privacy

Privacy concerns are often forgotten or purposely neglected during the early stages of the design process, especially for products designed for adults. For products designed for children on the other hand, this could result in a lawsuit due to stricter regulations such as Children’s Online Privacy Protection Act (COPPA) [44]. COPPA’s primary goal is to protect children’s privacy online and applies to services targeted towards children below the age of 13 (not services that just
might have young users). It does this by addressing the disclosure of personal information from children, such as location data, imagery, meta-data etc. [5][33]. It is therefore important to fully understand and comply with the domestic and international regulations for the product.

4.2.2 Ages 3-5: Preschoolers

Preschoolers are young children, often referred to as kids, that in most cases are in kindergarten or similar day-care. They spend most of the day socializing and playing with friends and peers and often share their experiences face to face rather than online [5]. They are capable of walking and running, but have not yet mastered their fine motor skills. These children have vivid imaginations, but lack patience for most challenging tasks [5][6]. At this age children start to understand gender identities, which is why it is important to keep characters and tasks gender neutral or balanced in order to satisfy both genders [5].

Challenge Level & Limitations

Children in this age group want to learn and to be challenged, however they lack the patience and ability to focus for extended periods. Creating easy tasks that are easy to complete is key to a successful application for these children [34][5][10]. If a task takes too long to understand and/or complete the child will simply close the application [5][39].

As a result of this lack of patience it is recommended to limit the number of distractions, such as advertisements and interactive elements [5][34][33][45]. Non-interactive loading screens that take too long should be avoided and when longer loading is required the loading screen should distract the child from the fact that they are waiting. This can be achieved by constructing these screens so that they contain some type of interactive mechanics or by a fun, yet simple, animation [45][34][33].

These children also have very limited memory, so providing the child with large quantities of information, such as instructions, should be avoided. By grouping small bits of information into smaller, more digestible, groups, this information is less likely to feel overwhelming [33][5]. In his book Design of Everyday Things [46] Norman presents the memory concept of knowledge in the Head and in the World. In this model short- and long term memory are parts of the head, while visible/audible retrievable information are parts of the world.

“Help kids find information that may be hard to keep in their head, and help them keep it in the world” [33].
Repetition

Repetition is a key part of learning, but it is also a key part of playing; children of this age love repeating the same tasks over and over, no matter how trivial they are. This is why repetition not only needs to be planned for, but also embraced by providing a simple way of repeating actions; it adds to the child’s learning experience [39, 34, 33, 32, 12]. A button that plays a sound may be tapped several times, simple missions will be replayed, a short video clip will be re-watched. A best practice is the cartoon series Blue’s Clues [13] that managed to surpass Sesame Street [14] in ratings by airing the same episode every day for a whole week, before releasing a new episodes the next week [47]. Children enjoy learning the episodes inside and out by heart.

Technology

Some has been mentioned about technical platforms earlier in Section 4.1.2 but special attention should be paid to the fact that children have little prior experience with technology at this age. Studies have shown that the best ways of understanding how well a child understands technology is by analyzing their prior exposure to it [14]. With the recent mass adoption of a more child-friendly interaction alternative; the touchscreen, the barriers for children interacting with technology have been lowered [48], especially with the introduction of tablets. Touchscreens allow for great natural user interfaces (NUI) [49] that allow users, particularly children, to quickly transition from novice to expert, while other interfaces, such as keyboard and mouse, require additional training.

Acoustics

As mentioned earlier, young children cannot read; some understand letters and are in some cases able to write simple words, at most. An application interface should never rely on text as a form of communication with the user, and therefore need to rely on other forms, such as auditory feedback [5, 39, 50, 21]. These can be divided into three different types: voice-overs (for instructions, feedback, and guidance), music (for background noise and as a reward when completing tasks), and interactive sounds (for pressing buttons or interacting with the environment) [5]. Combining these three types should be done with caution due to the risk of sound overlapping at repetitive taps or clicks. Checking if one interactive sound is playing before starting another is therefore recommended [39, 45]. Finally, do not overuse sound in applications, be clear, and use audio for clues; both for navigation and content [34, 5].

[13] For more information, see http://www.nickjr.com/blues-clues/
[14] For more information, see http://www.sesamestreet.org/
Aesthetics

Studies have shown that children rely heavily on visuals [51, 9, 12], especially when most touchscreen devices lack physical feedback and children this age are unable to read [5, 39, 50, 20]. Children prefer big, bold user interfaces with large imagery and cheerful colors; minimalistic and aesthetic interfaces are not for young children [26, 36, 52, 6]. While this is true, applications should not overuse too many different colors since this is often distracting and will increase the visual complexity of the interface [5].

Iconography is a problematic area and often needs to be adjusted and simplified [53]. Children at this age interpret icons in a more literal sense due to their lack of prior exposure to most icons [5]. Using a floppy disk icon to represent the action “save” is not obvious for children, icons should be representational in a literal sense [26].

Gestures & Interactions

Due to young children’s poor motor skills, some gestures and interaction patterns should be adjusted and sometimes removed. More advanced touchscreen gestures such as dragging, double tapping, scrolling, and all forms of multi-touch [5, 10, 14, 9, 26, 34, 12, 21] should be avoided since these are all types of learned interactions [39, 35]. Tapping along with short, simple swipes are recommended when designing for touchscreens since these are natural interactions for children [5, 39, 45, 10, 12]. Primary interactions, such as navigation, that rely solely on accelerometers can lead to unwanted accidents, especially on tablets, and should be avoided [39].

Although multi-touch should be avoided, it should be anticipated. Even at this young age, children are very social individuals and collaborative usage (more fingers on screen) is often common on larger screens, regardless if it was designed to be or not [39, 45]. Unwanted multi-touch features can also be triggered due to an accidental finger on screen as a result of the device being held inappropriately. Errors like these, along with miss-clicks, should be planned for [5] and forgiven or else the child will find no other option than to close the app [45, 34, 21].

Interactive elements, especially buttons, often need to be fine-tuned to suit these children. Buttons should be large enough so that they are easy to spot, and easy to click on [5, 37, 39, 34, 26, 33] and Fitt’s Law [15, 54] often needs to be exaggerated. Adding eye-catching colors is one way, but shadows, glows and simple motions can all be used to indicate that an element is interactive [34, 37]. Affordance is key when it comes to interactive elements among children; if an object looks like it is interactive, it better be so [37, 46]. If nothing happens when a child presses, what they believe is a button, they will press again, only

\(^{15}\text{A model of human movement often used in digital interfaces.}\)
4.2. Framework

this time harder [39] [45]. Finally, the amount of interactive elements on screen should also be limited, three or four at most [34]. The same applies to the behavior of these elements; an interactive element should have a single behavior, meaning it should only do one thing [5].

Navigation

Navigation is a central part of most application user interfaces which is why these need to be thoroughly considered and evaluated before launching a product. This applies to navigation in interfaces in general, but especially for young children since they do not understand deep and complex hierarchical menu structures like adults do [52].

Since children in this group do not understand the concept of 3D, it is recommended to simplify navigation down to a 2D layout [5] [10]. The UI can then be navigated using arrows [5] [37], preferably placed along the edge of the screen. However, note that if these are placed too close, they are likely to be pressed by accident (as described in previous section) [5] [27] [34] [6]. A solution to this is to place navigational elements in the upper part of the screen; in the left or right corner or in the center, out of accidental reach [37]. These elements also need to be differentiated from the background and the content [5].

Compared to toddlers and babies, children this age want, and more importantly understand, the concept of home, and it should therefore be indicated clearly [26] [52]. If this is not clearly indicated the child will simply press the home button, found on most touch screen devices, terminate the application and (hopefully) start over.

Due to their lack of patience children in this group are easily distracted. While this is not a clear problem itself, it becomes apparent when advertising is part of the UI, something children do not understand [14] [37]. The same applies to advanced menus such as settings and account management, both of which should be hard to reach in the application or in operating systems settings. Pop-up windows such as “Rate the app” or “Sign in to get rewards” should also be avoided [39] [45] [34].

Finally, the best way of creating an interface children love is by making the content the UI, which is the first order principle of NUIs [49]. After all, the content is what the children are there for [45].

Summary

It is easy to argue that 3 to 5-year-olds is the hardest group to design for [6] due to their differences and limitations compared to an adult’s. However, one could
argue that it is the easiest since the individual differences among these children are fewer [21]. The top three key takeaways from this age group are:

1. Create simple, repetitive tasks, too much challenge and the child will leave.
2. Be forgiving, try to empower the child to keep trying/playing.
3. Parents are also users, make it clear for them too.

4.2.3 Ages 6-8: School kids

By the age of 6, children start to take in other influences, outside their family, such as teachers, public figures, and peers. By finding idols that they identify with they start to develop identities of their own with unique moral values and areas of interest [5, 11]. These children understand how and why others think differently and that a certain solution may be affected by place and situation [11]. Differences between gender identity start to emerge and affect choices [21].

As these children grow up their memory increases and they have less difficulty with keeping information in their head instead of in the world [46, 5]. With this comes the ability to focus for extended periods of time, something children this age get frustrated at themselves if they are not able to [5]. 6 to 8-year-olds start to want to finish what they start; they do not want to quit an application in the middle of a level or challenge [3, 21].

Challenge Level & Content

While 6 to 8-year-olds enjoy more of a challenge they still prefer quantity over quality when it comes to content [5]. To satisfy both these demands, it is recommended to establish patterns of progression early on by creating an experience which is easy to figure out right away, but which is not necessarily easy to complete perfectly [5, 34, 11]. A best practice of this is Angry Birds [16] (especially version two), a game that has a myriad of levels (250 and counting) which are all easy to complete on the first try with one out of three stars. However in order to get three out of three stars, several tries are usually required.

Children in this age group are fully aware of the concept of winning and losing [5, 11], something that needs to be taken into consideration. Losing should be OK and not a negative thing; turn it into something funny, use constructive feedback, and motivate them to keep trying. However, avoid patronizing copy and voice-overs or the child might leave the application [50].

\[\text{Challenge Level & Content}\]

\[\text{Angry Birds}\]

\[\text{https://www.angrybirds.com/}\]
Social

Changing environments from kindergarten to primary school means that children are now separated into classes, based on their age. As a result of this, children quickly learn the concept of age and what it means to be younger and older. This also means that they start to develop a negative association with products and services designed for users younger than themselves [5]. At the same time they start to look up to their elders and find idols to identify with [11].

This age group is still not experienced with social media or online communication and can in many cases be scared of strangers [5]. A moderated or canned chat is recommended in order to avoid a sense of “stranger danger”.

Freedom & Exploration

As children grow up they start to both enjoy and expect open exploration; users want to be able to create, store and share their own content as well as take part of others creations [5]. A best practice of this is the game Minecraft (further described in Section 4.3.3) which allows for both user content creation and exploration.

While an open environment is appreciated among children, rules needs to exist. It is recommended that these rules are to be presented in a positive way in order for children to embrace them [5]. In circumstances where rules are not defined, children may create their own, like they often do when they play with others [5, 11].

Interaction & Navigation

Children in this age group have further developed motor skills, to the point where it is possible to sew and knit, saw and hammer; most types of gestures are now viable [10, 11]. At the same time these children start to see logic patterns beneath the surface of things, allowing for deeper and more complex navigational structures, such as 3D navigation [11, 5]. From around the age of 6 and up, children start to develop their narrative thinking abilities and their ability to recognize a red thread in a story is constantly increasing [11]. Utilizing this ability with tools that embrace storytelling often leads to a more immerse experience.

As described in previous section, these children prefer environments with a varying amount of rules. For navigation and interaction this means establishing rules early on and providing information up-front so these children feel prepared. Long instructional texts are seldom a good solution; simple and clearly outlined steps are therefore recommended [5].
Aesthetics & Reading

Just like preschoolers (ages 3 to 5), school kids rely heavily on visuals. However, when compared to the younger age group, these children have further developed figure-ground perception where they are able to distinguish objects from the background.

For these children it is also important to adjust the vocabulary, especially in copy. Around the age of 6 is when children start to learn to read in school, and by the time they reach 8 some basic reading skills in their native tongue are developed. Most children in this group can read simple words; “name”, “go”, “start”, “pause”, and “stop” are all fine, while longer explanatory texts are preferably communicated using voice-overs.

Summary

While these children are unique, they have many similarities with the 3 to 5-year-olds; they still love repetition, rely heavily on visuals and have physical and psychological limitations, such as lack of patience. The top three key takeaways from this age group are:

1. Can handle a challenge, the goal should not be too easy to reach.
2. Start to develop identities of their own, with specific interests.
3. Better understand a chain of events, opening up for deeper storytelling.

4.2.4 Ages 9-12: Preteens

Preteens have many similarities with teenagers; rebellious and heavily influenced by their feelings. These children do not want to be judged by their age and often consider themselves as young adults. They have a far greater understanding of the world than 6 to 8-year-olds and can distinguish between fact and fiction. They consume large amounts of video online and are still heavily influenced by the advertisement that come with them.

Experience

Most children have had limited experience with technology before they turn 5. However, at this age they have just started to understand the underlying mechanics behind it. Children start to recognize user interface conventions and logistics behind e-commerce (how it works, what and why it takes time). They can fully differentiate between actual content and advertisements, however it is still recommended to visually separate these. All purchases should require a parent’s permission and password since they can still be accidental.
Challenge Level & Content

While the two younger age spans are sensitive to advanced and demanding tasks, this age span enjoys the challenge and often want to become experts at these tasks, especially in their community [33, 5, 50]. Unlike younger children, this group is not satisfied by repetition; predictable content is boring and meaningless [40].

Just like 6 to 8-year-olds these children react negatively towards products and services that clearly are designed for younger users [33, 5, 50, 21]. Since a majority of preteens do not consider themselves as “kids”, they seldom navigate to those sections, regardless if the content is intended for them or not [36]. This mindset can be hard to design around and often requires careful consideration when it comes to branding, art style, and copy.

Open & Personalizable

9 to 12-year-olds have recently found their own, personal identities and are now looking to develop these further and become more niche, with their own unique interests [5]. In order to reach these young individuals it is recommended to create an open and customizable experience that appeals to a broad audience [5, 33]. Children want the freedom to move within a controlled environment, much like in Minecraft. In their book *Rules of Play: Game Design Fundamentals* K. Salen and E. Zimmerman define the word “play” as:

“Play is free movement within a more rigid structure” [42].

Provide children with the tools and content needed to tailor their own, personal experience and explore their creativity [5, 48, 27, 36]. Enhancing the feeling of ownership through personalization increases engagement; let them pick their own inappropriate usernames, let them customize the look of their avatars and create an open storytelling experience [5, 27].

Social & Technology

Between the ages 9 and 12 is when children become fully socially capable and start to use technology as a tool for communication rather than for pure entertainment [5]. A study from 2015 confirmed that 23% of Swedish 9 to 12-year-olds thought that they spent too much time playing games [3].

Despite the fact that they are social [21], these children still do not qualify for the terms of service of most major social networks, such as Facebook. Instead these children rely on other communication platforms, such as KiK[17] Snapchat[18]

---

[17]For more information, see http://www.kik.com/

[18]For more information, see https://www.snapchat.com/
4.3. Best Practices

Instagram, e-mail, or similar messaging platforms such as text messaging. These children have a clear understanding of what is “cool” and not and the usage of these platforms are heavily dependent on trends; they strive to fit in. This age span is also when most children get their first smartphones meaning that they start to own the devices they use most frequently. As a result, children using applications on mobile devices are likely to do so outside their home with limited bandwidth and a smaller screen. Subsequently, this group spends more time than ever online and slowly become less frightened of strangers online.

Summary

While these children are closer to, both in age and physical/social development, adults, they might not be the easiest ones to design for, due to their very different personalities. The top three key takeaways from this age group are:

1. Create highly personalizable experiences that empowers creativity.
2. These children are rebellious and want to break rules and test boundaries.
3. Technology is not purely used for entertainment, but also used as a tool.

4.3 Best Practices

A way of understanding what children like and not it is recommended to study popular applications among children. From recommendations gathered during the interviews and literature study, three applications were studied. A majority of the applications come highly recommended from child application review websites such as PappasAppar, FriKids, and TheiPhoneMom.

4.3.1 OSMO Suite

The OSMO Application Suite is an iOS game system designed for children 5 to 13 years old. The applications are all aimed to extend the interactions with the iPad beyond the digital elements on the screen to physical objects in the real world. At the core of the experience is an iPad table mount and a mirror that holds the iPad upright and angles the front-facing camera downwards. The accompanying five applications are all different:

\[19\] For more information, see https://www.instagram.com/
4.3. Best Practices

Numbers  Place tiles containing numbers and mathematical operations in front of the iPad and use math to free fish by popping bubbles on the screen.

Tangram  Solving classic Tangram puzzles in the shape of animals using wooden puzzle parts.

Words  Using plastic tiles containing letters (similar to those used in the board game Scrabble), children solve a hangman puzzle by placing the correct tiles in front.

Newton  By drawing lines on a piece of paper, children guide small balls on screen towards their designated targets.

Masterpiece  Teaching children how to draw by displaying guidelines of items on screen that are traced on paper.

The OSMO applications are all different, but share a clear vision; creating a fun and educational experience. They accomplish this with an intuitive UI, well translated texts, clear audible and visible feedback, fun and child appropriate content while at the same time supporting, and embracing, multiple users.

4.3.2 Toca Boca Tea Party

Toca Boca Tea Party is one of Toca Boca’s first and their most successful application. 2014, a study on young, Swedish children showed that Toca Boca games were the most popular game among 12 % of 2 to 4-year-olds. Their games are also the third most played game (with 8 %) among girls 5 to 8 [2]. However, Toca Boca’s success does not stop there; they have over 9 million active users every month spread across their 32 applications [20].

Tea Party is, according to Toca Boca, not a game, nor is it educational. The application (or as Toca Boca calls it, toy) is designed for kids ages 3 to 6 and focuses on play [20]. There is no clear purpose of the application, however it is designed to mimic a tea party where children can play with tea pots, mugs, cookies, donuts, cutlery, etc. This open-ended, exploratory gameplay where children can do as they please is a common theme across all Toca Boca’s toys and is one of the reasons for their success [20].

4.3.3 Minecraft

Minecraft is an open sandbox, adventure, survival game originally designed for PC in 2011 by the small, independent game studio Mojang [20]. Players are thrown into a automatically generated voxel world where they have to craft tools, hide from creepers (zombie like enemies), and build houses while at the same time continuously exploring their surroundings for more resources.

---

[20] For more information, see https://mojang.com/
Since the launch the game has sold more than 20 million copies world wide\(^{21}\) and is today available for all mayor platforms, even as Lego. Unlike Toca Boca Tea Party and the OSMOs applications, Minecraft was initially not designed for children. This has however not been a problem; Minecraft was 2014 the most popular game among just under one quarter of all Swedish children ages 5 to 8 years \(^{2}\). The corresponding number is over one third of children aged 9 to 12 \(^{3}\).

There are many factors to Minecraft’s huge success, the most evident is the possibility for self expression. Due to the game’s open-ended mechanics children are able to shape their own gameplay, and do, close to, whatever they feel like within the few predefined boundaries of the game. The game is very much a “What You See Is What You Get” type of environment; every place you see can be visited, every item you see can be picked up, and so on.

Minecraft is not a globally renowned game because it is easy to understand or to operate, nor because it has an intuitive user interface adjusted for the audience. It is because it has content and gameplay that appeals to people of all ages.

### 4.4 Conclusion

Designing good digital experiences for children is difficult, but not impossible; it requires both thorough research and user testing. It is also crucial to understand the users when designing: what drives them, how they think, and what they know, its not just about simplification and making buttons bigger \(^{39}\). Children are not dumb, they are simply different from adults \(^{5, 33}\); children want entertaining and expressive user interfaces while adults prefer minimalism that empowers productivity.

Digital products for children could, and should, be about more than just fun and games, however, does not necessarily have to be strictly educational \(^{33}\). Most children are there for the content of the application, not for the user interface nor to learn. Anticipating how a user will behave and use an interface is hard, the best predictor is simply based on their previous exposure to technology.

#### 4.4.1 Children in General

While the core target group for a product could be narrow, it should be made so that most children are able to use it. This is, as mentioned, paramount for creating an experience successful among children, much due to the fact that all children are different and develop differently. Creating an application for e.g. 6
to 8 year-olds does not mean that only the guidelines in 4.2.3 apply; the designer also has to consider the ones in Sections 4.2.1, 4.2.2, and 4.2.4 as well.

The following three items address general insights about working with children in different stages of their development:

**Repetition → Exploration** At a young age children prefer repetition, e.g. they can, and want to, complete the same map, over and over again. As they grow older, repetition becomes boring and users tend to want new content, preferably exploratory with greater freedom.

**Entertainment → Productivity** Entertainment is the single reason most children use digital applications in the first place. While many teens use some products the same way, they are prone to use many for functionality and productivity.

**Limitations → Challenge** While the youngest toddlers are limited, both physically and mentally, teens have few cognitive limitations and, in many cases, better motor skills than adults. Generally, the older children get, the more of a challenge they can, and want to, handle.

As a final note to summarize the Theoretical Framework:

“Make products kids will love, not products that only kids will love” [33].
Chapter 5

Results

The Result chapter consist of five main sections: 5.1 Interviews, 5.2 Framework Remarks, 5.3 User Tests, 5.4 Personas, and 5.5 Prototypes.

5.1 Interviews

Many of the important aspects (especially from questions 3, 4, 5, 7, and 8) gathered during the interviews are referenced in the Theoretical Framework in Chapter 4, however some interesting results previously not mentioned are summarized below:

- All interviewees said that the most important and obvious difference between designing for children and adults is that they themselves are adults and therefore think like adults. Children think and behave in a totally different way and therefore require a different experience than adults.

- Mixed feelings were expressed on which age span was the easiest/hardest to design for. Some thought 3 to 5-year-olds were the easiest and 9 to 12 the hardest, while someone else said the complete opposite.

- There was a wide spread on how the interviewees wanted to structure the age spans. One suggested the age spans 3 to 5, 6 to 7, 8 to 9, and 10 to 12, while another suggested the same groups as in the Theoretical Framework.

- When asked about the main purpose/goal behind creating products for children the interviewees all had similar answers: create a fun and entertaining experience where children feel free and comfortable to explore and experience the product.
• Among the recommended applications were YouTube Kids\footnote{For more information, see https://kids.youtube.com/}, Ocean Swimmer\footnote{For more information, see http://www.sagomini.com/app/sago_mini_ocean_swimmer/}, Mario Cart\footnote{For more information, see http://mariokart.nintendo.com/}, Toca Band\footnote{For more information, see https://tocaboca.com/app/toca-band/} and Sneak\footnote{For more information, see http://www.madeinme.com/sneak/}.

5.2 Framework Remarks

The following list contains the major user experience complications in the application based on the Theoretical Framework defined in the previous chapter. However, bugs, typos, and small mistakes are not included since these do not affect the fundamental features of the application.

5.2.1 General

1. Throughout the application there is a lot of loading. While some of these loading screens are a technical necessity and often shorter than three seconds, they are not interactive and quickly become frustrating and boring.

2. While this is a comprehensive application with a large amount of features, the navigational hierarchy can be made with fewer navigational levels to lower the cognitive load on the youngest users.

3. The icons used throughout the application are at times very specific, something that is hard to work around. However, most of the icons do not have any text descriptions associated with them, making the application hard to understand if the user missed the tutorial.

4. Repetition is not generally embraced. For example, once a Mission is completed, there is no simple way of replaying the mission. In order to replay it the user has to navigate back to the Hangar and then find the “Build Mission Log” and select the mission. This also applies to testing ships in the Test Tunnel; once the user has completed the flight he/she gets redirected back to the Hangar.

5. The whole experience in the application is heavily dependent on the user being able to read due to the lack of voice-overs. This applies to both the onboarding of the application and general gameplay, such as mission briefings and mission objectives. Users unable to read therefore require help from a parent, sibling, or similar to understand the purpose and goal of the application.
6. While the copy in the application is translated based on the users location, some (such as Swedish in Sweden) of the translations have questionable quality. There are a lot of words, especially titles, that are not translated and therefore remain in English, leaving some phrases barely readable for children. Even translated sentences can be hard to understand due to the maturity of the language being used.

7. Everything associated to building in the application is done through a long-press gesture (where the users taps and holds). While this is evident after repetitive usage, it is not clear for first time users.

8. How different parts (wings, motors, etc.) in the Creative Builder and Mission Builder affect the ships performance (such as speed, fire power, etc.) is very unclear. In the Mission Builder their effects are not even viewed, leaving the user struggling to find the correct part to place in order to complete the mission.

9. The Creative Builder (which is also used for Missions) is clumsy to use, especially building, destroying, and rotating the ship. The builder is not forgiving when it comes to pressing the connection points on the ship, nor does it handle missed clicks very well making for a unpolished experience, far worse than building with physical Lego pieces.

10. Since the application is very CPU and GPU heavy, it quickly drains the device’s battery while at the same time heating up the phone to relatively high temperatures. This, together with the size of the application (around 830 megabytes) could make parents think twice before installing it.

### 5.2.2 Specific

11. In the Hangar, R2D2 does not appear tappable, something that also applies to all the other characters used in the build missions. The other interactive elements either have a blue glow, an outlined button shape, and/or have arrows pointing towards it.

12. There are two different galleries, one personal and one public, which, for the user, look and feel similar. How these differentiate from each other is unclear along with how to reach these. The personal gallery can be reached from the Photo Booth and the R2D2 menu, while the public gallery can be reached from both the R2D2 menu and the Hangar.

13. The blueprints in the Creative Builder are hard to recognize. This becomes apparent when completing Missions where specific parts need to be placed in order to complete the mission.

14. When in a “building mission”, it is not clear how parts affect the flight characteristics (such as speed, size, and fire power) of the ship.
15. Mission objectives, such as “coloring the ship in a specific color” and “build a fast enough ship” are not generally communicated clearly.

16. Some operating system specific features, such as Notification Center and Control Center on iOS, are easily triggered when controlling the ship in the Test Tunnel due to the gestures for steering.

17. In order to fly in the Test Tunnel (located on the right in the Hangar), the user has to tap the ship (located on the left in the Hangar), then an icon of a pilot, select a pilot and then fly. This confuses the user since they clearly see the Test Tunnel on the right.

5.3 User Tests

The following are the major user experience complications in the application found during the user testing with parents and children. The findings are divided into five main areas: Text & Copy, Missions, Creative Builder, Test Tunnel, and Photo Booth. However, bugs, typos and small mistakes are not included since these do not affect the fundamental features of the application.

Text & Copy

The text in the application used in most places, especially during the tutorial and in mission briefings, is generally too hard to read. This is due to four main reasons:

- The amount of text is generally too long; a majority of the children did not read the text in the tutorial, nor in the mission briefings.

- Two of the youngest children found the printing-effect applied on the text hard to focus on. When the text is done “printing”, the text starts to twitch to simulate the effect of a bad reception, something that also frustrated the slower readers.

- The copy used is well written and easy to understand for the older children, especially if they know a little English. However, the youngest find many of the words, such as names, places, and titles hard to read.

- While children found reading long text hard and frustrating, parents gladly read them. Views that did not contain text however, often resulted in parents feeling lost. The lack of text on icons also often meant that parents had to guess what they meant:

---

6Each letter appears after the other with a small, less than 50 millisecond, delay to mimic the effect of an old typewriter
“I’m not tapping that, that is a radio” - A parent’s comment on what she thought the camera icon was.

Missions

Several issues were found during the completion of missions, the most evident was the lack of understanding the goal of the mission, how to reach it and when it was reached, something most of the children and parents struggled with. Even if the children clearly saw the objectives presented before the mission, many had problems understanding how the pieces of the ship would help reaching the defined goal. For the easy missions, most of the children figured it out. However, for the harder ones, many simply ended the mission after trying a number of times without any success or help.

Another common problem was the indication of the completion of the mission, most of the children and both parents simply continued building after the mission was finished. This could sometimes be a conscious decision, especially among the children, that they felt they wanted to continue building, although most simply did not understand that they had finished the mission. One of the parents thought he had to use up all the key-points in order to complete the mission.

Creative Builder

Most of the problems were discovered in the Creative Builder where all children and parents felt the interface was unpolished and hard to use. The most common problems with the builder were:

- The blue key-points that are used to connect new pieces to were often very hard to press, resulting in frustration and a number of hard taps.
- Using long press to build pieces with “the force” is something all users had issues with. Some tried to tap the part in the list, some tried to drag the part out from the list onto the key-point, and some used two fingers, one in the list and the other on the key-point.
- All children and parents accidentally destroyed parts at least once during the testing session. However, the youngest children often made that mistake at least a couple of times before understanding the feature.
- The oldest children quickly understood how the rotation feature worked, with the occasional swipe in the wrong direction. However, the youngest children found this hard to use and were often frustrated that they could not see the rear of the ship.

The users, both parents and children, also had problems with understanding what the different parts are and how they affect the ship. Some users understood
that a piece was a wing or a motor, however only one fully understood how these parts affect the three specifications for the ship (speed, size, firepower).

While the color picker was an appreciated feature, it had two noticeable issues. The first was the lack of an accept button after picking a color, something that resulted in a quick pause before trying to tap outside the color picker which then closes it. The second was a complaint about not being able to choose their very own colors, such as pink, gold, and silver.

**Test Tunnel**

The Test Tunnel had a few usability issues that often resulted in a crash and frustration:

- Most of the children and one parent started swiping and tapping long before the ship reached an obstacle in the tunnel resulting in that they tapped pass the tutorial showing them how they control the ship. In some cases this did not affect the gameplay in the beginning since they often did the correct swipe right away. However, when walls that require multiple taps on screen in order to shoot it down they were left confused.

- Once swiping to turn, there is no way of returning to the center during the animation of the ship, something all the children and parents tried repetitively without any success.

- Swiping right to fly right and left to fly left was very intuitive for the older children, but the younger ones, along with both parents, felt more stressed while flying resulting in more impulsive and uncontrolled gestures. As a result they swipe on an angle or do short swipes, something the application currently does not support.

Apart from the issues that made the user crash, two other problems were found. The first is the approximately 4 to 5 seconds of wait before the user, both children and parents, sees that he/she can rebuild their ship by doing a long press, something indicated with a fingerprint icon. The second problem is not being able to replay the Test Tunnel again, without going to the hangar, something most children, especially the youngest expressed they wanted to do.

**Photo Booth**

Not many problems were found in the Photo Booth except three:

- There is a button with a light saber icon on it with the function of changing the glow on the thrusters. This is something most the children did not understand since the ship is always rotated towards the users, with the thrusters hidden behind the hull of the ship.
• In order to toggle between rotating the ship and the background, the user needs to press one of two buttons, something that many users did not quickly understand.

• Since all five backgrounds are located in space, there is a lot of empty and dark space. However, almost all backgrounds contained a large planet that was often not in focus, as in “on screen”, when the background was chosen. This left many children believing that there was nothing else in the background than empty space resulting in users simply tapping “next background”.

5.4 Personas

The following are the three personas developed during the second phase of the thesis and are based on participants from the user tests. All three children are in the determined age span of the products and can therefore be considered as potential users of the Lego Star Wars application.

5.4.1 Johan

Johan is an 8-year-old boy in his 2nd year of compulsory school who is full of creativity; he spends most of his free time building with Lego and Duplo, either alone or with friends and family. Johan lives in an apartment in a smaller town with around 10 000 inhabitants with his mother and one year older sister. The whole family rides their bike together to school every morning, where his mother works as a teacher.

Johan does not own a phone, but often borrows the tablet he and his sister shares to either watch movies or play games such as Toca Builders.\(^7\) No one in Johan’s family has seen the Star Wars movies, even though they often visit the cinema.

5.4.2 Jenny

Jenny is a 12 year old girl in a Nordic capital city who just started her 6th year in compulsory school. She lives with her two parents and three younger siblings (two brothers, one sister) in a villa in a calm neighborhood. Jenny is old enough to catch the buss to school, a trip which takes around 20 minutes one way, during which she plays games like Terraria\(^8\) and Subway Surfers\(^9\) on her smartphone.
When she is not in school she likes to read fantasy books, practice football, play Minecraft on her laptop, and meet with her friends. Jenny has never played with Lego, but used to furnish doll houses when she was 6. While she has seen the Star Wars films, she never thought that they were that special.

5.4.3 Richard

Richard is a 10 year old boy who is a real Star Wars nerd. He knows all the characters and planets names by heart and dreams about becoming an astronaut. He watches the animated version of Star Wars on TV every morning where his favorite character is Yoda. Richard lives in a medium sized town where he walks, together with his father, to school every morning. He has an 8 years older brother who he looks up to and often brags about to his classmates in 4th grade.

Richard thinks Lego is intended for younger children since he has never seen his brother play with it, so he has never really built with it either. Instead he spends a lot of his time watching shows online, on his own tablet. Currently Richard does not have his own smartphone, this is however something his parents are considering for his birthday.

5.5 Prototypes

The following are some parts of the prototypes created during the course of the thesis. However, due to the amount of content, not all of these are shown here.

5.5.1 Lo-Fi

The following are four different sketches/wireframes that were created during the early stages of the prototyping, all of which are drawn on a dot-grid paper. Figure 5.1 shows the current Hangar along with an alternative way of accessing the Test Tunnel. Figure 5.2 illustrates how a merge between the current Private Gallery and Public Gallery could look. Figure 5.3 shows a result screen after completing a flight in the Test Tunnel. Finally, the last figure, Figure 5.4 is a mix of different interactive objects found in the application.
5.5. Prototypes

Figure 5.1: A overview of the current Hangar with the alternative way of accessing the Test Tunnel symbolized by the small, blue, rectangular arrow on the right side of the wireframe. The rest of the view is left unchanged.

Figure 5.2: This merge of the current Private Gallery and Public Gallery is a completely new view. The buttons on the top are, from the right, back, filter (where the user can choose to view only popular, private, public, or all images), and take photo. The grid of boxes are the pictures the user has saved, showing the number of likes (only if an image is public) in the small container, inside some of the images.
5.5. Prototypes

Figure 5.3: Another, completely new screen, shown right after the completion of a flight in the Test Tunnel. This screen contains the chosen pilot (a Lego figure) on the left, and on the right (from the top) some motivational text, the time the flight took, along with some tips and tricks on how to reach a better time. The two buttons in the bottom corners are replay (on the left) and return to the hangar (on the right).

5.5.2 Hi-Fi

The following are some of the Hi-Fi prototypes created digitally, based on the Lo-Fi prototypes presented in Section 5.5.1. Some of these have interactive elements, however these are, due to their format, not shown in the following figures. Figure 5.5 shows the current Hangar along with an alternative way of accessing the Test Tunnel as seen in Figure 5.1. Figure 5.6 illustrates how a merge between the current Private Gallery and Public Gallery could look as seen in Figure 5.2. Finally, Figure 5.7 shows a result screen after completing a flight in the Test Tunnel as seen in Figure 5.3.
Figure 5.4: This figure contains a number of small details used throughout the application. The two on the top are the current button (on the left) and the new, purposed button with a descriptive title (on the right). The middle figure on the left is the improved indicator showing how a part affects the performance of the aircraft, both in the Creative Builder and during Missions. The last row are two versions of how R2D2 can be designed to look more interactive than the current one used. The one on the left has a blue glow around it, while the right one has a rectangular arrow with an icon pointing towards it.
Figure 5.5: The finalized Hi-Fi prototype of Figure 5.1 with the current Hangar view with the suggested addition of the Test Tunnel icon.

Figure 5.6: The finalized Hi-Fi prototype of Figure 5.2 of the new, merged Public and Private Gallery view.
Figure 5.7: The finalized Hi-Fi prototype of Figure 5.3 of the newly created Reward Screen, presented after each Test Tunnel flight.
Chapter 6

Discussion

The Discussion chapter consist of five main sections: 6.1 Results, 6.2 Additional Findings, 6.3 Limitations & Drawbacks, 6.4 Future Work, and 6.5 Conclusion.

6.1 Result Discussion

In the following sections we will discuss and describe many of the results (presented in Chapter 5) gathered during the course of the thesis.

6.1.1 Framework Results

Out of the 17 issues defined during the application review process (presented in Section 5.2), only 4 were not found during the user testing (described in Section 5.3). These were number 1, 10, 13, and 16 and guesstimates behind their absence are addressed below:

Problem 1 None of the users expressed any concerns about the loading screens. This could be due to two factors: the loading screens only show up for a relatively shot amount of time (approximately 1 to 3 seconds), something that is not too frustrating or the children did not get to use the application long enough to get annoyed.

Problem 10 The heating of the device never became a problem during the user testing, something due to three things: the test were performed on an iPad (with a higher powered CPU than a smartphone), the device was always connected to a power source (allowing the CPU to perform better), and the users never held the device (it was placed flat on the floor).
The size of the application was never a real concern to the children or parents either, since the application was already installed on the supervisors iPad when they started. However, this is something we believe most children and parents will find frustrating when installing the application themselves, especially on a device with limited memory and poor cellular reception.

**Problem 13** None of the users really cared that the parts, viewed as blueprints, were hard to see, they simply placed them anyway. However, since the question was not asked, we are unable to tell if they understood what the parts would look like before building them. As a result, it might not be necessary to correct this error.

**Problem 16** Triggering OS specific features never happened during the user testing. However, this is likely due to the large form factor of the iPad compared to the one on a regular smartphone. Further testing, on a smartphone, would therefore be needed to draw any final conclusions on the matter.

There were a couple of issues that the application review process did not foresee, indicating that a revised version of the theoretical framework might be needed. With that said, some of the issues found during the user testing are however very application specific, such as the background problem in the Photo Booth described in Section 5.3.

### 6.1.2 Improvement Recommendations

While some issues discovered during the application review and the user tests have been corrected and visualized in the prototypes, many remain unaddressed. This is due to the fact that most suggested corrections can not be visualized and some of these are therefore described in the following section:

**Creative Builder**

In order to solve the most frequently occurring issues found in the Creative Builder the following three recommendations were defined:

- Increasing the touchable areas for the key-points on the ship will make them easier to press. This will eliminate most of the frustration in the Creative Builder and during Missions

- When destroying already place parts on the ship, the effect of these pieces coming apart should begin as soon as the long press action is triggered. This would then clearly show the user that the part that they are currently pressing will be destroyed. An alternative solution to this could be to have two separate modes for **building** and **destroying**.
• Adding a title on the lists of all available parts such as “wings”, “thrusters”, and “weapons” will help all users, parents and children, to understand what the pieces are, before they place them on their ship. This is useful in both the Creative Builder and during the Missions.

Test Tunnel

The following three recommendations have been made for the Test Tunnel view:

• By adding the functionality of changing direction mid-turn will allow users to feel they have more control over the ship making it possible to correct errors before it is too late. An example is if a user swipes left, changes his/hers mind, and quickly swipes right to return to the center position.

• The controls also need to be more forgiving when it comes to short and angled swipes. It is therefore recommended to lower the current threshold of what is to be considered a swipe, both the required length and distance of the action.

• If the user crashes he/she has to rebuild the ship, a feature that is represented with a fingerprint icon. This icon should fade in after around 1 second, instead of the current 4 to 5 to minimize the wait and confusion on what to do.

Photo Booth

The following two recommendations have been made for the Photo Booth:

• To simplify the task of rotating the world and the ship, a proposed method was defined based on the placement of the users finger. If the user grabs the ship, he/she would rotate the ship, if the user grabs the background, he/she would rotate the background.

• To prevent users from believing some backgrounds only contain empty space, the focus/placement of the backgrounds should center around the planets in them instead of the center of the image.

Text & Voice-Over

The solution to the heavy use of text is here addressed with two recommendations:

• The large sections of copy should be made shorter and along with a simpler language in order to get more users to read it. An alternative way of doing
this could be to introduce voice overs for the Tutorials and the Mission descriptions, allowing non-readers to fully understand the application without the need of a parent.

- Removing the glitching effect on texts (especially used in the Tutorial) along with picking a less compressed font will allow young users to easier read the texts.

Missions

The following two recommendations have been made for the Missions:

- To solve the problem of users not knowing when a mission is finished we recommend using sound, possibly of a trumpet or a short jingle, to inform the user that the mission is complete. Furthermore, confetti or flowers could come flying into the scene to symbolize “mission success”.

- In Figure 5.4 we addressed the issue of users not knowing how to the parts affect the characteristics, such as “firepower” and “size”, of the ship. What the figure does not show is that change of a characteristic is indicated with a clear colored glow, green if increased and red if decreased.

6.1.3 Additional Recommendations

While most issues in the current application have been addressed through prototypes (see Section 5.5) or in the Improvement Recommendations (see Section 6.1.2), somewhat biased, additional features and functions have purposely been left out. Some of these ideas are described in detail bellow:

Replays Since the application is built in Unity1, the ability to implement replays of Test Tunnel flights, that could later be shared with friends and family online. Not only would this feature help children understand how improvements in their flights can be accomplished, it would also be a tool for children to share their experience through a “Let’s Play2-format of sorts.

Boost Currently the fastest time that can be achieved in the Test Tunnel is 1 minute and 30 seconds. Building a ship that can reach this top speed can be accomplished after only completing approximately 2 missions (depending on their rewards). In order to make the game “last longer” a boost feature could be added in the Test Tunnel, adding another dimension to the current gameplay.

---

1For more information, see https://unity3d.com/
2A video format where users document and comment their experience in a game.
**Easter Eggs** The current application is very much a *What You See Is What You Get* (WYSIWYG) experience, meaning there are no real surprises to explore or to look for. For the younger children this is not necessary, however, for older children, 12 and up, the addition of hidden features could add to the overall experience. An example of this could be a small robot that only drives around in the background, which, when pressed, does a funny animation and flies from the scene.

**Achievements** There are currently no real achievements in the application driving the user to stay in the “play loop”. Integrating the application with services like Game Center to create challenges and achievements could further encourage children to keep playing and building.

**Character’s Ships** Users spend a lot of time building ships for Star Wars characters during Missions, something most users enjoyed. However, the ability to fly these ships in the Test Tunnel could encourage children to finish all missions before becoming bored with the application.

**Performance** While this is a highly visual experience with rich 3D characters and advanced graphical effects, the application is in need of a large performance overhaul. A target size for an application like this should be around 300 megabytes, not 820. The high CPU/GPU usage is also causing the device, especially smartphones, to lose battery very quickly resulting in a phone that is almost too hot to hold.

**Age Limit** From the user testing it became evident that children around the age of 7 have a hard time fully understanding the application. This is mostly due to the youngest’s lack of will or ability to read longer texts, even when they were asked to. However, this does not mean that they cannot be users, only that they might need some external guidance in some parts of the application. With that said, our recommendations are that the lower age limit is to be increased from 7 to 8, or possibly even 9, if no changes (such as the ones presented in Section 6.1.2 and 5.5) are made to the current application.

### 6.2 Additional Findings

The following are findings that are not considered to be directly related to the main focus of the thesis, but nonetheless related:

**Screenshots** When asked to take a photo of their newly built ship, both the two oldest, and most experienced children started looking for the home and power button on the iPad in order to create a screenshot in the creative builder. While this should still be supported, a pop-up could tell these users about the built in Photo Booth right after their screenshot action.
Interactive Elements As defined in the Theoretical Framework, it is important to clearly mark which elements are interactive and not so children understand where to, and not to, tap, something that is very well done in the current application. The parents on the other hand, often tapped on objects that neither looked, nor were, interactive, such as texts, dimmed down buttons, and static background elements.

Photo Booth While the older children (10 and up) tried and enjoyed the built-in Photo Booth features, they never spent any more time than they had during the user tests. The younger children (below 10) however spent a lot of time just exploring the photo capabilities of the application, rotating the ship, changing the backgrounds, trying different colors, etc.

Tutorial The tutorial in the current application is very well made in many ways, but most importantly it shows the user the different parts and features of the application early on. The yellow arrows, coupled with R2D2 as a guide made the children understand what the different features were and how to use them. With that said, the tutorial only takes the children so far; many of the children asked “what do I do now” when the yellow arrows stopped appearing suggesting for a longer, and possibly less mandatory onboarding experience.

Fingerprint Icon Throughout the application a fingerprint icon is used to symbolize the action “press and hold” and/or “long press”. While working very well in conveying the appropriate action, almost all children used their thumb when this symbol was showed. This could be due to how fingerprints are retrieved in movies; by placing your thumb in ink and then on paper.

The Experience All children expressed their joy in being able to participate and try the application. A majority asked if they were able to download the application on their own phone afterwards and continue playing, suggesting that the overall experience was positive. The parents however did not enjoy the application, both said they had trouble understanding the purpose of it.

6.3 Limitations & Drawbacks

Due to the time limitations there are several ways to improve upon our framework and experiments. The largest, and possibly most significant limitation, is the low number of participants in the user testing. Other limitations and drawbacks include:

Geographic Throughout this thesis, Swedish references (such as the school system, legal system, etc.) and statistics (such as media consumption, technology exposure, etc.) have been the foundation for the framework. Sweden
is considered to be among the world's most technically advanced countries \cite{55} and is therefore not a good representation for the global market. With that said, it is a good indicator of where the rest of the world will be in a couple of years.

**Gender** When children move into the third age group, 9 to 12, gender starts to play a large role \cite{21}. Boys and girls this age do not have the same interests and work in different ways, which is why an extended study needs to be conducted to see if this affects the purposed Theoretical Framework. However, this was already a defined restriction in Section \ref{sec:2.3} and is therefore acceptable.

**Tests** In order to create a more rigid framework, more tests need to be conducted. The current evaluation was only conducted on a small test group, on a single platform, using only one application as a reference. For it to be statistically sound it is important to have a larger test-base with more testers and applications to apply the Theoretical Framework to.

**Background** As stated earlier, Sweden is the main geographic reference throughout the thesis. However, there are other factors that could affect the way we interact with technology. These include social status, economical status, ethnicity, cultural heritage, etc. While some of these factors might not play a big role, further research has to be done.

**Individual Differences** All kids are different, some develop faster physically, some psychologically, and some socially, regardless of their background. This ultimately makes it impossible to create a single framework that satisfies all user needs at all time. With this said, it is important to understand that the child, the user, is never wrong.

### 6.4 Future Work

To further prove the framework's validity and robustness, there are a number of things that can be done:

**Age Groups** While covering the ages 3 to 12 is good, researching more ages would make the framework more complete. A suggestion could be to divide the remaining ages of minors into three age spans, 0-2: Babies and Toddlers, 13-15: Young Teenagers, and 16-18: Old Teenagers.

**Format** While a thesis is an appropriate way of conducting academic studies and research, it is generally not a format that is easy to consume for most non-academics. A different format/medium, such as a website, a blog post, a book, or a simple checklist, would therefore be more suitable to reach more designers.
6.5. Conclusion

Updates As more and more technology is introduced, the framework needs to be overlooked and updated to stay relevant. There are already large areas, such as virtual reality and wearable technology that need chapters of their own. As this technology becomes mass adopted, habits among children change; today we use touchscreens to interact with phones, while in the future we might just use voice input.

Further Testing As mentioned in Section 6.3, further testing can be conducted, both in the application review phase, through user testing with the current application, and also on the revised version developed using the prototypes presented in Section 5.5.

Research More references and resources can be used to further strengthen the claims made in the Theoretical Framework, but more importantly these claims need to be tested. Although the current framework builds upon “giants”, there are a lot of issues in user experience design that still needs to be discovered, defined, and categorized.

Parent Interviews While conducting user tests on parents is a good way of understanding how adults will use the application, it does not necessarily explain how they feel about allowing their children to use the application. To fully understand this, interviews, containing questions such as “Would you allow your child to use this application?”, with the parents should be conducted.

6.5 Conclusion

More than 75% of the problems found in the during the application review were also discovered during the user testing, which is considered a relatively positive result. As a result, the framework is, in this specific case, considered to be mostly functional. However, while the guidelines created work relatively well for the Lego Star Wars application, does not mean it is applicable to all digital products targeted towards children.

During this thesis we have learned many new things about user experience for both children and adults. The most evident conclusion is the fact that children and adults are different, both in how they think and act but also in how and why they use digital products. This is why designing for children requires careful consideration, well-tested user interfaces, intuitive interaction design, clear acoustics, uncluttered visual design, and at the same time entertaining content.
6.5.1 What Happens Next?

Our findings will, during the summer of 2016, be further investigated and the purposed suggestions and prototypes will be evaluated and iterated until the North Kingdom production team either approves or rejects them. The approved suggestions will then be included in a future release of the application, most likely by the end of 2016. The Theoretical Framework will also be communicated through an appropriate channel, such as an internal presentation, within North Kingdom. However, our plan is to release the framework in the format of either a website or a blog post in order to reach as many user experience designers as possible.
Chapter 7

Acknowledgments

The author would like to thank everyone at North Kingdom for their support and mentorship during this period. A special mention goes to Adrià Verdaguer, Elizaveta Shkirando, Ulrika Höjgård, Marcus Ivarsson, David Eriksson, and Linus Nilsson. Also, a sincere thank you to all the children and parents that participated as test subjects during the evaluation phase.

A huge thanks to all our interviewees: Linus Nilsson, Chris Lindgren, Petter Karlsson, and Sofia Persson, who all helped shape the Theoretical Framework and for giving the author a look into their everyday work. A special thanks to Chris Lindgren for inviting us to a full day seminar on children and gaming.¹

Thanks to all the participants, children and parents, that participated during the user tests. Thanks also to the parents of the participating children who let us borrow, record, and interview these children, our results would have looked very different without them.

Last but not least we would like to thank everyone that helped review this thesis, especially the peer-reviewers; Victor Winnhed, Albin Hübsch, Elin Nilsson, Alexandra Björnham and the mentor at Umeå University, Thomas Mejtoft.

¹For more information, see [http://www.goo.gl/VHgpjX](http://www.goo.gl/VHgpjX)
Bibliography


Appendix A

Interview Questions

• Tell us a bit about yourself:
  – What is your background; education, previous work places, etc.?  
  – What is your current title, work place, and responsibilities?  
  – How long (in time or number of projects) have you worked with UX for children?
• What are the most important/apparent differences between designing for adults and designing for children?
• How do you involve children in your design & development process?
• What do you think about dividing children into groups by age? Is this a good idea? If so which spans?
• Is there something that you can say about designing for:
  – Children in general?  
  – Children ages 3-5?  
  – Children ages 6-8?  
  – Children ages 9-12?
• Which age group would you consider to be the hardest and the easiest to design & develop a product for and why?
• Do you have any recommendations for doing research with/on children?
• If you had to recommend one app for children (any age), which app would it be and why?
• Do you have any other comments?
Appendix B

Interviewees

**Linus Nilsson**  User Experience Director at North Kingdom in Skellefteå, Sweden. The interview was conducted using Skype between the Skellefteå and Stockholm offices on the 6:th of April, 2016.

**Chris Lindgren**  Play Designer at Toca Boca in Stockholm, Sweden. The interview was conducted at Toca Boca’s offices in Stockholm on the 7:th of April, 2016.

**Petter Karlsson**  Play Designer and Research Manager at Toca Boca in Stockholm, Sweden. The interview was conducted at Toca Boca’s offices in Stockholm on the 7:th of April, 2016.

**Sofia Persson**  User Experience Designer at SVT Interactive in Stockholm, Sweden. The interview was conducted at SVT’s offices in Stockholm on the 13:th of April, 2016.