**CZECH TECHNICAL
UNIVERSITY
IN PRAGUE**

F3

Faculty of Electrical Engineering

Department of Computer Science

Master's Thesis

Design of a therapeutic application for reducing digital addictions

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Open Informatics, Software Engineering

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Supervisor: doc. Ing. Daniel Novák, Ph.D.

MASTER'S THESIS ASSIGNMENT

I. Personal and study details

Student's name: **Petrková Veronika**   Personal ID number: **492151**

Faculty / Institute: **Faculty of Electrical Engineering**

Department / Institute: **Department of Computer Science**

Study program: **Open Informatics**

Specialisation: **Software Engineering**

II. Master's thesis details

Master's thesis title in English:

Design of a therapeutic application for reducing digital addictions

Master's thesis title in Czech:

Vývoj terapeutického apliakce pro redukci závislosti na digitálních médiích

Guidelines:

1) Conduct a comprehensive review of the literature on digital addiction and analyze existing solutions.
2) Enhance an existing mobile app to track therapeutic progress and deliver tailored content feeds.
3) Develop a feature to recommend games, ranked by their engagement level and potential for addiction.
4) Perform user testing with at least five individuals to assess the updated design, and conduct both quantitative (with at least 5 users) and qualitative (with around 10 users) evaluations of the implemented application.

Bibliography / sources:

[1] K Lukavská, et. al The associations of adolescent problematic internet use with parenting: A meta-analysis, Addictive Behaviors, Volume 135, 2022,
[2] K. Lukavska, The effects of parental control and warmth on problematic internet use in adolescents: A prospective cohort study, Journal of Behavioral Addictions, 2020.
[3] K. Lukavska, The immediate and long-term effects of time perspective on Internet gaming disorder, Journal of Behavioral Addictions, 2020.
[5] Vondrackova, P., & Gabrhelık, R. (2016). Prevention of internetaddiction: A systematic review.Journal of Behavioral Addic-tions,5(4), 568–579

Name and workplace of master's thesis supervisor:

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Date of master's thesis assignment: **02.02.2024**   Deadline for master's thesis submission: **24.05.2024**

Assignment valid until: **21.09.2025**

_____   _____   _____
doc. Ing. Daniel Novák, Ph.D.   Head of department's signature   prof. Mgr. Petr Páta, Ph.D.
Supervisor's signature   Dean's signature

III. Assignment receipt

The student acknowledges that the master's thesis is an individual work. The student must produce her thesis without the assistance of others, with the exception of provided consultations. Within the master's thesis, the author must state the names of consultants and include a list of references.

_____   _____
Date of assignment receipt   Student's signature

Acknowledgement / Declaration

I want to express my sincere gratitude to doc. Ing. Daniel Novák, Ph.D., for being a kind and patient supervisor whose guidance and expertise were invaluable throughout completing this diploma thesis. I also want to express my thankfulness to Petr Bělej, a graphic and UI designer, for the opportunity to discuss my design ideas with him. I am grateful for his valuable time and professional recommendations. Lastly, I am grateful for the unwavering support of my family, friends, and my partner throughout my studies.

I declare that the presented work was developed independently and that I have listed all sources of information used within it in accordance with the methodical instructions for observing the ethical principles in the preparation of university theses.

Prague, date 24. May 2024

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Abstrakt / Abstract

Hlavním cílem této práce bylo přispět k vývoji mobilní terapeutické aplikace pro snížení závislosti na digitálních médiích. Přínos spočíval v analyzování literatury týkající se zdraví a provedení konkurenční analýzy stávajících řešení na trhu spolu se dvěma opakováními uživatelského testování se zaměřením na testování použitelnosti. Celý proces návrhu byl konzultován s odborníky z psychologie. Zjištění vyplývající z analýzy literatury, doporučení odborníků a výsledků z uživatelského testování ovlivnily fázi návrhu a implementace. Druhá iterace uživatelského testování byla provedena za účelem měření použitelnosti a zlepšení spokojenosti uživatelů. Výsledkem této práce je funkční mobilní aplikace s vylepšenou použitelností a přidaným obsahem a funkcemi na míru cílovým uživatelům.

Klíčová slova: závislost na digitálních médiích, mobilní aplikace, testování použitelnosti

Překlad titulu: Vývoj terapeutického aplikace pro redukci závislosti na digitálních médiích

The main aim of this thesis was to contribute to a therapeutic mobile application for reducing digital addictions. The contribution was made by analyzing health-related literature and conducting a competitive analysis of current solutions, along with two iterations of user testing with a focus on usability tests. The whole design process was consulted with experts in the field of psychology. Findings from a review of health-related literature, experts' recommendations, and user testing results influenced the design and implementation phase. The second iteration of user testing was conducted to measure usability and user satisfaction improvements. The result of this thesis is a functional mobile application with improved usability and added tailored content feeds and features.

Keywords: digital addiction, mobile application, usability testing

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Glossary and Abbreviations

- **screen time** - Denotes the amount of time individuals spend engaged with different electronic displays, including smartphones, tablets, television, video games, computers, or wearable technology. [1]
- **digital media** - Refers to various content that reaches the user through devices with a screen.
- **PFE coping** - Problem-focused engagement coping scores [2]
- **EFE coping** - Emotion-focused engagement coping scores [2]
- **IGD** - Internet gaming disorder
- **PIU** - Problematic internet use
- **CTU** - Czech Technical University in Prague
- **Bundle ID** - Application's unique identifier for iOS applications
- **UI** - User interface
- **CRUD operations** - Create, Read, Update, Delete operations

Chapter 1
Introduction

We live in a world where digital technologies are constantly evolving and available for everyone of all ages, including children. Digital technologies refer to computing devices equipped with screens, such as computers, mobile phones, and tablets. These devices can run various applications and frequently provide entertainment through gaming, enable immediate connection with others through social media, allow real-time access to news, and much more. Although developed for seemingly good purposes, they bring certain risks (either directly or indirectly).

Children encounter smartphones and other digital devices at a very young age, allowing them to use these technologies more naturally than their parents. However, young children are also more vulnerable to the risks associated with these devices due to their underdeveloped critical thinking skills. Therefore, parenting has become more challenging than before. Many parents are concerned about their children's safety. Still, they lack knowledge about this issue and struggle to start conversations with their children about the potential dangers and how to address them.

The main focus of the thesis will be digital parenting mobile applications, which are incredibly useful tools for parents. These applications typically offer a range of features designed to balance their children's online and offline time. Users can set screen limits, monitor online activities on the internet, track inappropriate content, monitor children's messaging applications, or even track location to ensure safety in the real world. The better approach is to educate parents about communicating with their children rather than issuing orders, bans, or tracking their activities despite their good intentions.

The thesis outcome is a mobile application that extends the existing Digital Parenting application. The application was designed to function as an educational resource, offering parents examples of how to raise their children in this digital era. I want to continue with this approach. Experts from practice, mainly psychologists, participate in the project, and all the knowledge the application will present is based on their research.

1.1 Goals

This thesis aims to contribute to the development of a therapeutic application for reducing digital addiction and promoting healthier digital habits among parents and their children. To address the issue of digital addiction, the thesis proposes to improve an existing mobile application by adding new features. These features would track the user's progress and offer personalized content feeds based on research and user testing.

The first main objective is to conduct a comprehensive review of existing literature on digital addiction, examining both the positive and negative effects on young children

and their development. Furthermore, a systematic review of similar mobile applications will be presented to compare them with the current state of the Digital Parenting application.

Following this, user testing will be conducted with a small group of participants. This evaluation will involve both quantitative and qualitative approaches to gather feedback and ideas for improvement. To do the user testing on devices, the application needs to be published publically on the App Store and Google Play Store.

The next main objective is to implement new features based on user feedback obtained through user testing. Additionally, the games module will be expanded to include new game reviews and more features will be introduced to enhance the application's usability and attractiveness. After the implementation phase, the next iteration of user testing will be conducted to evaluate the progress and gather new feedback. By achieving these objectives, the thesis aims to provide a more comprehensive solution to digital addiction while promoting healthier digital behaviors within families.

1.2 Structure

The thesis structure follows the main objectives. It consists of an introduction, four main chapters, and a final conclusion.

The first part is mainly theoretical. I aim to specify the particular risks of using digital technologies and outline their impact on children's lives. Then, I will explain why educating parents about their usage is essential. Additionally, I will evaluate existing applications, compare them, and point out their strengths and weaknesses compared to the Digital Parenting application. Moreover, I will provide a thorough evaluation of the current state of the Digital Parenting application. This will include an explanation of its core functionalities and features. Furthermore, the implementation details will also be briefly described.

The second part is intended for user testing. This section aims to provide a comprehensive understanding of how user testing was conducted and the results of its outcomes. I will present the methodology used and explain why particular methods were chosen, focusing on the usability testing approach. The testing phases, tasks, and methods of selecting the participants will be described in detail. Additionally, the results and findings obtained from the user testing will be analyzed, summarized, and presented in the form of clear and concise graphs.

Subsequently, I will outline my contributions to the application, emphasizing the implemented changes and additional features. Before starting the implementation process, the functional and non-functional software requirements will be established. The implemented changes will be described in terms of both implementation and content. I will also provide an overview of the publishing process for the most popular stores, including the iOS App Store and Google Play Store.

The final section will describe the second iteration of the evaluation process. I will omit the methodology, as it remains unchanged from the first user testing. Instead, I will focus on the interpretation of results and compare the results from the first and

second iterations of user testing. Then, I will present the conclusion of our testing processes and the implementation of the changes. In addition, I will discuss our plans for future work on the application, summarize effectiveness, and offer recommendations for enhancements in subsequent iterations.

In conclusion chapter, I will provide a brief summary of the motivation and main objectives. Each of the main sections of this thesis will be examined, and the results will be summarized in general.

Chapter 2
Research and analysis

2.1 Impact of digital technologies on children

In examining the impact of digital technologies, I will focus on children under the age of fifteen. They are typically in the early years of primary school, and their parents' role is still significant while they greatly influence their children. Therefore, it is crucial to educate parents first as they pass on their experiences to their children.

Initially, I would like to define the basic terms we will encounter: screen time and digital media. The term screen time denotes the amount of time individuals spend engaged with different electronic displays, including smartphones, tablets, television, video games, computers, or wearable technology. [1] The second term, digital media, refers to various content that reaches the user through devices with screens. This includes games, educational applications, videos, podcasts, etc.

2.1.1 Excessive screen time

Excessive screen time affects three main areas of health. It could have a negative effect on children's development and both their physical and mental health. Therefore, we have medical guidelines with the right amount of time recommended for each age category.

Particularity:

- Children **under the age of two** should not be allowed to engage in screen time.[1] [4]
- Children **between the ages of two to five years old** should spend at most one hour per day on devices. [4]
- There is no recommended screen time limit for children **older than five years**, but rather, focusing on building healthy routines is advisable.

Development

Screen time can have both risks and benefits for a child's development. The main benefit of well-chosen media is better language and literacy development, even better if the parent is co-viewing the content with the child. Responsive games and educational applications can lead to better information retention. However, with increased screen time, the risks of speech delays, communication difficulties, and autistic behavior also increase. [1, 5]

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[1] One of the reasons for not recommending children under two screens is that they do not understand the content before finishing their second year and learn intensively from interactions with parents. [3]

Physical health

Research findings have demonstrated a clear correlation between excessive screen time and undesirable body composition characterized by conditions such as higher BMI or increased fat mass. Additionally, individuals with prolonged screen exposure have higher energy intake and a tendency to make less nutritious dietary choices, opting for food high in energy but lacking fruit and vegetables containing essential nutrients. Excessive screen time before bedtime shows disturbed sleep patterns. Similar findings were observed in children, adolescents, and adults regardless of age. [6]

Mental health

The evidence supporting the connection between screen time and depressive symptoms, such as anxiety and depression, is well established. However, it is important to note that not all use of digital media is inherently connected to negative mental health outcomes. Children who use digital media moderately show a lower tendency toward mental health problems. [6]

Interestingly, girls may be more vulnerable to mental health problems with increased screen time compared to boys, as one Swedish study shows. [2] The study was conducted on 2431 boys and 2362 girls. This finding is visualized in graph 2.1 with a 95% confidence interval.
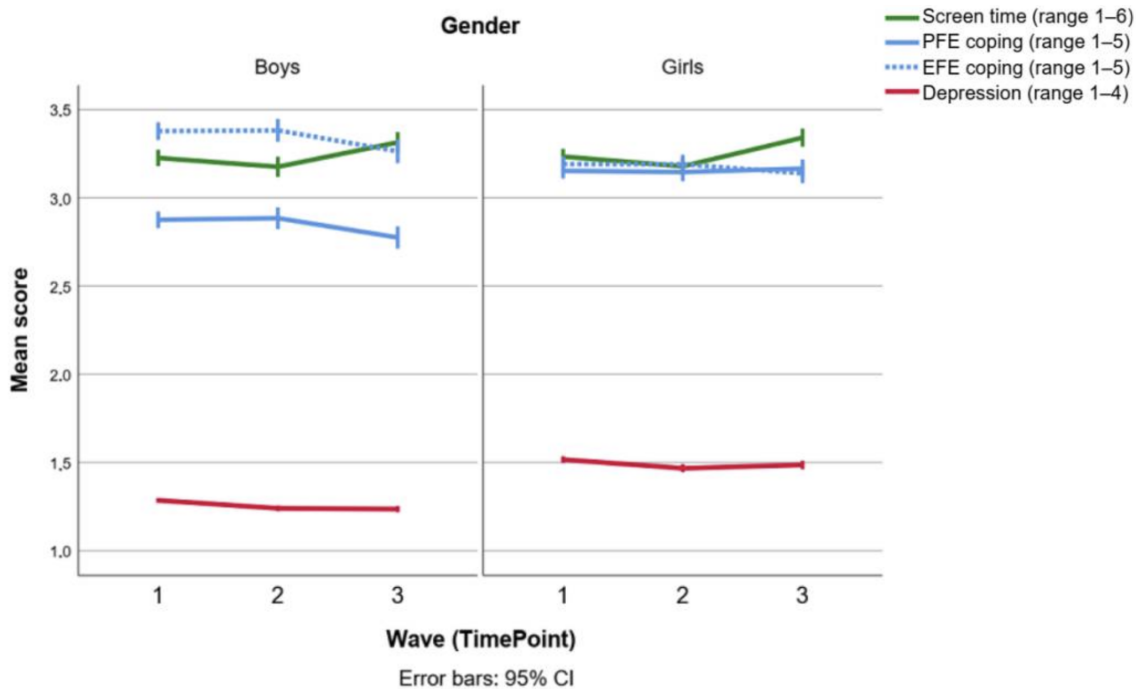
Figure 2.1. Descriptive statistics for screen time, PFE coping, EFE coping and depressive symptoms. Timepoint (1 = baseline; 2 = three months; 3 = twelve months) [2]

2.1.2 Potentially harmful content

It is easy to encounter harmful content on digital media and the internet. This applies especially to children, who are more prone to experience unwanted content via articles, videos, or games. The category itself is social media and messaging platforms

with additional hidden dangers. Therefore, educating children about online safety and responsible internet usage is crucial.

Social media

Children who use social media for multiple hours daily are more likely to experience behavioral problems, cyberbullying, online grooming, sleep difficulties, and eye problems such as myopia, eye fatigue, dryness, blurry vision, irritation, burning sensation, conjunctival injection, ocular redness, and dry eye disease. Additionally, excessive social media use can lead to sexting, exposure to pornography, unwanted sexual material online, and early sexual activity. The same relates to access to inappropriate articles or videos. [7].

Social media has a significant influence on the learning process of children aged six to twelve, both at school and at home. Excessive use of social media can reduce the effectiveness of learning as it can lead to a lack of focus. Therefore, it is recommended that young children be supervised by adults when using social media. [8]

Games

Online game addiction can have a negative impact on students' enthusiasm for learning. However, when it comes to learning the English language for non-native speakers, games can have a positive impact. Children who regularly play English games show more interest in learning because they already understand the meaning of what they are learning. [9]

Similarly, gaming should not be that much of a problem; as study [10] shows, "gamers who are more negatively time oriented are more likely to show symptoms of internet gaming disorder (IGD). In contrast, a positive orientation toward one's future seems to prevent the occurrence of IGD symptoms, even in the long term." The same study suggests that relatively non-problematic gamers are prone to losing interest in gaming, "within three years, the importance and frequency decreased".

2.1.3 Role of the parents

Research on how parenting affects teenagers' problematic internet use (PIU) found that about 8.1% of 15-year-olds in ninth grade reported having problems with using the internet excessively. This study revealed significant relationships between parenting styles and PIU. Specifically, parental responsiveness was negatively and moderately associated. "Maternal strictness showed a weak positive association. The authoritative parenting style in both parents decreased PIU, with a PIU probability of 3.21%, while a combination of maternal authoritarian and paternal neglectful parenting was associated with PIU probability as high as 20.9%". [11]

A study on gaming provides several recommendations for parents and teachers regarding children's well-being. For parents, the study suggests actively encouraging children to participate in meaningful activities without cell phones and emphasizes the importance of providing enough love and attention. Meanwhile, teachers should promote social interaction with the surrounding environment and create a conducive learning environment with close friends. [9]

Recently, the American Academy of Pediatrics has developed quick and simple guidelines for parents and clinicians on how to discuss digital media with families. It is referred to as **The 5 Cs of Media Use**. [12]

The 5 Cs stand for[1]:

- **Child** (Who is your child, how do they react to media, and what are their motivations for using it?)
- **Content** (What is worth their attention?)
- **Calm** (How do they calm down emotions or go to sleep?)
- **Crowding Out** (What does media get in the way of?)
- **Communication** (How can you talk about media to raise a smart and responsible child?)

The guidelines are divided into five handouts based on children's ages: infants, toddlers, pre-schoolers, school-age children, and older teens. In each handout, all five categories are discussed, and recommendations are given.

2.2 Competitive analysis

In this section, I will give a detailed explanation of what competitive analysis is, why it is important, and how to conduct a successful one. Then, I will walk through the process of carrying out a thorough competitive analysis specifically for the Digital Parenting application, emphasizing the main components and strategies involved.

2.2.1 Introduction

Competitive analysis is a crucial factor in achieving success with the product, as it is the best practice in marketing and sales. Conducting a competitive analysis includes identifying both direct and indirect competitors through market research to uncover their strengths and weaknesses compared to our own. Typically, this process involves creating a description of the company's target market, details about the company's product and products of competitors, pricing comparison or customer satisfaction, and measurable ratings. [13]

2.2.2 Steps taken

In conducting a competitive analysis for the Digital Parenting application, it was necessary to begin by identifying the main competitors in the market. This was done by comprehensively searching for a similar mobile application or target audience. The next step was to pick and download representative examples of the applications targeting either parents or children or both groups. The representatives included applications from small startups and big companies. I was inspired by the most downloaded parenting applications[2], as well as by comparing applications on the iOS App Store and

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[1] `https://www.aap.org/en/patient-care/media-and-children/center-of-excellence-on-social-media-and-youth-mental-health/5cs-of-media-use/`
[2] `https://www.linkedin.com/pulse/best-parental-control-apps-keep-your-kids-safe-online-directlinepro-jhvgc`

the Android Google Play Store. The only restriction was that the application should have a freemium or free trial. After conducting research, the chosen applications were downloaded and thoroughly tested.

Secondly, the advantages and disadvantages of each one were gathered. My analysis focuses on multiple criteria, and each application was evaluated and compared to others based on given criteria. For the evaluation, the following categories were selected: target audience, price structure, versions, customer satisfaction, strengths and weaknesses, functionality, design, and supported platforms.

2.2.3 Results

The results will be presented on the following pages. Each of the seven applications that were chosen, including Digital Parenting, was thoroughly tested and evaluated according to the specific criteria outlined in section 2.2.2. Eventually, I am going to compare them in a clear table.

■ Qustodio

- **Web page:** `https://www.qustodio.com`
- **Target audience:** Parents. They offers two applications, one for the parent's device and the second one for the child's device.
- **Price structure:** Subscription is monthly or yearly. Free version is not available, but they offer free trial of premium parental control features.
- **Versions:** Basic and complete. The basic application with the tools needed for core protection for \$54.95/year or \$4.58/month and complete application with advanced safety features and full customization costs \$99.95/year or \$8.33/month.
- **Customer Satisfaction:** 4.4 on App Store and 2.9 on Google Play (overall 3.65)
- **Strengths:** Great and reliable screen time management, logging, and banning when the time is up.
- **Weaknesses:** No free version is available (after trial), and even the essential functions are paid. There are multiple complaints from users that kids can hack the parental account.
- **Functionality:** The application offers various functions. You can filter content for children - in the parental application, users can apply filters on the categories of web pages that need to be blocked on children's devices or only set an alert to visit them. Integrated monitoring feature displays search history, screen time, location, and more. A parent can set the screen time, plus the internet can be shut down in a minute if the parent wants. The application also tracks suspicious contacts with whom the child exchanges messages, reads the messages' content, and blocks them if needed.
- **Design:** It has a clean look and straightforward design.
- **Platforms:** The application is available on Windows, macOS, ChromeOS, Android, iOS and Kindle.
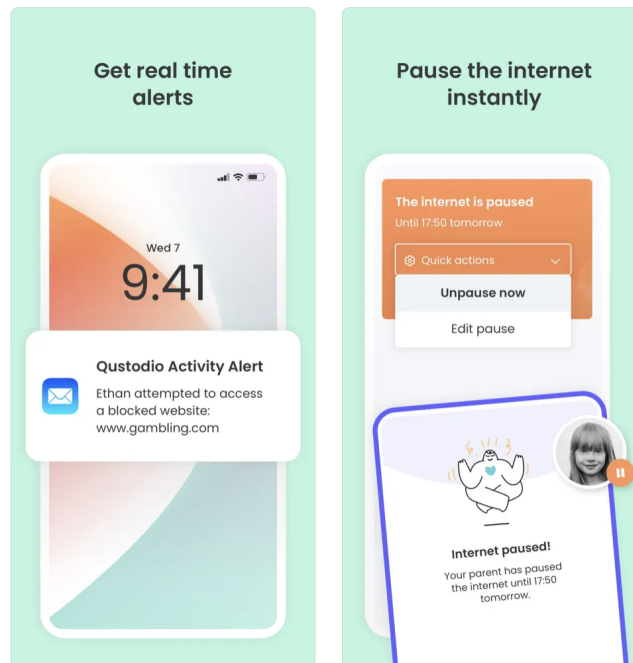
Figure 2.2. Example of screenshots from the application. The screenshots are available on the App Store page at `https://apps.apple.com/us/app/qustodio-parental-control-app/id1501720596`.

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Thumsters

- **Web page:** `https://www.thumsters.com/`
- **Target audience:** Both parents and kids. They have two applications, one for the parent's device and the second one for the child's device.
- **Price structure:** The application designed for a parent has a free version but offers a subscription with more features. The kid's version of the application is free.
- **Versions:** Basic and Subscription. The basic version is free. They offer a variety of subscriptions. Monthly Premium Subscription for $7.99, Yearly Premium Subscription for $47.99, 6-Month premium subscription for $59.99, ThumbsUp full account - 1 year for $79.99 and Monthly Premium Subscription for $12.99. Additionally, they have one more application in beta version called Thumbsters Professional, which enables therapists and clinicians to provide top-notch care and support for families in need and second one called Thumbsters Education for moder approach to education.
- **Customer Satisfaction:** 4.9 on App Store and 4.1 on Google Play (overall 4.5)
- **Strengths:** The app has an appealing design for the kids, and the creators use positive reinforcement instead of banning and restricting it. They use goal setting and a rewarding approach.
- **Weaknesses:** The app is not well known and can be considered untrustworthy.
- **Functionality:** The application allows parents to set goals for their children to work towards. Every thumbs up helps them get closer to achieving them and motivates them to be consistent with their attitudes and behavior, creating healthy habit loops. There are stats available where the parents track the progress of their child.
- **Design:** The design is attractive, full of colors, and monster-themed without looking too overwhelming.
- **Platforms:** The application is available on Android and iOS.

Figure 2.3. Example of screenshots from the application. The screenshots are available on the App Store page at `https://apps.apple.com/au/app/thumsters/id1274298804`.

■ Canopy

- **Web page:** `https://canopy.us/`
- **Target audience:** Parents. They have only one application, which can be configured as a parent application or the child's application.
- **Price structure:** The application has a 7-day free trial and then offers a paid version. The plan can be chosen from monthly to yearly.
- **Versions:** The application has only one version, but you choose how many devices you want to control. The parent can choose from a plan with up to 3 devices ($7.99 per month), a plan with up to 5 devices ($9.99 per month), and a plan with up to 10 devices ($15.99 per month). The up to 10 devices plan also includes a 15% discount on the yearly plan ($99.99 annually).
- **Customer Satisfaction:** 3.2 on App Store and 3.8 on Google Play (overall 3.5)
- **Strengths:** The application focuses on filtering inappropriate content, but the child can view the content after the parent's permission. One application that can serve as a parent or child. It is a very popular application with multiple awards and over two million devices worldwide[1].
- **Weaknesses:** There are few functionalities compared to similar applications. Users have difficulties to install it.
- **Functionality:** The application's main focus is on protecting children from inappropriate content like pornography, sexting, and sending nude pictures. They have an integrated filter that scans the webpage and filters out undesired content. It also automatically scans conversations and images taken and downloaded. The child can access the content after the parent's review.
- **Design:** The design is clean but could be more responsive and attractive.
- **Platforms:** The application is available on Windows, macOS, ChromeOS, Android and iOS.

Figure 2.4. Example of screenshots from the application. The screenshots are available on the App Store page at `https://apps.apple.com/us/app/canopy-parental-control-app/id1492266682`.

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[1] According to `https://canopy.us/`

■ **Bark**

- **Web page:** `https://www.bark.us/`
- **Target audience:** Parents. They have two applications, one for the parent's device and the second one for the child's device.
- **Price structure:** The application has a free trial and then offers a paid version with monthly fees.
- **Versions:** The application offers all features in one version; they do not have a premium version. It costs $14.00 per month, and the number of registered devices is not restricted. They offer the a mobile phone device, which has Bark's parental controls built right in, for $29/month, and Bark home, which is an internet filter for internet-connected devices in the home, starting at $9/month.
- **Customer Satisfaction:** 4.1 on App Store, 3.8 on Google Play (overall 3.95)
- **Strengths:** The application offers standard features that most of the similar applications have. The application was promoted in the most well-known media organizations. Offers unlimited kids' devices. The invention of 2023 was the introduction of a mobile with built-in parental control.
- **Weaknesses:** They do not offer a free plan (only trial), and the paid version could be expensive.
- **Functionality:** This application offers features like text, email, and web monitoring, as well as monitoring in well-known applications like Gmail, Facebook, Pinterest, YouTube, etc. It sends alerts for issues like cyberbullying, online predators, suicidal ideation, etc. It contains advice and tips from a child psychologist. The parent has information about the location of their child.
- **Design:** The design is attractive, modern, and responsive, following current trends in mobile application UI.
- **Platforms:** The application is available on Kindle, Android, and iOS mobile devices.

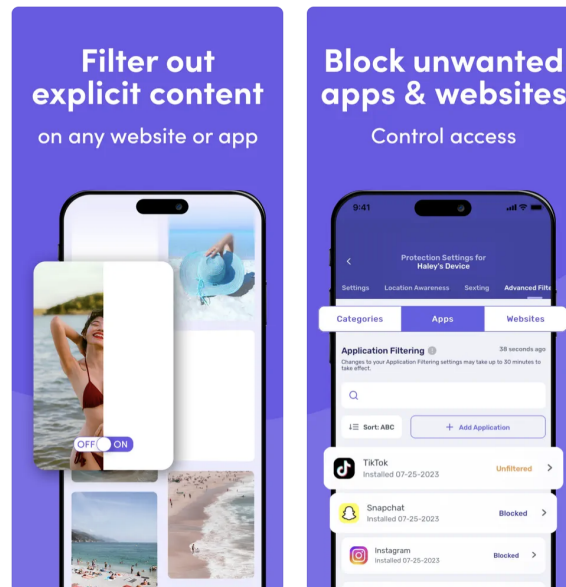**Figure 2.5.** Example of screenshots from the application. The screenshots are available on the App Store page at `https://apps.apple.com/us/app/bark-parental-controls/id1477619146`.

■ **Norton family**

- ■ **Web page:** `https://norton.com/products/norton-family`
- ■ **Target audience:** Parents. They have only one application, which can be configured as a parent application or the child's application.
- ■ **Price structure:** The application has a month-free trial and then offers a paid version with yearly pay.
- ■ **Versions:** The free trial ends after a month, and then, the application costs $49.99/year. Company Norton offers multiple applications, not only parental control. If you purchase Norton 360 Deluxe or Norton 360 Premium, you get Notron Family included in those packages. Notron Deluxe costs $54.99/year for the first year, then $119.99/year. Norton Premium costs $54.99/year for the first year, and then $139.99/year.
- ■ **Customer Satisfaction:** 3.9 on App Store and 3.5 on Google Play (overall 3.7)
- ■ **Strengths:** The application is available in 22 languages, including Czech and the brand is well-known.
- ■ **Weaknesses:** They do not offer freemium (only trial). The location service often doesn't work as expected - the location is not always actual.
- ■ **Functionality:** The application offers standard content for parental applications like monitoring sites and content that the child views, enabling setting limits on screen time and tracking the child's location. The application enables the creation of filters like school time, game time, etc., and enables/disables internet connection, applications, etc, which can be used during the filter.
- ■ **Design:** It is minimalistic with the brand's color scheme, but quite old and contains too much information - the application structure is not well designed.
- ■ **Platforms:** The application is available on Windows, macOS, Android and iOS.
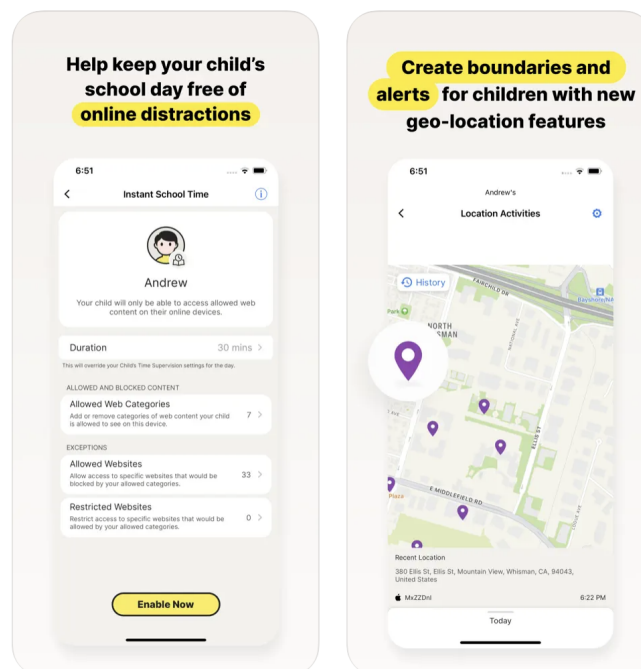
Figure 2.6. Example of screenshots from the application. The screenshots are available on the App Store page at `https://apps.apple.com/us/app/norton-family-parental-control/id1447157106`.

Pingo by Find my Kids

- **Web page:** `https://findmykids.org/`
- **Target audience:** Parents and kids. They have separate applications for parents (FindMyKids) and for kids (Pingo)
- **Price structure:** The kid's application is free, but the application for parents is paid - monthly, yearly, or unlimited.
- **Versions:** The subscription costs $2.99/monthly, $19.99/yearly, or $51,99 for an unlimited version. Any of these subscriptions do not include access to the live listening function.
- **Customer Satisfaction:** 3.7 on App Store and 4.7 on Google Play (overall 4.2)
- **Strengths:** The application offers a live listening function where the parent can actually hear who his/her kids are with. It contains a discreet SOS button. When pressed, the parent gets an urgent notification that his/her child is in a dangerous situation. A notification pops up as well if the child has a low battery.
- **Weaknesses:** The application does not offer a free version for parents, even though the kid's application is always free. Due to functions like live streaming and tracking location, the phone tends to drain the battery very fast.
- **Functionality:** Compared to other digital parenting applications, this application focuses on the kid's safety in the real world. It offers a live listening function where the parent can actually hear who his/her kids are with. Parents can get notifications when the children arrive at school, activity, or home.
- **Design:** The application was designed for kids; it is colorful and appealing, with a nice penguin avatar. It is modern, responsive, and follows design principles in mobile application UI development.
- **Platforms:** The application is available on Android and iOS or wearables with GPS tracking.
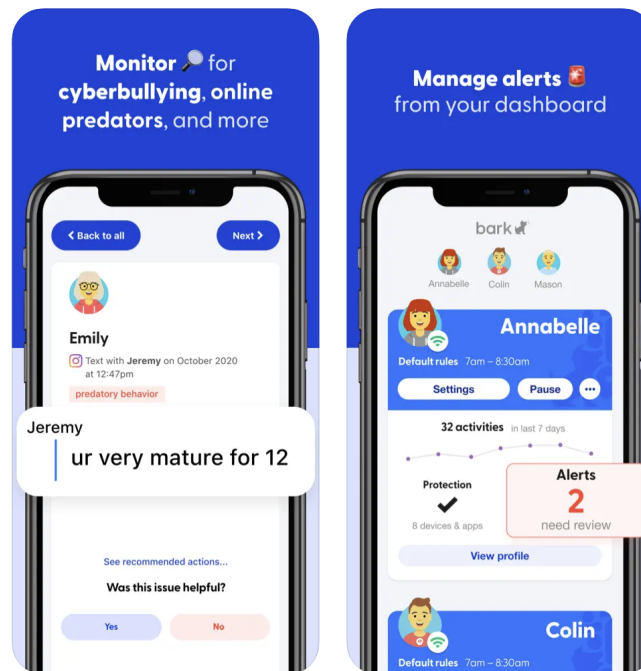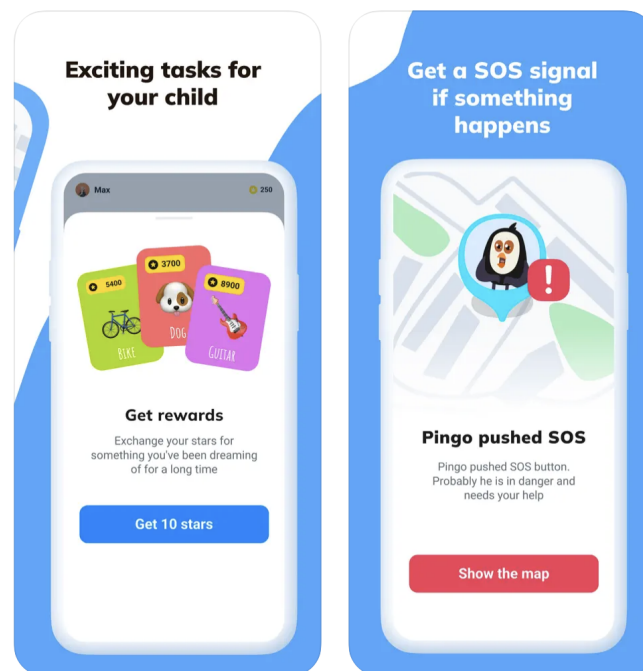

Figure 2.7. Example of screenshots from the application. The screenshots are available on the App Store page at `https://apps.apple.com/us/app/pingo-by-findmykids/id1372841733`.

■ **Digital parenting**

Digital Parenting is the mobile application being developed at the CTU and is the focus of this thesis. This review was done on the application's initial state before introducing new features and improvements. During the early stages of this thesis's development, the application wasn't publicly published on the App Store or Google Play Store.

- ■ **Web page:** `https://digital-parenting.online`
- ■ **Target audience:** The primary target audience is parents, but the application is meant to be used in cooperation with children. There is only one application, which is meant to be installed on the parent's mobile device.
- ■ **Price structure:** All functionalities in the application are free.
- ■ **Versions:** The application does not restrict any of its sections to premium accounts and is available for free.
- ■ **Customer Satisfaction:** Customer satisfaction is unknown because the application is not available online.
- ■ **Strengths:** Developed in collaboration with experts in psychology, the application serves as a comprehensive guide for parents, offering advice on implementing healthy household rules and promoting digital safety.
- ■ **Weaknesses:** The application provides only a few functionalities, it currently lacks engaging features that would encourage regular use.
- ■ **Functionality:** The application offers educational sessions for parents and enables setting rules for children's screen time, internet safety rules, and activities/zones without screens. Additionally, the application features a module with game reviews, providing scores based on multiple parameters like potential for addiction and harmful content.
- ■ **Design:** The design could be more visually appealing. It also contains multiple bugs.
- ■ **Platforms:** The application is available only on iOS TestFlight for internal testing. Android testing is conducted using .apk packages on test devices.
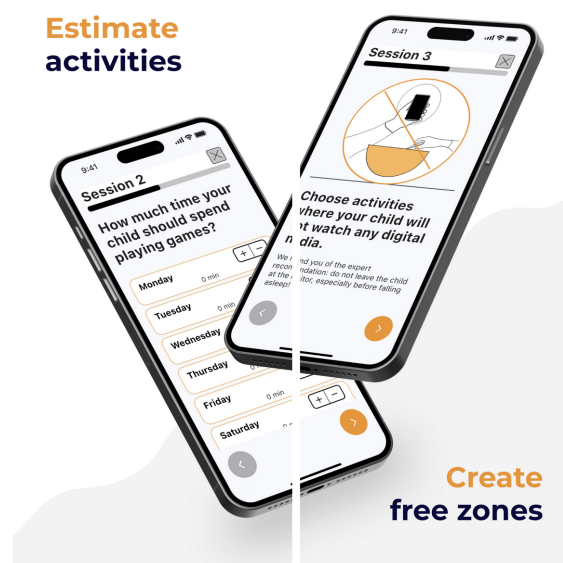
Figure 2.8. Example of screenshots from Digital Parenting application.

■ 2.2.4 Comparison and conclusion

Most of the reviewed applications focus exclusively on parents. Only Thumsters and Canopy focus on both parents and children. Each of the applications focuses on different aspects. Only one of the reviewed applications has a rating of 4.0 or higher.

The Digital Parenting application stands out with its unique approach. Even though we do not know our place in the market landscape, the application has the potential to cover the market gap by offering a manual for parents, which is not built to track children's activities or monitor content. Unlike many of the reviewed applications, Digital Parenting does not implement any tracking functionalities or track the children's activities or messages. The following table summarizes each application's key findings in four categories (target audience, strengths, and customer ratings).

Application	Target	Strength	Rating
Qustodio	Parents	Locate family	3.65
Thumster	Parents, Kids	Rewarding system	4.5
Canopy	Parents, Kids	Filtering content	3.5
Bark	Parents	recomendation	3.95
Norton family	Parents	blocking websites	3.7
Pingo	Parents	SOS button	4.2
Digital Parenting	Parents	Lectures	unknown

Table 2.1. Comparison of digital parenting applications based on selected criteria.

■ 2.3 Analysis of the current application

In this section, I will analyze the Digital Parenting application's current state, including its main functionalities, data model, backend, frontend, and the frameworks used in its implementation.

■ 2.3.1 Functionalities

The following section describes the main functionalities of the application - sessions, rules, and game scoring. Besides them, the application enables users to sign up, log in, create children, change language, and delete the account entirely.

■ Sessions

The core functionality of the Digital Parenting application is the sessions module. The application consists of six educational sessions, each focusing on a different topic. The goal of the sessions module is to educate parents and offer them suggestions on how to start a conversation with their children about rules and limits related to screen time and digital media usage. Some sessions include interactive features, such as tools for setting rules, creating screen-free zones, or reflecting on how the child uses digital media. The interactive sessions are designed for parents to involve their children and communicate the rules with them. [14] The examples of screens and UI can be found in figures 2.9 and 2.10.
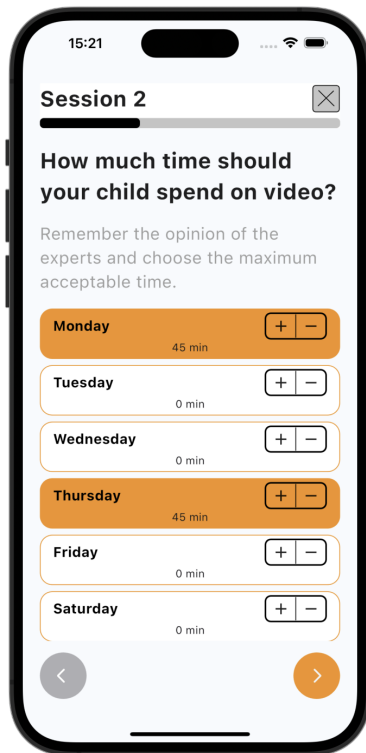
Figure 2.9. Example of interactive screen in sessions module
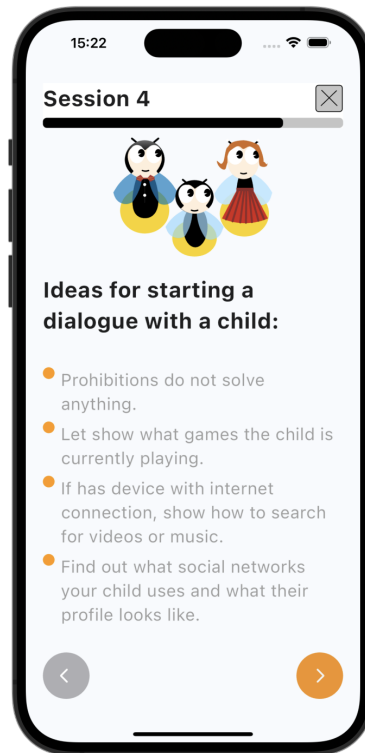
Figure 2.10. Example of static screen in sessions module

Rules

The rules module contains rules that parents can set together with their children. They are not meant to restrict but to find a compromise. The rules are categorized into four groups:

- Screen time limits
- Activities without screens
- Screen-free zones
- Internet safety rules for children

Rules are being discussed and set primarily in the sessions module. However, users can set or reset these rules individually at any time through the rules module. That means each child can have a different screen time limit or banned zones. The rules module is displayed on a separate tab for easy access and reference. The rules apply to each child individually. The examples of screens and UI can be found in figures 2.11 and 2.12.

Games Scoring

Responsible gaming requires the understanding of transparent guidelines and limitations on elements such as loot boxes, advertisements, explicit content, violence, language, and in-application purchases. These measures aim to create a secure and equitable gaming environment for users.

As the manifest declares, the gaming module not only offers practical comparisons between games but also scores them based on their content, taking into account the
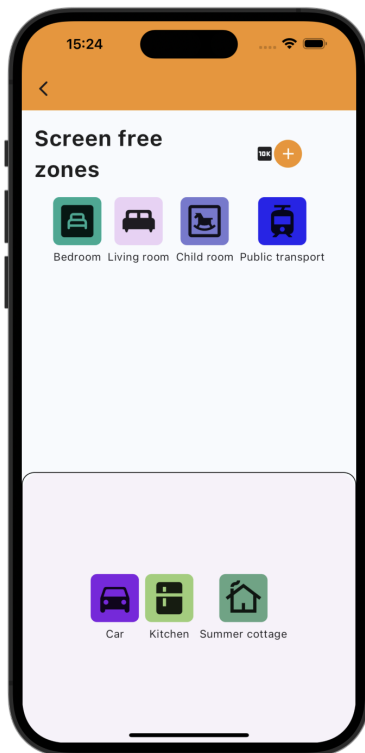
Figure 2.11. Screen free zones screen in rules module
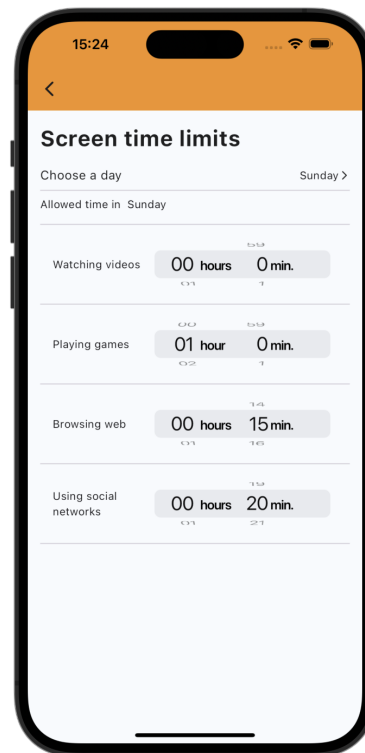
Figure 2.12. Screen time limits screen in rules module

presence of any unwanted elements previously mentioned. Registered users can comment and rate particular games to add more value to the rankings. The examples of screens and UI can be found in figures 2.13 and 2.14.

2.3.2 Implementation details

Initially, Digital Parenting was developed separately for iOS and Android devices. The Swift framework was used for iOS implementation, while Flutter was used for Android. Then, the versions were merged using only Flutter because the framework enables multi-platform development.

Flutter is an open-source framework developed by Google for building visually appealing, high-performance applications for multiple platforms using a single codebase. With Flutter, developers can write code once and compile it natively for mobile, web, and desktop platforms. The framework uses the Dart programming language and provides a wide range of pre-designed widgets, along with code samples and detailed documentation for developers[1]. [15]

Architecture

The application uses BLoC architecture principles provided by `flutter_bloc` library. This mechanism divides the application into three layers: presentation, business logic, and data layer [16], which are represented by three entities, namely State, BLoC, and

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[1] `https://docs.flutter.dev/`
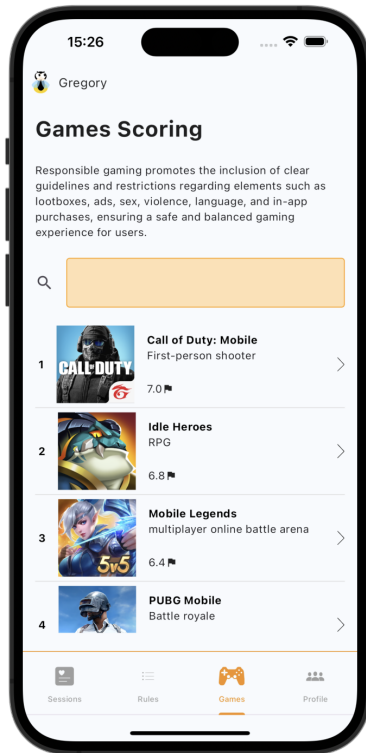
Figure 2.13. Games module overview
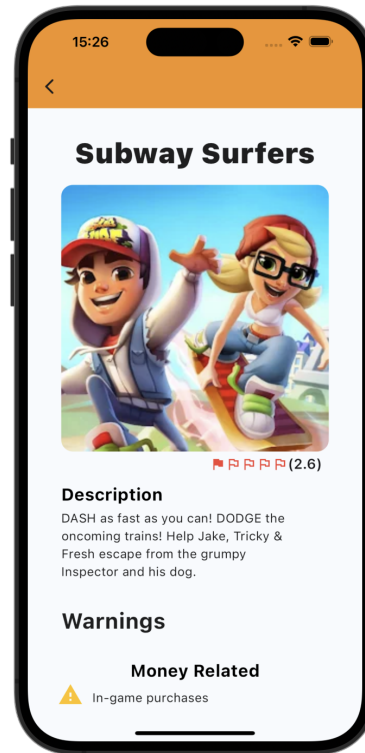
Figure 2.14. Example of game details in games module

Event. Compared to the default flutter `setState` application, the BLoC state management has smaller CPU utilization, memory usage, and execution time. [17]

UI is generated based on the application's active state. An event is an action triggered by user input or interaction with the UI (pressing a button, text input, etc.). The event contains information about actions that are forwarded to the BloC entity for processing. BLoC receives the event and reacts by emitting a new state that triggers a redraw of the UI. [14]

The application communicates with a backend server and uses MongoDB to store data. More information can be found in the following section about the backend. Locally, it uses the Hive database, which is a NoSQL offline database, to enable the application to operate in offline mode. [18]

■ Backend and Data Model

The backend server is implemented using a monolithic architecture and implements a client-server model. The client (mobile application) communicates with the server through a REST API. [19]

The backend application uses MongoDB as a database system. MongoDB uses a dynamic database schema, which allows fast and easy data storage and structure changes. The data are stored in BSON format[1] derived from popular JSON format.

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[1] `https://www.mongodb.com/resources/languages/bson`

20
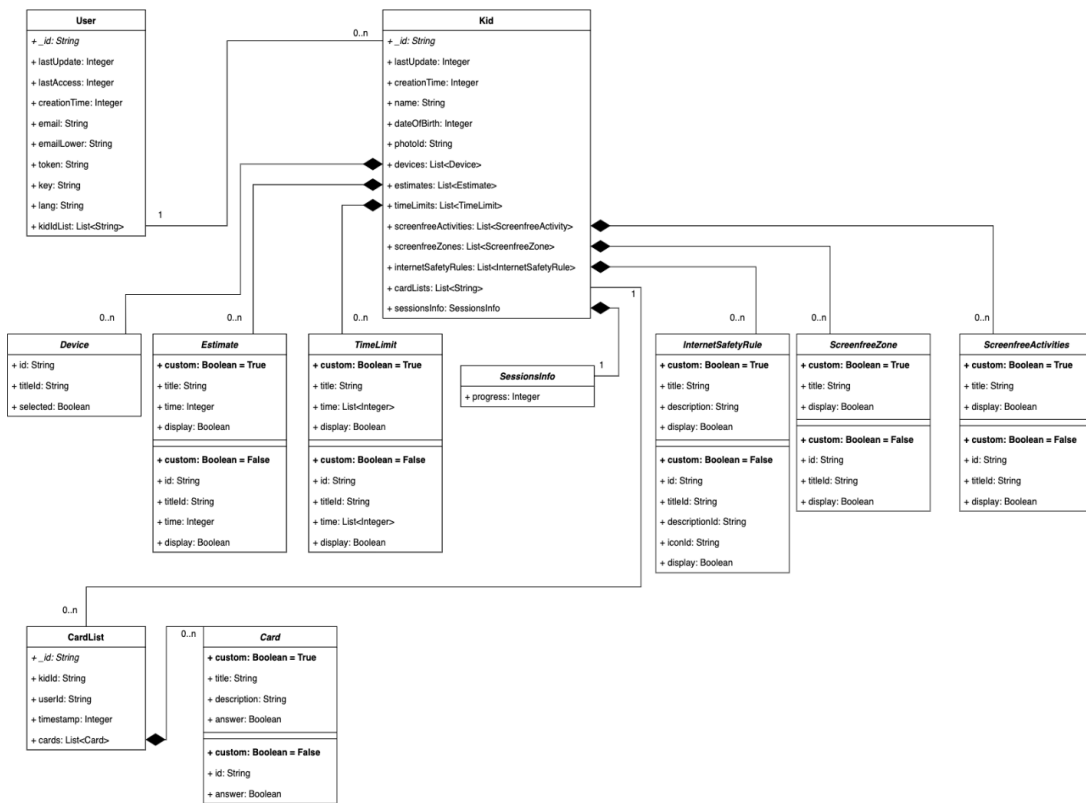
Figure 2.15. Data model [14]

Both the client application and backend server use the same data model. The data model defines two main data types: User and Kid. The data model is represented by the diagram in figure 2.15.

Chapter 3
User testing

3.1 Usability

The crucial aspect that distinguishes successful mobile applications from unsuccessful ones is usability [20]. According to Jakob Nielsen, a leading figure in the usability field, usability has multiple components traditionally associated with these five usability attributes: [21]

- **Learnability:** The system should be easy to learn so that the user can rapidly start getting some work done with the system.
- **Efficiency:** The system should be efficient to use, so that once the user has learned the system, a high level of productivity is possible.
- **Memorability:** The system should be easy to remember, so that the casual user is able to return to the system after some period of not having used it, without having to learn everything all over again.
- **Errors:** The system should have a low error rate, so that users make few errors during the use of the system, and so that if they do make errors they can easily recover from them. Further, catastrophic errors must not occur.
- **Satisfaction:** The system should be pleasant to use so that users are subjectively satisfied when using it; they like it.

Usability can be effectively evaluated through usability testing. During this process, a group of individuals representing the target audience is selected and asked to perform specific tasks on the target system. In our case, the target system is a mobile application. While doing this, each of their action is being observed and analyzed. [21] More information about the process of usability testing is described in section 3.2.2.

3.2 Methodology

A study on applications in healthcare education [22] suggests that combining different usability evaluation methods is beneficial as well as including both subjective and objective usability measures. I decided to use a combination of different user testing methods to obtain results from multiple points of view and ensure better quality and usability of our application.

3.2.1 Co-design methodology

Co-design is an approach that involves individuals from various fields to participate in the design process. The term originated in the participatory design tradition of the 1960s in Scandinavia, which emphasizes community involvement in decision-making.

The co-design method is based on this principle and involves collaboration between stakeholders to develop products from multiple perspectives. Typically, the people involved in the design process are mostly non-designers, such as end-users, domain experts, developers, or even people irrelevant to the project. However, this cooperation benefits both the research team and the participants. [23–24]

The process itself includes brainstorming sessions, stakeholder requirement meetings, usability testing, and evaluation. I incorporated all of the listed techniques in my research and testing. The stakeholders included in the process were developers, psychology and research experts, and end-users. In the thesis, I mean this established group of people (developers, psychology, and research experts) when I refer to our team.

3.2.2 Usability testing

Performing user testing with real end users is a crucial and irreplaceable method to ensure application usability. Since it is being tested on specific interfaces, it provides insights into how people think and use the application. [21] The method can be both qualitative and quantitative. The qualitative approach involves gathering observations and insights on how users interact with the application to understand their experience better. In contrast, the quantitative approach collects benchmarks and metrics describing the user experience. [25]
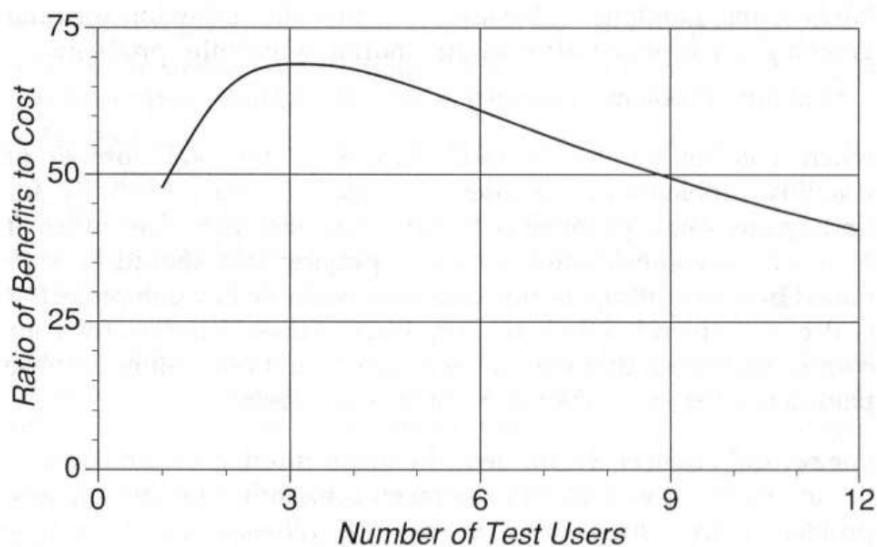
Figure 3.1. The pay-off ratio for user tests with various numbers of test users. [21]

1. Usability laboratories

There are various ways to carry out usability tests, with usability laboratories being the most commonly known method. People involved in the process are separated into two groups: participants who perform the test and observers who observe the test. A moderator is responsible for leading the entire process and communicating with the participants.

A typical usability lab consists of two rooms separated by a one-way mirror. The first room serves as a test room where the test is conducted. Usually, only the participant is present in this room, and occasionally, the moderator can visit him to check on him. On the other side of the one-way mirror is the observation room. The moderator explains the background and situation while the observers watch and take notes. [21]

2. Field/remote testing

Remote testing in the user's familiar environment enables direct observation in usability testing. The entire team doesn't have to be physically present at the exact location and time, and evaluation can be done lately without the participant. Semi-remote field testing involves the participant and moderator being physically present in the same location, usually at home. Full remote testing is conducted via video conference. This approach enables automated data collection, as the video can be replayed later. [26] The test tasks do not need to be only artificially made; the user's own tasks and goals can reveal valuable usability issues. [27]

I performed two iterations of user testing involving both qualitative and quantitative approaches. Each user group consisted of five participants, as shown in figure 3.1, indicating that an increased number of participants is not advantageous.

The test was performed as field testing. The main reason is that we did not have the resources, facilities, and equipment to perform tests in a usability lab. However, the method of field testing has its benefits, as described in the previous paragraph. [27]

3.2.3 Questionnaires

The questionnaire is a useful tool that can complement usability qualitative testing. However, relying on this method alone is considered ineffective because it proves inaccurate in identifying usability problems. Nevertheless, it can reveal issues and findings that were not identified in usability tests. [28]

I used this method as a complementary method to usability tests 3.2.2 to obtain qualitative data from the post-test questionnaire. I used open-ended questions interleaved with closed-ended ones. Closed-ended questions are easier for participants to answer and are less cognitively demanding. The drawback is that they can bias the responses. On the other hand, open-ended questions provide detailed answers and better insights, but they require more cognitive effort from the participant. [29]

3.3 User testing report

In the following section, I am going to present the result from the first iteration of user testing, emphasizing usability testing, which is considered the most crucial part. The difference between user and usability testing is that user testing includes all kinds of testing products with the users, typically observing interaction with the product. In contrast, in usability testing, participants are given a list of tasks they need to perform with the product. [30]

Firstly, there is a theoretical part explaining our objectives and methodology. The second part focuses on screening criteria and participant profiles, followed by the testing process. Finally, the results and key findings are presented together with descriptive charts. The report's template and structure were inspired by the Xtensio platform template[1].

◼ 3.3.1 Goals

Before creating the testing scenario, our team had established three main objectives we aimed to achieve through user testing. Each of them is described in detail and gives information about why the goal was essential for us.

◼ Identify bugs & issues with the product

We aimed to identify bugs and issues with our application because it is essential for improving its usability and overall user experience. A large amount of bugs in the application can lead to loss of clients and low ratings. Since we have only a pilot version of the application, the bugs will be discovered in the early stage, which significantly reduces development time and cost.

◼ Test product with the target audience

Testing with the target audience provides direct feedback from the intended users. It provides insights into how the users interact with the product, and we get to know their way of thinking. Target users may have different needs and preferences than we thought they had, and the feedback is used to make necessary adjustments to improve the product, ensuring it meets all of the user's needs.

◼ Reveal confusing experiences with the product

It is good to know which parts of the product are not simple and straightforward for the users who see it for the first time. The developers and testers may not see it because they know how the product works. User testing can provide valuable insights before launching.

◼ 3.3.2 Methodology

For our user testing, I used the usability testing method with a qualitative approach. With each participant, I conducted a moderated usability testing session with me as a moderator. This approach is described in detail in section 3.2.2. Every participant was requested to complete a post-test questionnaire within a period of one week.

◼ 3.3.3 Outreach & screening

We wanted to test our product with the representation of real users, which are parents who have at least one child in the first grade of elementary school. To ensure this, we collected a few screening criteria:

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[1] `https://xtensio.com/how-to-write-a-usability-testing-report/`

- **Age:** between thirty and fifty years old
- **Number of children:** at least one child
- **Children:** at least one child in the first grade of elementary school
- **Place of residence:** Czech Republic

I gathered the potential testing participants via random and snowball sampling strategies. At first, I asked my close family and friends who met the criteria, and then they recommended their family members, coworkers, friends, etc. If it was possible, we met and did the testing in person. If it wasn't, we communicated using the video meeting platform Google Meets with mobile screen sharing.

3.3.4   Participant profiles

I conducted the usability testing with 5 participants who met the given screening criteria. The participants' qualities and characteristics are summarized in the table, followed by charts.

Age	Gender	Number of children	Place of residence
45	male	3	Zlínský kraj
34	male	2	Středočeský kraj
47	female	2	Středočeský kraj
45	male	1	Praha
38	female	2	Moravskoslezský kraj

Table 3.1. Summary of Participants
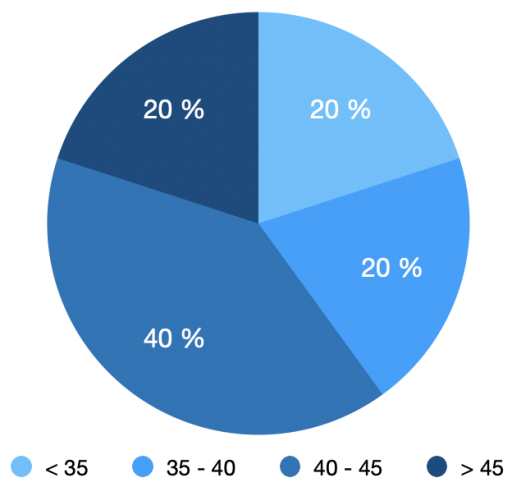
Figure 3.2. The age distribution of the participants.
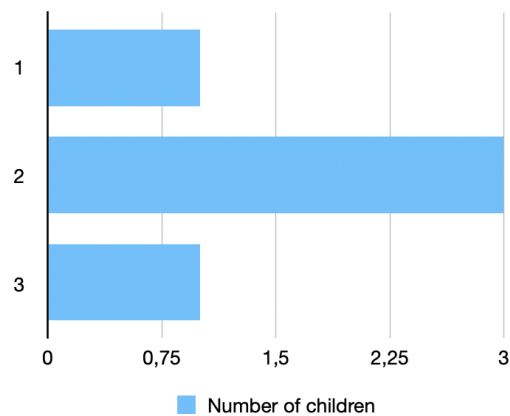
Figure 3.3. The distribution of the participants by the number of children.

3.3.5   Testing phases

- **1. Preparation:** The preparation phase occurs before the actual testing and without the participant. I went through a checklist of what needs to be done (find

information about the participant, prepare the list of tasks, link to the application, etc.).

- **2. Ice breaking:** This phase was the most critical. I welcomed the participant, introduced myself, made some small talk, and silently scanned him to get to know him.
- **3. Briefing:** I explained to the participant what I expected from him. I especially pointed out that it is desirable to make mistakes - they are not his mistakes but ours (bad design) because I do not test him but the product. I asked him to think aloud so I could get a better idea of what he was thinking about. In the end, I informed the participant that the meeting would be recorded only for my personal needs so I could get back to the crucial part of the testing if I needed to, and I asked for his consent.
- **4. Pre-test interview:** I sent him a link to the application, helped him install it (if necessary), and let him go through the login. I did not explain what I'd be testing afterward, but I gave the participant one minute to go through the application so he could get a better idea of it.
- **5. Testing:** The main part of the whole process. I was giving the task descriptions and observing his behavior and the issues he had. I tried not to interfere with his flow. Instead, I was taking notes of the observations.
- **6. Post-test interview:** In this phase, I asked for feedback - on how the participant liked the testing process, his impressions, and his evaluation. I was not asking about the application's design but his feelings towards the testing.
- **7. Debriefing:** This phase was the most informal. I thanked him for participating and explained to him what I was observing and how he helped me. If the meeting was in person, I gave the participants a small chocolate as a reward.

3.3.6 Testing tasks

Our team designed six tasks for user testing. In the testing process, I went through them in the given order. If the participant had trouble finishing some of them, I helped him a bit, or we skipped that task. It depended on how much time he already spent on the task and how close he was to completing it.

1. Task

   - **Goal:** Create a new child.
   - **Prerequisites:** The user is logged in to the application.
   - **Success criteria:** A new child is created, and the user can see it on the main page as active.

2. Task

   - **Goal:** Change the current child.
   - **Prerequisites:** The user is logged in to the application and has at least 2 children created in the application.
   - **Success criteria:** The user successfully changed the active child and the new child is displayed on the main screen as active.

3. Task

- ▪ **Goal:** Add a kitchen and bedroom to the list of screen-free zones.
- ▪ **Prerequisites:** The user is logged in to the application and the kitchen or bedroom is not present in the screen-free zones list.
- ▪ **Success criteria:** The user successfully added given rooms to the screen-free zones list. And those rooms are visible in the list.

4. Task

- ▪ **Goal:** Add a new custom screen-free zone to the list.
- ▪ **Prerequisites:** The user is logged in to the application.
- ▪ **Success criteria:** The user successfully added a new location to the screen-free zones list. This location is visible in the list.

5. Task

- ▪ **Goal:** Go through all sessions.
- ▪ **Prerequisites:** The user is logged in to the application and has not finished any sessions.
- ▪ **Success criteria:** The user successfully went through all sessions and on the home page, there is a label that no more sessions are available.

6. Task

- ▪ **Goal:** Find out the risks in Temple Run 2
- ▪ **Prerequisites:** The user is logged in to the application.
- ▪ **Success criteria:** The user navigated to the screen with the games, opened the details for the game Temple Run 2, and reviewed the warnings.

◼ 3.3.7 **Results**

Data obtained from usability testing are provided in the appendix, with a circa one-page summary for each participant. I evaluated how each of the tasks was successfully completed, which is summarized in the graph 3.4. The issues that have been categorized as significant or issues that were reported by more participants are depicted below. The results helped identify functional and non-functional requirements that are as well described and resolved in the implementation phase.

From graph 3.4, we can conclude that the tasks that caused the most confusion are tasks four and one. The first task focused on creating a new child. The low score is due to several factors, including the fact that this was the first task. Therefore, the participants were unfamiliar with the application, which influenced their performance. The second finding is that most of them naturally opened the menu drawer and searched for the option here. But in the drawer menu, there was only the option for changing a child, not adding a new one. The fourth task had the lowest score, and two participants did not manage to complete this task at all. The most confusing aspect was the iconography used for adding a new custom zone. Participants often reported that they had the plus
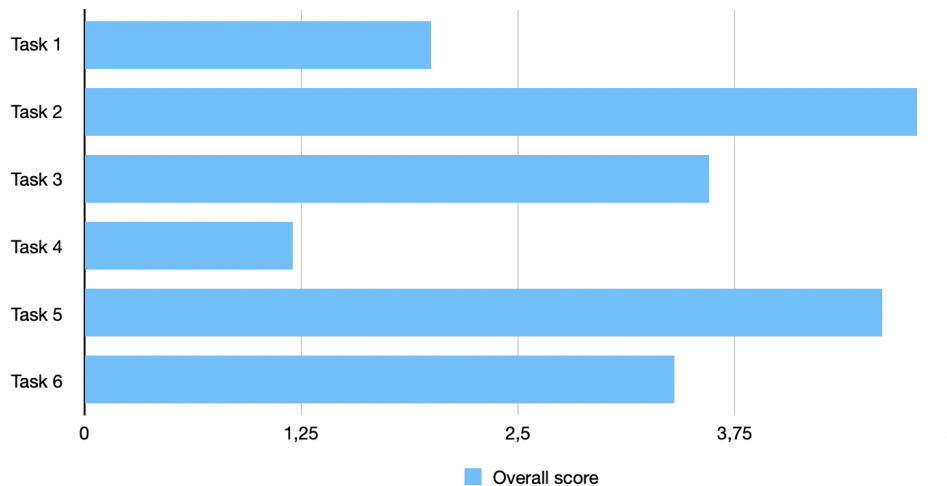
Figure 3.4. Task scores

sign associated with adding a new custom zone and did not pay attention to the 10k button at all. They thought that that was not a clickable button.

On the other hand, the tasks with the highest score were the second and fifth tasks. The participants found the solution to the second task when they were looking for the option to add a new child. This could lead to misleading results if attempting to change a child without having created one previously. However, this is the real case scenario (the user cannot change the active child without creating one). The fifth task involved reviewing all the sessions, and most participants quickly found it.

Based on my personal observations, I have concluded that participants find the application navigation confusing, especially at the beginning, and do not fully understand the purpose of the application. The design and wording in the Czech language seem to cause the most confusion. Overall, all liked the application's idea and expressed their concerns about digital media usage.

Questionnaire results

Each participant had to fill in the post-test questionnaire in a one-week period after testing. The form is in the attachments section of this thesis. The results from the post-test questionnaire were processed, and I will present the summarized results and key findings.

The graphic design of the application was evaluated on a scale of one to ten. The results can be interpreted in various ways. I chose the theory that originates from saying that people are divided into three categories. Detractors, the unhappy users, Passives, and Promoters who are satisfied[1]. The values 1-6 belong to detractors, 7-8 to passives, and 9-10 to promoters.

From graph 3.5, we can conclude that respondents did not like our graphical design, and we need to focus on it in the next phases of development.

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[1] `https://www.qualtrics.com/experience-management/customer/net-promoter-score/`
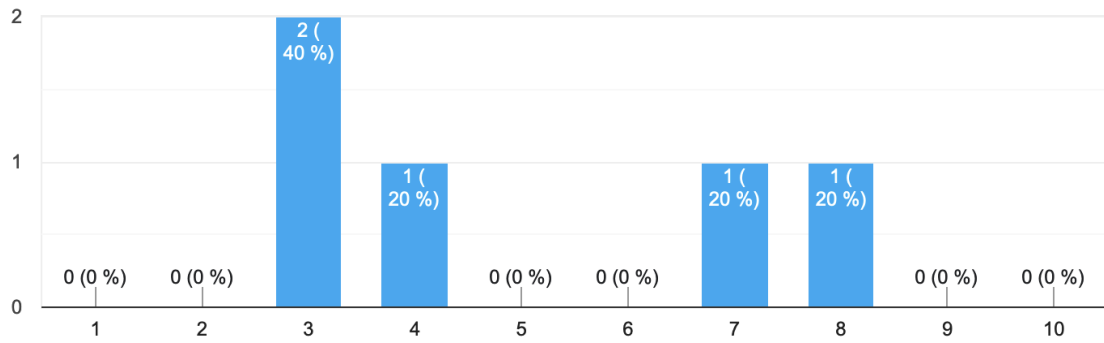
Figure 3.5. Application design scores

The sessions module was liked by respondents; they rated its quality as good. The most liked session was the last one, focusing on safe and responsible gaming. The topics that respondents would suggest focusing on in the future are AI, communication tips, recommendations on tracking tools, and YouTubers' evaluation, together with age categories. Overall, the session module was ranked as the most valuable.

The downside of the application seems to be its design and not comprehensible navigation and layout. What we need to focus on is that most participants answered that Digital Parenting is the application that they would not use on a regular basis.

The respondents liked the application's idea. Most of them did not have experience with any application for parental control, but all of them showed that they see a digital world as potentially dangerous for their children and would welcome help in navigating through it.
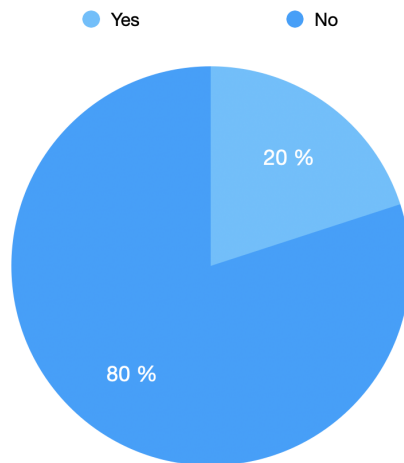
Figure 3.6. Graph representing the ratio of participants who would use the application regularly.

3.3.8 Bugs and issues

During the testing process, several bugs and issues were identified that need to be addressed before launching the new version. These issues can be categorized into a few

categories. Most of them are bugs in the user interface, and the rest are semantic. I am including screenshots of the crucial ones or the most reported ones.

■ UI bugs

There are several UI bugs that need to be addressed. These bugs are displayed in figures 3.9, 3.12, 3.11, 3.7 and 3.8.
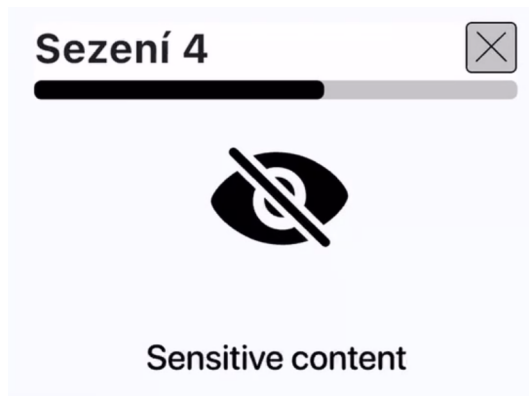
Figure 3.7. Bug 1

Figure 3.8. Bug 2

In figure 3.7, the icon is not aligned properly, and the label *Sensitive content* is a part of the icon, which means it cannot be translated to other languages.

The screen with Internet safety rules contains rules in boxes. As shown in figure 3.7, one of the rules was too long to fit into the box, and the text that overflowed was not readable.

The last session (figure 3.7) has a long description, and the start session button does not fit into the container.

Figure 3.9. Bug 3

Figure 3.10. Bug 4

Another visually disturbing element was present in screen-free zones and activities. As shown in figure 3.7, each zone had a separate colorful box. However, the colors kept changing after each user interaction, which caused confusion for the users.

The 10k button for adding a custom free zone present in the same figure caused confusion among users, resulting in a high task failure rate. In figure 3.7, the top bar overlaps with content when scrolled down.

Semantic bugs

Figures 3.13 and 3.10 illustrate the presence of semantic bugs. Figure 3.13 shows a popup window that appears when a user tries to add a custom screen-free zone, but the label doesn't provide clear instructions on what to do. Figure 3.10 is taken from the game review section, but the Czech language is poor. Additionally, many translation issues were observed during testing - labels or texts were only in English.
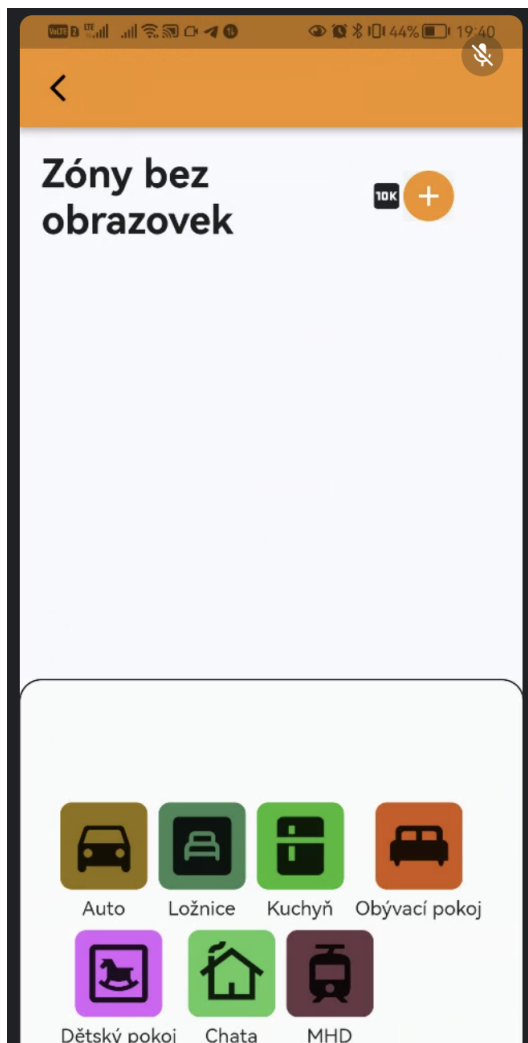
Figure 3.11. Bug 5
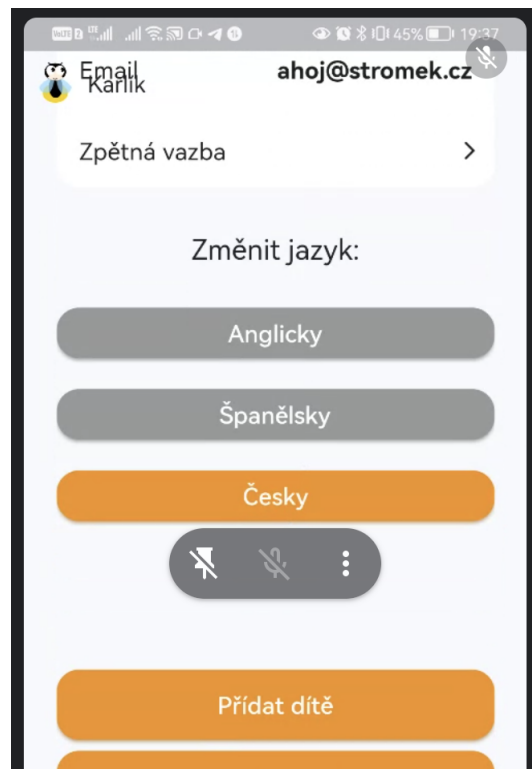
Figure 3.12. Bug 6

Logical bugs

Logical error is visible in figure 3.14. The screenshot is from the section where the user sets a time limit for children's activities. It shows that it is currently possible to restrict social site access for more than 24 hours a day, which is not logically possible.
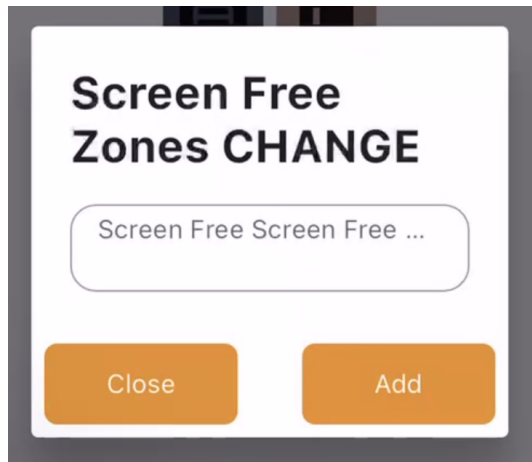
Figure 3.13. Bug 7   **Figure 3.14.** Bug 8

3.3.9 Recommendations & action items

Overall, the application's UI is not user-friendly and can be confusing. We need to address that in the implementation phase.

3.3.10 Disclaimer

It is important to remember that participants bring their own experiences and biases to the test, and that may affect their actions and impressions. The usability test method that was used has its limitations (as does every testing method). Therefore, the test results may be biased due to several factors:

▪ The sample size used may not be representative of all tager user groups for the product.
▪ Although my moderation started with a specific order of tasks and agenda, the questions and tasks given to each participant varied.
▪ Human error and incorrect interpretations of qualitative feedback can impact the outcomes.
▪ The product may contain several bugs.

3.3.11 Effectiveness and what to do better

During each testing session, six tasks were performed, which was a reasonable amount. The participants did not feel overwhelmed at the end. However, the request to go through all the sessions was not reasonable. The participants mainly focused on the first sessions and spent less time on the last ones. Next time, we will avoid such long and exhausting tasks.

I made a vast amount of notes during the testing. Next time, I will focus more on the participants and briefly note their performance. The participant profiles were too long, more than one page, and should be reduced in the second iteration of user testing because it is not necessary.

The usability testing method was beneficial, in my opinion. I received valuable feedback from a user who saw the application for the first time. The parts of the application that I considered to be straightforward were not as easy to understand for real users, and now we know what to improve.

Chapter 4
Implementation

4.1 Publishing process

To test the application in the public space, it was necessary to publish it. The application was developed using the Flutter framework, which supports publishing on the two main application stores - the App Store for iOS users and the Google Play Store for Android users. In this chapter, I will describe the steps taken to successfully publish the Digital Parenting application[1].

Publishing the application into public application stores requires a Privacy Policy[2] and Business Terms and Conditions[3] documents. A Privacy Policy explains how the application collects, uses, and protects users' data, ensuring transparency and compliance with privacy laws. On the other hand, Business Terms and Conditions set out the rules and guidelines that users must agree to when using the application. They protect the application legally and establish user responsibilities.

4.1.1 Apple App Store

Preliminaries

Three main things are needed for successful submission to the App Store:

- XCode
- Apple Developer account
- enrollment in Apple Developer Program

XCode is an integrated development environment (IDE) for developers who are building applications for Apple platforms. The IDE is only available for computers with a macOS operating system.

Apple Developer account is an essential resource for building applications for Apple ecosystem products. The basic account you can create is for free. With this account, you can access documentation, sample code, forums, and beta software but cannot distribute the applications. To be able to distribute the applications, enrollment in the Apple Developer program is needed. It is a membership-based service, and the program's annual fee is $99. [31]

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[1] The publishing process is described in the implementation chapter, even though the application needed to be published before the user testing process.
[2] https://digital-parenting.online/privacy-policy/
[3] https://digital-parenting.online/terms-and-conditions/

■ Publishing process

Each of the submitted applications requires a unique identifier known as a **Bundle ID**. This identifier must be registered with an Apple Developer account. The Bundle ID serves as a way for Apple to identify your application, ensuring that no two applications have the same Bundle ID. It is good practice to name Bundle IDs in reverse DNS format - *com.medali.digitalparenting* was used for the Digital Parenting application.

The application itself needs to be registered in App Store Connect. App Store Connect is a set of tools used by members of the Apple Developer Program to publish and manage applications [31]. The new application can be easily added after filling in the necessary application details like Bundle ID, name, or primary language.

The next step in the publishing process is to create Xcode project settings. After completing the necessary information, the application is ready to be added to the Apple Developer account.

```
open ios/Runner.xcworkspace
```

After that, App Bundle (`.ipa` file) is created by executing the following flutter command:

```
flutter build ipa
```

This generates the file that can be located in the `build/ios/ipa` directory, and from here, it can be uploaded to App Store Connect. The easiest way to do that is to use Apple Transporter App[1]. You simply dragged the generated .ipa file, and the transporter did the whole work. Now, you can see the application in your Apple developer account.

The whole publishing process needs to be finished directly in Apple Connect[2] by logging into the developer account. Just fill in the details and prepare the application for Apple store submission. After that, the application is available in App Store. [31–32]

■ 4.1.2 Google Play Store

■ Preliminaries

In order to publish an application into the Google Play Store, an account in Play Console[3] is needed. After paying a 25 USD one-time registration fee, the account is completely free.

■ Publishing process

Before submitting to the Google Play Store, the application needs to be signed with a digital certificate. Android uses two signing keys: the **upload key** and the **application**

---

[1] `https://apps.apple.com/us/app/transporter/id1450874784?mt=12`
[2] `https://appstoreconnect.apple.com`
[3] `https://play.google.com/console/`

signing key. An `.aab` or `.apk` file signed with the upload signing key is uploaded to the Play Store, while end-users download the .apk file signed with the application signing key. [32]

To obtain an application signing key, the android keystore system[1] is needed. The application already had generated a keystore, and the following command checked its validity.

```
keytool -list -v -keystore keyfile.keystore
```

The keystore must be referred to from the application in the `key.properties` file. The `build.gradle` file needs access to the keystore. The Gradle file enables automation and management of the build process. In addition to the custom keystore, the Gradle file has required properties such as `applicationId, minSdkVersion,` and `targetSdkVersion` that need to be specified. Another important file is the `AndroidManifest.xml` file, which is essential for every Android application. It provides crucial information about the application to the Android build tools, the Android operating system, and Google Play.

The last step in the publishing process is to build an application bundle and publish it into Google Play Console. The easiest way of doing it is by executing the following flutter command:

```
flutter build appbundle
```

which creates an application bundle in `/build/app/outputs/bundle/release/app.aab`. This application bundle is ready to be published in the Google Play Console. Besides uploading a new version, the application properties need to be completed. [32]

4.2 Software requirements

Misunderstandings between all interested parties (stakeholders, developers, project leaders, etc.) during software development are quite common. Therefore, the software requirements are an essential part of the software development lifecycle. They specify how the final system should behave, the features it should implement, and describe the purpose of the developed software. The software requirements guide all the crucial phases of developing new software, including design, development, and testing.

Software requirements can be divided into two main categories. Functional and Non-functional requirements. **Functional requirements** should answer the question *What?*. They define the behavior or features of the system. On the other hand, **Non Functional requirements** specify *How?*; they define the quality attributes of the system.

The software requirements for Digital Parenting were gathered in iterations on weekly meetings with psychology experts and my supervisor. The user testing result, recommendations from the experts, and our personal experience with the mobile application

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[1] `https://developer.android.com/privacy-and-security/keystore`

design helped us establish the following requirements. It is crucial to note that the implemented functionalities exceed the specified requirements, as they were discovered during the development process.

4.3 Functional requirements

Functional requirements define the behavior of the system in terms of what the system shall do. The requirements are divided into categories, and each category relates to one or a group of screens in the application.

Main screen

FR 4.1. The application should display active sessions and challenges on the main screen.

FR 4.2. The application should display a congratulations banner on the main screen when no more sessions and challenges are available.

FR 4.3. The application should enable users to evaluate the progress.

FR 4.4. The application should display the option to start the challenge on the main screen.

FR 4.5. The application should display the option to start the evaluation process on the main screen.

FR 4.6. The application should enable adding new children from the menu drawer.

FR 4.7. The application should support profile pictures in child accounts.

FR 4.8. The application should enable editing children's properties (name, date of birth, and profile image).

Blog screen

FR 4.9. The user should see a list of blog posts in the mobile application.

FR 4.10. Blog posts should support all the supported languages in the application (English, Czech, and Spanish).

FR 4.11. The system should enable creating and storing blog posts in the database.

FR 4.12. The web application should provide UI for creating new blog posts.

FR 4.13. New blog posts should be added in the runtime without the need to publish a new version of the application.

Rules screen

FR 4.14. The system should generate a PDF file with a summary of rules and screen time limits.

FR 4.15. The system should display the statistics for each child based on the evaluations made.

FR 4.16. The list of challenges should be visible from the rules screen, including the inactive challenges.

FR 4.17. The user should be able to repeat the challenge once it has been finished.

FR 4.18. Each challenge should be unlocked a week after the previous one. The first challenge should be unlocked 5 minutes after signing in.

4.4   Non-functional requirements

We gathered fewer Non Functional requirements because the application in its core is already implemented and the requirements already addressed. However, non-functional requirements define the quality of the system from technical or -ability views such as maintainability, scalability, extensibility, usability, etc.

NR 4.1. The application should support both iOS and Android platforms.

NR 4.2. The application should have a user satisfaction rating where at least 75% of respondents indicate they will use it regularly.

NR 4.3. The application should have integrated monitoring tools.

NR 4.4. The application should support multiple languages, particularly Czech, English, and Spanish, and translate all the text elements in the application.

NR 4.5. The application should include developer documentation.

NR 4.6. The application should be intuitive, allowing new users to understand main functions within 10 minutes without needing guidance.

4.5   Main features

After conducting user testing on the mobile application designed for digital parenting, several crucial insights were gathered. These insights are described in detail in the section 3.3.7 and the appendix. Following the testing and brainstorming phase, it was time to implement the changes derived from the feedback. This chapter will provide a detailed description of the implementation of these changes, along with the application's screenshots before and after.

As a result of discussions with psychology experts, we have identified three main features that need to be integrated into the application: challenges, evaluation of progress with the statistics section, and blog segment with informative articles. In addition, we managed to fix identified bugs and introduced new small functionalities that were missing, and improved the overall UI design.

4.5.1   Challenges

Challenges are introduced as a long-term feature. Each challenge encourages the parent to do an activity with his child, which creates a deeper connection and helps tighten the bond between them. Unlike sessions, challenges do not have an educational background for either parent or child. However, they reflect the central theme of digital media and safety.

The artificial limitation was added to encourage regular application usage, which the digital parenting application struggled with a lot. It is not possible to skip the challenge or unlock a different one earlier. Similarly, if the parent does not complete the previous challenge, the new one will not be opened even though the time limit has passed. However, once the challenge has been completed, the user can repeat it as many times as they want.

Each challenge has its name, brief description, image, and counter indicating how many times the challenge has been repeated. The actual content of the challenge was con-
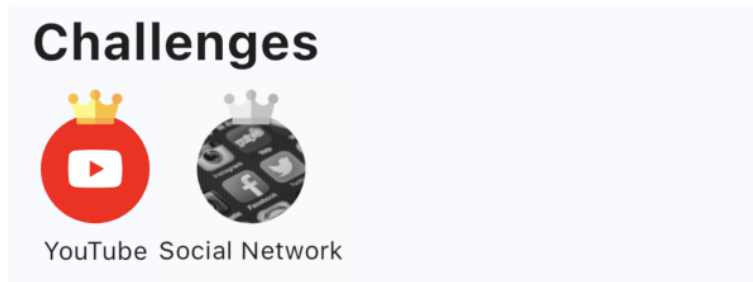
Figure 4.1. The diffenece between open and closed challenge

sulted with psychology and pedagogy experts. Initially, we introduced two challenges, and more will come in the future. The first one is focused on YouTube. The parent is encouraged to ask his child about his favorite YouTubers, watch some videos together and discuss them. In the second challenge, parents, children, and other family members work together to create a personalized family social network to share ideas, photos, and more online.

■ Implementation details

The challenge module is a brand new module; therefore, the mobile application and backend server needed to be modified. The challenge data are stored as `challengeInfo` in the database under the child entity. The `challengeInfo` entity contains three attributes. An integer `progress` indicates how many challenges the parent had completed, a list of `unlockTimes` displays unlock time for each challenge in the Long format in Unix epoch timestamp[1] and lastly, a list `numberOfRepetition` indicates how many times each challenge has been already completed.

```
challengeInfo: {
  progress: 0,
  unlockTimes: [ Long('1715687838777'), Long('1716292338777') ],
  numberOfRepetition: [ 0, 0 ]
}
```

■ 4.5.2 Blog

The blog section does not require any interaction with the children. It is a feed with blog posts on various topics. Those topics aim to inform parents about potential risks on the Internet and make them informed about what is going on in digital media and the social network world. Similar to the challenges, blog posts will be added in the future to make the user more engaged.

Our first blog posts are about how YouTube platforms can influence children and how to use AI chatbots like ChatGPT to prepare for school. Similar to the challenges, more blog posts will be added to give our users a reason to return to the application.

■ Implementation details

As the blog section is a new module separated from the current ones, it needed to be implemented completely on both the application and backend servers.

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[1] `https://www.epochconverter.com/`
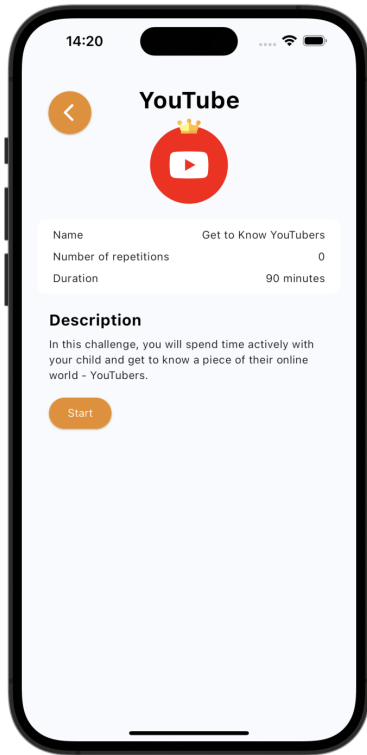
Figure 4.2. Challenge screen 1
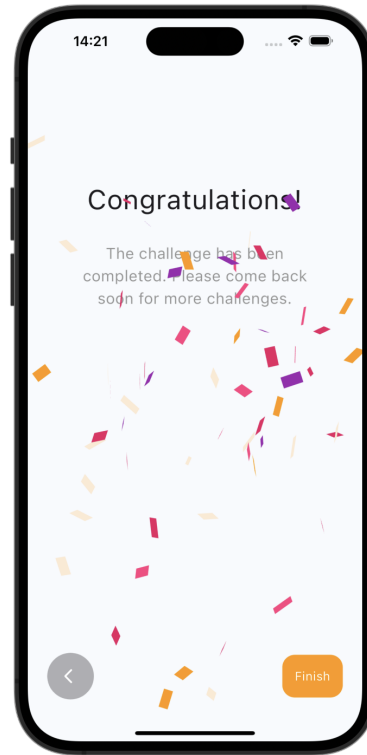
Figure 4.3. Challenge screen 2

In the backend, a whole new data entity and new endpoints were needed to list blog posts, get blog post details, and create new ones. CRUD operations were implemented, but delete is currently not supported. Admins can create new blog posts separately using a dashboard web application. Therefore, to add new blog posts, there is no need to publish new versions of the application on the Google Play Store or the App Store. In order to create a new blog post, the admin needs to fill in content in all supported languages (Czech, English, and Spanish), attach an illustrative image, and estimate the time needed to read the blog post (in minutes).

```
{
    _id: ObjectId('6639ef60d007bb325f7fe13f'),
    title_cs: 'Title in cs',
    title_en: 'Title in en',
    title_es: 'Title in es',
    content_cs: 'Content in cs',
    content_en: 'Content in en',
    content_es: 'Content in es',
    estimated_time: 5,
    image_path: '/uploads/image_name.jpg',
    date: Long('1715072864438'),
    user_list: []
}
```

Similarly, changes are reflected on the mobile application side. A new screen, cubit, state, and hive object have been created. Any time the user opens the blogposts tab, the application sends a request on the backend to check for new blog posts. Since the
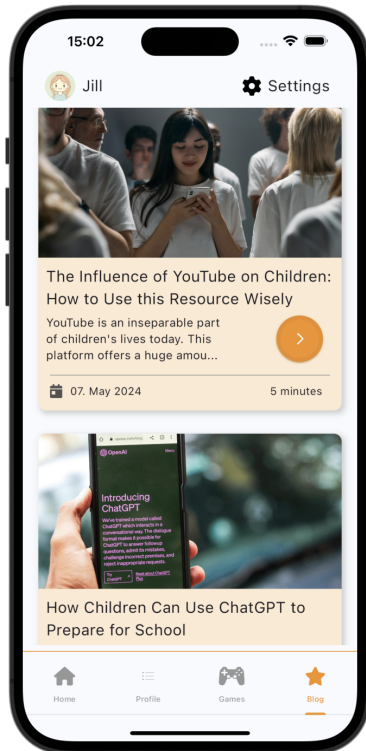
Figure 4.4. Blog screen 1
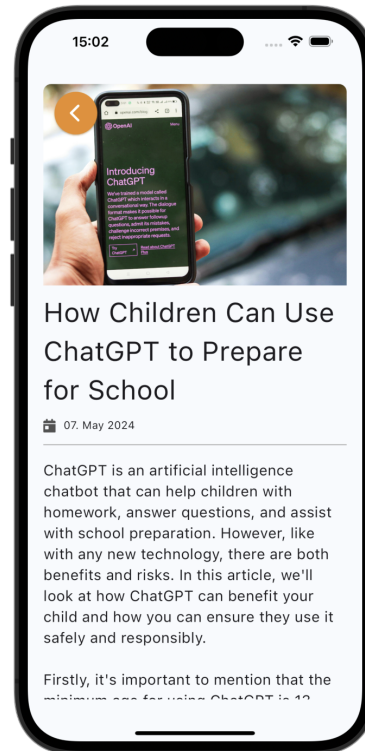
Figure 4.5. Blog screen 2

application does not have an admin interface, creating and deleting blog posts from the application is not possible.

4.5.3 Evaluation and statistics

The evaluation feature consists of two parts: the evaluation itself and the statistics derived from the evaluation results. There was missing feedback in the application. Although parents could decide with their children on screen time limits, screen-free zones, etc., they never go back in and reflect on whether the rules were set correctly and how the rules were (or were not) followed.

In the evaluation part, users evaluate four of the rule categories separately: screen time limits, screen-free zones and activities, and internet safety rules. Each category has a slider, allowing parents to set a value based on how well the rule was followed.

In the statistics section, users can view how well the rules were followed and identify the main issues. The more evaluations are made, the more accurate the statistics will be.

Implementation details

The evaluation and statistics module is also a newly introduced module. However, the statistics module is similar to the challenges module because they are related to a specific child. Likewise, the evaluation data are stored as `sliderValues` in the database under the child entity. The `sliderValues` entity contains two attributes. An integer

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number of inputs indicates how many times the evaluation has been completed, and a list of **values** displays the particular values obtained from evaluation for each of the given categories.

```
sliderValues: { values: [ 96, 72, 68, 72 ], numberOfInputs: 5 }
```

The values are stored as averages from each evaluation. The first position indicates how screen time limits were followed. The second and the third are related to screen-free activities and zones. The last one indicates how the Internet safety rules were followed. The new average can be easily calculated from the values array, an array of results from the new evaluation, and the **numberOfInputs** variable as:

$$average_i = \frac{\overbrace{prev_i \times numberOfInputs + new_i}^{all\ values\ of\ i}}{\underbrace{numberOfInputs + 1}_{new\ numberOfInputs}}$$

This calculation is performed in Flutter. Once completed, the child's information is updated, and the server updates the child's attributes in the database.

In Flutter, two modules needed to be created: the evaluation and statistics module. The evaluation module, which users can access directly from the home screen, uses the Flutter Slider widget[1] for its implementation. On the other hand, the statistics module is developed using the **fl_chart**[2] package, a Flutter package designed for creating charts. Specifically, the bar charts library was used in this case.
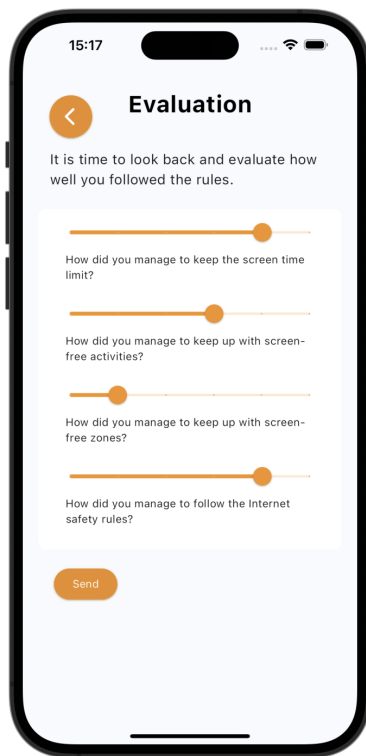
Figure 4.6. Evaluation screen
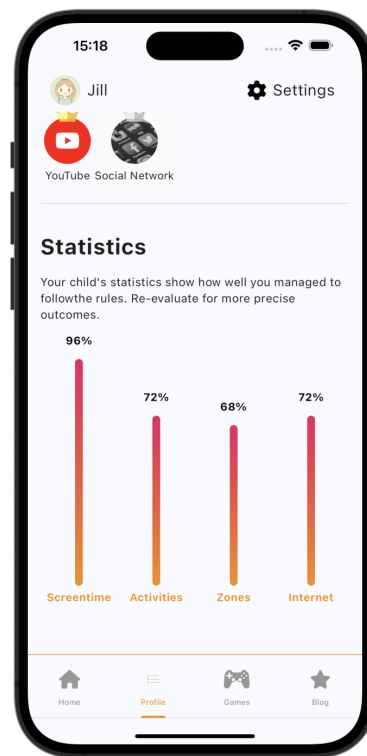
Figure 4.7. Statistics screen

---

[1] `https://api.flutter.dev/flutter/material/Slider-class.html`
[2] `https://pub.dev/packages/fl_chart`

4.6 UI improvements

The entire UI was completely redesigned to fix bugs and inconsistencies like overlapping or missing elements, iconography, or inconsistencies in color or design. Only the color scheme and images remained unchanged.

A collaborative design tool Figma[1] was used to create design mockups. A mockup is a high-fidelity simulation of how the final mobile application UI will look. Creating a mockup before the development starts can save a significant amount of time and costs because the mockup is easier to develop and change based on discussion with the team members and test users. The Figma draft can be found in the appendix of this thesis.

The application's layout was rearranged to be more user-friendly. The bottom bar categories changed:

- Session tab was replaced by Home tab
- Rules tab was renamed to Profile tab
- Games tab stayed unchanged
- Profile tab was replaced by Blog tab

The new settings screen has been added and can be accessed from the top left corner of the main screen. The drawer has been redesigned as well, and now it offers the ability to not only change the active child but also add a new one, which was the most requested feature from user testing. In the following sections, the most visible improvements will be described in more detail.

As a reflection of those changes, the general application's navigation has been changed, as depicted in Figure 4.8. The user starts on the Home screen and can navigate to Profile, Games, and Blog independently.
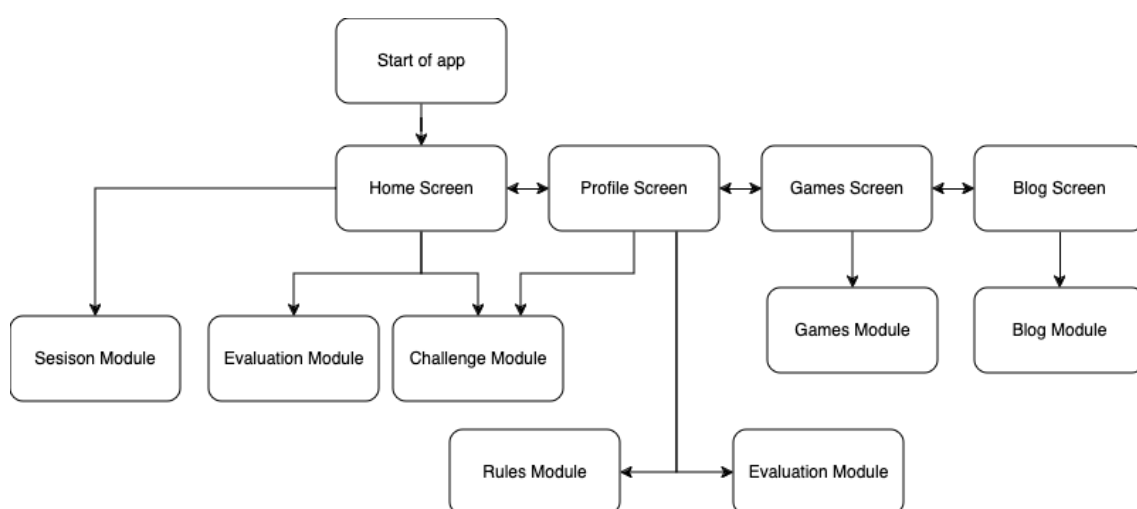
Figure 4.8. Application general navigation

---

[1] `https://www.figma.com`

■ 4.6.1 Home screen

The home screen now displays the active session, challenge, and evaluation items, serving as a notification center. The user starts the challenge or session by clicking on the start button. Once the challenge or session is completed, they disappear from the screen. When the user finishes all sessions and challenges, a congratulations banner is displayed. Evaluation items stay on the home screen because there is no limit on performed evaluations.
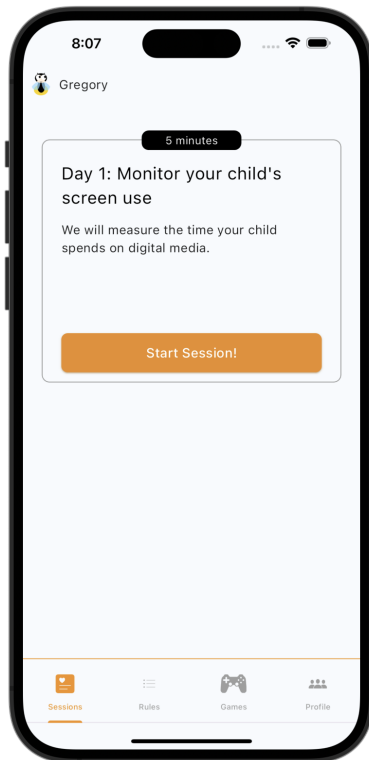
Figure 4.9. Home Screen before
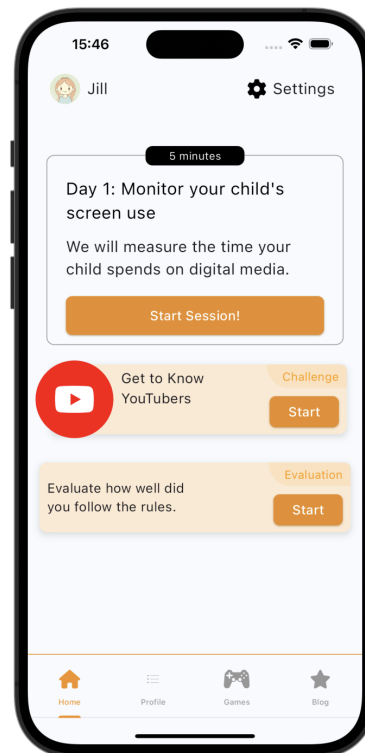
Figure 4.10. Home Screen after

■ 4.6.2 Profile screen

The profile screen contains all the settings for the particular child that is currently selected. It is now divided into three parts: rules, challenges overview, and statistics. Rules remain the same; users can display and modify rules like screen time limits, screen-free zones and activities, or internet safety rules.

Active challenges are colored in the overview panel, and inactive and greyscale challenges are colored. Users can view details for both inactive and active challenges by clicking on the icons. Detailed description is in section 4.5.1.

The statistics section displays charts, more about statistics and evaluation in section 4.5.3.

■ 4.6.3 Settings

The settings screen is a perfect example of UI redesign. It incorporates principles of proximity and usability and features a visually appealing design with icons. It includes
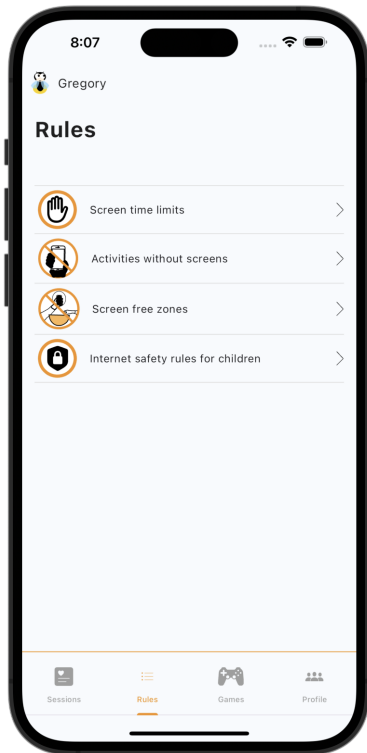
Figure 4.11. Profile screen before
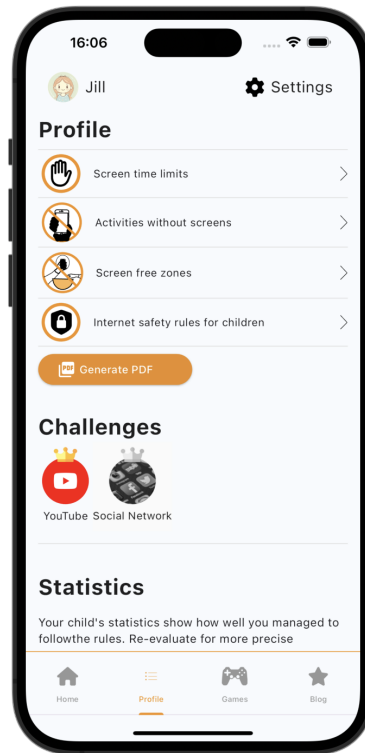
Figure 4.12. Profile screen after
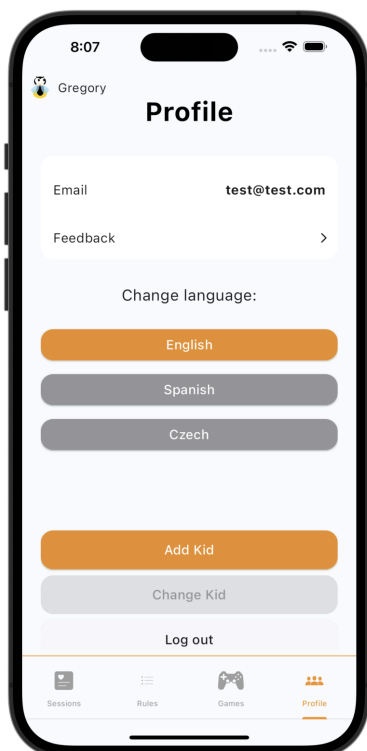
Figure 4.13. Settings screen before
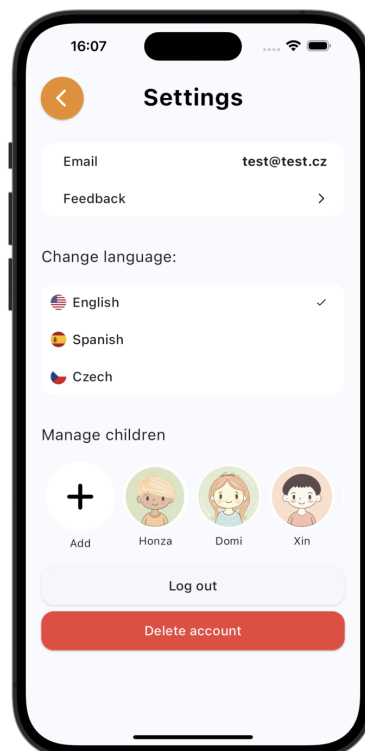
Figure 4.14. Settings screen after

flags for each language that users may be familiar with from other applications, making it easy to learn. The back button is consistently present throughout the application.

4.7 Minor features

This section outlines minor new features and improvements in the application. The changes are based on the feedback given by users in testing and questionnaires and aim to enhance user experience.

Several bugs identified during user testing have been resolved and are no longer present in the new version. A detailed list of bugs can be found in the UI bugs section. Additionally, minor relevant improvements and features addressed in the user testing report were implemented.

4.7.1 New profile pictures

Previously, children did not have profile pictures. In the new version, each child now has a profile picture, enhancing the visual representation of the child within the application. Users can select from a variety of fourteen inclusive profile pictures, each representing diverse hair, skin, and eye colors, as well as different gender representations. Profile pictures are generated using an AI generator Midjourney[1].

Figure 4.15. Example of new profile pictures

From an implementation perspective, the profile pictures are stored in the assets folder within the Flutter application's source code. These pictures are indexed from 0 to 13. To integrate this change, the children's data model needed to be modified. A new integer property, `photoId,` was added to the children's entity so only the index of selected profile picture is saved into the database, simplifying data management and reducing storage requirements. We have already deployed the server, and users are registered in the application, but their children do not have profile pictures. In order to preserve their children and ensure the application does not crash, the property needed to be nullable, and when they did not have photoId, an implicit one was used.

4.7.2 Export to PDF

This new functionality enables parents to save children's statistics and rules in PDF format. They can store it on their mobile phone or share it via email, messages, or another platform. Results of user testing and brainstorming sessions with parents suggest that parents would appreciate the option to print the rules on one page and attach it to the child's clipboard or fridge to make the rules easily accessible.

---

[1] `https://www.midjourney.com/home`

The PDF is generated at runtime when the user presses the "generate PDF" button. The Flutter `pdf`[1] and `printing`[2] packages were required to implement PDF generation and store it in the device memory.

The pdf is generated in the runtime when the user presses the generate pdf button. Flutter `pdf`[3] and `printing`[4] packages were needed to implement pdf generation and store it into device memory. Permissions were added for both iOS and Android systems to enable the storage of PDFs in memory. For Android, this line was added to the `AndroidManifest.xml` file.

```
<uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
```

For iOS, NSPhotoLibraryUsageDescription key was added to `Info.plist` file for accessing iPhone's file system.

```
<key>NSPhotoLibraryUsageDescription</key>
    <string>Save PDF</string>
```

4.7.3 Modify children

Users can now edit children's information directly within the application. This includes modifying a child's birthday, name, and profile picture, providing users with greater flexibility. This option can be found under the current child in the drawer.

To implement this change, both the application and the backend server needed to be modified. The server has been prepared for this feature and has implemented all CRUD operations.

4.7.4 Add child option in the drawer

Creating a new child directly from the drawer menu was the most requested feature. It allows users to quickly add new children without navigating through multiple screens. However, the functionality is now duplicated because we wanted to have the option to create a new child in the settings screen.

4.7.5 Deleting custom zones

Users can now delete custom zones within the application. Again, the backend was prepared for this functionality since it implements all of the CRUD operations. On the frontend, the user must long-press the zone item to delete the added screen-free zone or activity. The deletion process involves a confirmation popup to prevent unintended deletion.

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[1] https://pub.dev/packages/pdf
[2] https://pub.dev/packages/printing
[3] https://pub.dev/packages/pdf
[4] https://pub.dev/packages/printing

4.8 Conclusion

After completing all necessary publishing steps, including creating documents such as the Privacy Policy and Business Terms and Conditions, setting up developer accounts, building the application, and meeting all publishing requirements and review processes for both the Apple App Store and Google Play Store, the application was successfully published online.

The selected features, such as challenges, blog posts, evaluations, and statistics, were implemented without significant complications, as well as minor UI improvements and bug fixes. With all of the described changes, the application is ready for the next iteration of user testing. The more iterations are made, the more user-friendly the application is and offers users the content that they want.

Chapter 5
The second iteration of usability testing

After completing the implementation phase, we conducted a second iteration of user testing. The application was tested on five users performing qualitative usability and user testing and on ten users performing quantitative user testing using a questionnaire.

The methodology remains the same as it was during the first user testing and is described in detail in section 3.2. Unlike the first user testing, it was not possible to test on the devices (in the discussion section 5.2, I am explaining why). In contrast to the testing purpose, the virtual simulator of a mobile phone was used, and testing was performed on the computer. This test configuration is not ideal because it introduces additional biases into the results. However, we attempted to simulate the mobile phone environment as closely as possible.

5.1 User testing report

In the following section, I am going to present the results of the second iteration of user testing, which included both qualitative usability testing and quantitative questionnaires.

Before summarising the findings, I will explain the goals of the user testing, summarize the characteristics of the involved participants, and specify the tasks that participants were asked to perform during the testing session. This introduction will provide a clear context for the results, ensuring they can be accurately interpreted.

5.1.1 Goals

Our team established three primary goals for the user testing. The goals are similar to the first iteration of user testing in terms of identifying bugs and confusing experiences with the mobile application. However, the new goals focus on testing and evaluating the quality of updated design features and newly implemented functional features.

Test the functionality of the newly implemented features

The crucial goal is to test the functionality of the newly implemented features, primarily the Challenges, Blog, and Evaluation modules.

Test the updated design

The next goal is to test the updated design, focusing on its usability and visual attraction. The previous version had significant design issues, including numerous UI bugs and an overall design rating of 5 out of 10.

■ **Identify bugs and issues with the application**

The bugs that were identified in the first iteration of user testing are fixed in the new version of the application. However, some of them may have been missed, or the implementation may have created new bugs that need to be addressed. The application was not thoroughly tested before launch due to a lack of resources. Nonetheless, we conducted user testing to identify the bugs and, therefore, to test the application.

■ **5.1.2 Participant profiles**

The application was tested with the representation of real users, specifically the parents. Four out of five participants were the same people as in the first test. The remaining one was chosen based on our screening criteria 3.3.3. Having the same participants gave us the advantage of evaluating the progress of the application in time.

■ **5.1.3 Testing phases**

The testing phases remained the same as in the first testing. They are described in section 3.3.5. Due to the limitation of being unable to test on target devices, all tests must be performed in person.

■ **5.1.4 Testing tasks**

For the second iteration of usability testing, our team created six tasks, which we figured out to be sufficient without overwhelming the participant.

Two tasks remained the same, the second one testing the ability to create a new child and the third that creates a new custom screen-free zone. As before, I went through them in the given order. If the participant struggled with some task, I provided him assistance, or we skipped that task.

1. Task

   - **Goal:** Review the new version of the application and identify changes.
   - **Prerequisites:** The user is logged in to the application.
   - **Success criteria:** The user should list at least four improvements, including at least two major features such as Challenges, Blog, or Evaluation.

2. Task

   - **Goal:** Create a new child.
   - **Prerequisites:** The user is logged in to the application.
   - **Success criteria:** A new child is created, and the user can see it on the main page as active.

3. Task

   - **Goal:** Add a new custom screen-free zone to the list.
   - **Prerequisites:** The user is logged in to the application.
   - **Success criteria:** The user successfully added a new location to the screen-free zones list. This location is visible in the list.

4. Task

- ■ **Goal:** Read the latest blog post.
- ■ **Prerequisites:** The user is logged in to the application.
- ■ **Success criteria:** The user navigated to the screen with blog posts and opened the details of the latest one.

5. Task

- ■ **Goal:** Perform an evaluation and observe the results.
- ■ **Prerequisites:** The user is logged in to the application.
- ■ **Success criteria:** The user completes an evaluation and views the statistics.

6. Task

- ■ **Goal:** Complete the first challenge.
- ■ **Prerequisites:** The user is logged in to the application.
- ■ **Success criteria:** The user completes the YouTube challenge.

■ 5.1.5 Results

Participant profiles are included in the appendix of this thesis. This time, I decided only to note down the scores for each task and gather the list of bugs or issues each participant had with the application, along with a summary of their views. The overall scores are visualized in graph 5.1. From the obtained data, we can conclude that the fifth task caused the most confusion among the participants. Yet, overall, tasks have a high score compared to the first test.

That could be due to multiple reasons. The participants were already familiar with the application, and the changes project to the updated version is best for their recommendations and to suit their needs. The design bugs, inconsistencies, and confusing experiences were fixed, leading to an enhanced overall user experience and application usability.
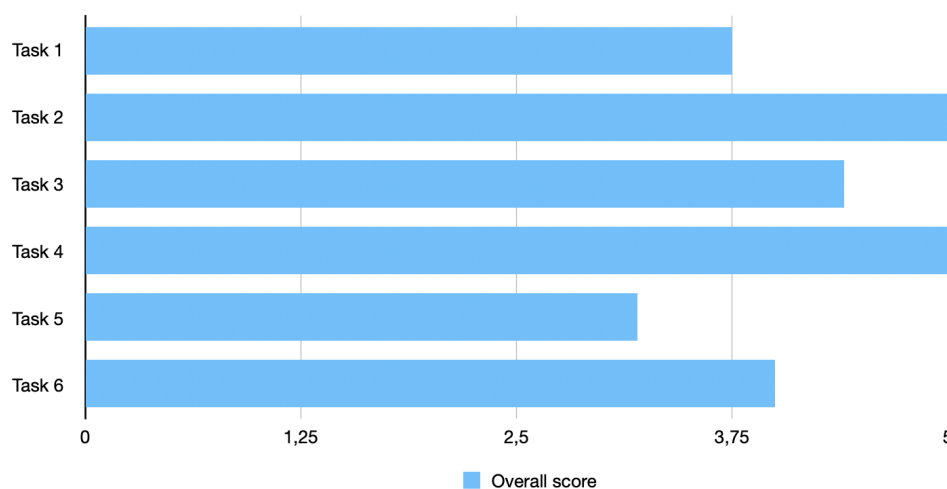
Figure 5.1. Tasks scores 2

Challenge module

The feedback for the challenge module was not negative, but the feature was not highly appreciated either. Some participants did not understand its purpose since we already have sessions in the application. However, most of the participants liked the topic of YouTubers as their children watch YouTube often.

There is a bug in the challenge details. The time counter is not correctly displayed, as shown in figure 5.2.
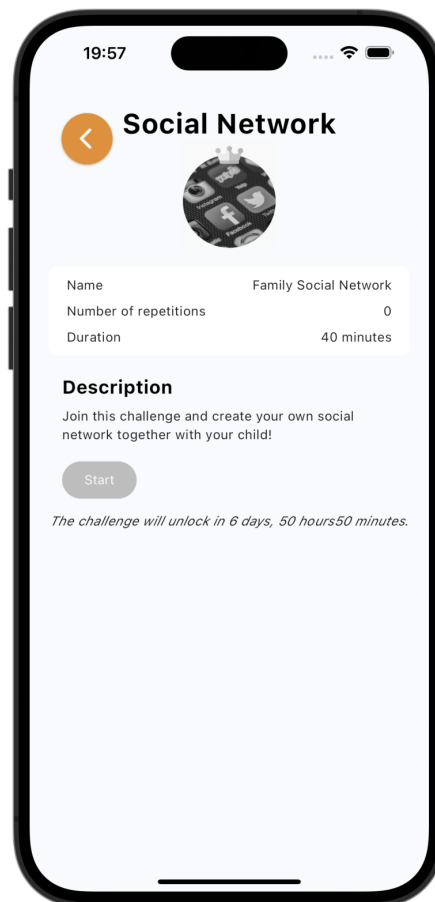
Figure 5.2. Bug in updated UI

Blog module

The blog module was popular among the participants. Many of them thought that the module was already present in the application during the first iteration of usability testing. Some participants liked that there was no action with their children required in this module, and they enjoyed it.

From the questionnaire results, participants suggested blog topics on neuroscience studies, social media platforms, or the harmfulness of blue light before bedtime.

▉ **Evaluation and statistics module**

The evaluation and statistics module was the highest rated despite causing the most confusion. The participants considered the idea of evaluation as beneficial. However, the implementation details in terms of usability should be improved.

The participants did not like the values of the sliders and labels. The labels were too close to both sliders (above and below), and sometimes, participants needed clarification on whether the description was above the slider or below it. Values on the sliders were described in natural language, but the statistics were in percentages. The participants suggested it might be better to have it unified, preferring the percentage visualization. Some participants missed the midpoint on the scale when trying to remain neutral.

After the evaluation, there is no confirmation that the results were saved, and they are not displayed on the same screen. Users needed to look for them in a different tab on the application.

▉ **Questionnaire results**

As visualized in figure 5.3, the graphical design was evaluated once again on a scale of one to ten. Using the same interpretation of results as in 3.5, we could say that the design was significantly improved. None of the participants scored the design as seven or below. Most of them even evaluated the design with a score of 9 or 10, which indicates that they liked the design.
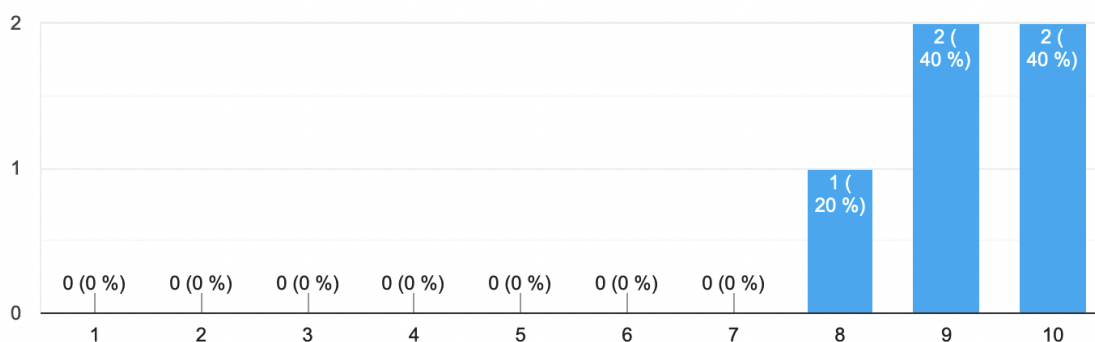
Figure 5.3. Application design scores 2

In both iterations of user testing questionnaires, we asked the same question: *Would you use the Digital Parenting application regularly?*. Unlike the results in the first testing 3.6, the respondents in the second user testing responded differently, as shown in figure 5.4. According to the results, the updated version of the application has a better chance of being used by more users on a regular basis than the previous version. In addition, all the respondents would recommend the application to their friends or family.

We gather a list of the mobile games that children are playing. We have already included some of them in our mobile application (Subway Surfers, Plants vs. Zombies, Brawl Stars). Other recommendations are games like Crossy Road, Gardenscapes, Tetris-based games, and Hungry Shark Evolution. We are integrating these games into our
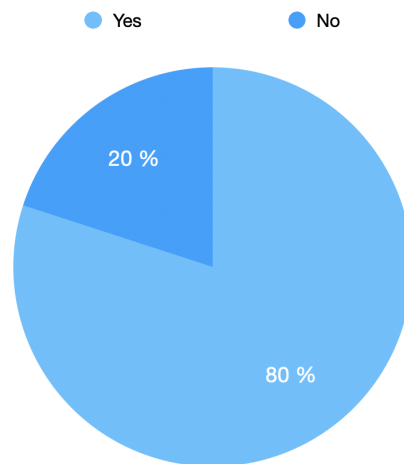
Figure 5.4. Graph representing the ratio of participants who would use the application regularly 2

application to expand our list of reviewed games that are popular among the children of our users. Maintaining the list of the most popular games is challenging. The new games are published on a regular basis, and trends are changing. However, we aim to cover the most popular ones, mostly among Czech children.

5.2 Discussion

The second iteration of usability testing provided us with valuable insight into the functionality and usability of newly implemented features, as well as evaluated the updated design and fixed bugs. The results show significant improvements in usability and user satisfaction compared to the first iteration.

The primary focus was on testing new features such as challenges, blog, and evaluation modules. The blog module received positive feedback, while the evaluation module, even if it needs some improvements, was the most appreciated feature. The challenge module received mixed feedback, with some users questioning its necessity. Overall, the main goal of attracting users to use the application on a regular basis was achieved according to the results of the user testing.

The tests were performed on mobile simulators instead of the target devices. That was caused by the inability to deploy the updated server, and therefore, publishing the new version of the application in the App Store and Google Play Store was not possible. The issue with server deployment was caused by outdated deployment instructions.

Developers from multiple countries worked on the Digital Parenting project before. According to [19], the server is hosted on the cloud platform service Heroku[1]. Unfortunately, Heroku canceled the free plan that we were using, and our account was deleted. The existing documentation for the deployment process was not updated after the Heroku account was canceled, and the server was deployed differently. We had

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[1] `https://www.heroku.com/`

two options: deploy the server again, which would result in the loss of the accounts of the already registered users, or contact the previous developers to obtain the updated deployment process. We reached out to previous developers, but the communication is slow, and we are still waiting for updated guidelines.

Chapter 6
Conclusion

The motivation behind the Digital Parenting application was the increasing use of digital media by young children and the concerns of parents. Parents are worried but unsure about the specific risks and ways to communicate the issue with their children.

The main aim of this thesis was to contribute to the development of therapeutic applications for reducing digital addiction and promoting healthier digital habits among parents and their children. This was accomplished by following several steps: conducting a competitive analysis of similar mobile applications and evaluating the current design, performing the initial round of user testing, implementing changes based on the results from user testing, and then conducting a second round of usability testing to evaluate the progress.

A systematic review of health-related literature confirmed the motivation. The competitive analysis evaluated multiple similar applications and revealed the potential market gap in the parental application market in providing parents with educational material without restrictions or tracking their child's activity.

Two rounds of user testing with a focus on usability testing were conducted. The first round was needed to examine the current state of the application in order to add the tailored features and content. After the testing phase, the outcomes were used to guide the implementation phase. Mainly, challenges, evaluations, and blog posts were added to the application in order to attract more users who would use the application regularly. The game module was extended, and the revealed navigation issues and bugs were fixed to improve the application's user experience and usability. The second round of user testing was made to track the progress. The results indicate improved usability; however, the thesis discusses potential biases that may have occurred.

The outlined aims were achieved, and a new version was developed. However, further application development is planned.

6.0.1 Future improvements

The user testing identified several areas for future improvements. Firstly, the evaluation and statistics module requires usability enhancements focusing on UI while performing the evaluation. The position and content of the labels need to be modified. Secondly, we need to include confirmation that the results were saved and where they are located.

Minor bug fixes, such as the incorrect time counter or translations, should be fixed before publishing the new version of the application. Furthermore, we are planning to expand the blog module by including not only topics suggested by users but also continuing our cooperation with experts from psychology and pedagogy.

Getting frequent user feedback and conducting more usability tests in the future is crucial to ensure the application's usability and functionality of the new features.

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Appendix A
Usability testing report

A.1 Participant 1

- **Age**: 47 years old
- **Number of Children**: 3
- **Place of residence**: Zlínský kraj
- **Form of testing**: online via Google Meets / in person

A.1.1 First testing

Tasks

- **Task 1 (create a new child)**: The participant navigated on the correct screen (profile) and was looking for an add new child button. The button was not initially visible without scrolling so he did not find it. I gave him a hint because this step was necessary for the next task.
- **Task 2 (change the current child)**: Everything was smooth and straightforward.
- **Task 3 (add a kitchen and bedroom to the list of screen-free zones)**: The participant managed to complete the task but was confused about the design.
- **Task 4 (add a new custom screen-free zone to the list)**: The participant was not sure how to add a new custom zone to the list. He tried to tap on each button on the screen, and eventually, he succeeded.
- **Task 5 (go through all sessions)**: The participant went through all sessions without assistance. He brought us some insights.
- **Task 6 (find out risks in the game Temple Run 2)**: The participant successfully read the risks of the given game. However, he was confused a bit about the iconography (he did not know the difference between an empty and filled triangle).

Task	1	2	3	4	5	6
Score	1/5	5/5	4/5	2/5	5/5	4/5

Table A.1. Overall score of participant 1 in testing 1

Issues found

- The scroll in the profile is not visible (iPhone SE 2).
- The 10k button in adding a new screen-free zone should have a different icon.
- The accordion component on the `Internet safety rules` screen is difficult to interact with.
- The question sign in the comment section is misleading.

▪ Observations

- The drawer should contain an option for adding new children.
- The background of the icons in the rules screen changes the color.
- Are short-form videos, like Instagram Reels and TikTok clips, categorized as a video-watching activity?
- Poor language choices in the Czech language.
- Which activities are related to the child's education? "I don't understand what "are related" means. I would have used a better formulation."
- The recap of the sessions would be great.
- It would be nice to know if my time assumptions are in line with the expert's recommendations.
- I don't know if an instant messaging platform (Messenger, WhatsApp, etc.) counts as social media.
- He did not understand the color codes used for the game's warnings.

▪ Evaluation

The participant really liked the app's idea, although he did not fully understand its purpose. He asked what the app for the children looks like and where he could see his child's screen time. He complained about the scrolling and language choices (which were too informal for him). He had a habit of checking if a new page was scrollable whenever he switched to it.

▪ A.1.2 Second testing

▪ Tasks score

Task	1	2	3	4	5	6
Score	5/5	5/5	4/5	5/5	3/5	4/5

Table A.2. Overall score of participant 1 in testing 2

▪ Issues found

- The time description in a new challenge is in the wrong format.
- The participant wants to be able to select a custom icon for the custom zone.

▪ Observations

The participant really liked the new app's design, especially the icons in children's profiles. The scroll issue has been resolved, and he said that it really improved the user experience. He noticed multiple features, including evaluation, generating PDF files, and new designs. Unfortunately, he was not sure whether the blog was or wasn't in the previous version. The trickiest part was the evaluation process, as he was not sure how to measure how the internet safety rules were followed. In the statistics module, having a calendar or history of ratings would be appreciated. However, the evaluation feature is the reason for using the app on a regular basis.

A.2 Participant 2

- **Age**: 35 years old
- **Number of Children**: 2
- **Place of residence**: Zlínský kraj
- **Form of testing**: online via Google Meets / in person

A.2.1 First testing

Tasks

- **Task 1 (create a new child)**: The participant opened the first session. When he did not find an option for creating a new child, he tried to click on the child's name in the top left corner and did not succeed again. Finally, he tried to open the correct screen (profile) and again was looking for an add new child button. The button was not initially visible without scrolling so he did not find it. I gave him a hint because this step was necessary for the next task.
- **Task 2 (change the current child)**: He already found the change child button (in the previous task). Therefore, everything was smooth and straightforward.
- **Task 3 (add a kitchen and bedroom to the list of screen-free zones)**: The participant opened the first session again but did not find what he was looking for. Then he tried to get through the whole app before he asked again what the task was. Eventually, he added both rooms to the list.
- **Task 4 (add a new custom screen-free zone to the list)**: The task of adding a custom screen-free zone was not completed by the participant. This was because he misunderstood the instructions and added a new pre-defined zone instead. Although I explained the correct process to him again, he was not able to complete the task successfully. Therefore, we had to skip it.
- **Task 5 (go through all sessions)**: The participant went through all sessions but did not pay attention to the descriptive texts. I thought that the silence was putting pressure on him. Instead, he often asked me what he should do.
- **Task 6 (find out risks in the game Temple Run 2)**: The participant was confused about what Temple Run 2 meant, so I had to explain to him that this was the name of some game. After the hint, he was able to find the game and warning but did not know if the task was done or what to do next, so he tried to add a comment. I stopped him at that point.

Task	1	2	3	4	5	6
Score	1/5	5/5	3/5	0/5	4/5	2/5

Table A.3. Overall score of Participant 2 in testing 1

Issues found

- The scroll in the profile is not visible (iPhone 7).
- The 10k button in adding a new screen-free zone should have a different icon.

Observations

- The drawer should contain an option for adding new children.
- The app is not well-arranged and can be a bit confusing for someone seeing it for the first time.
- Adding a custom screen-free zone should be more visible.
- An overview of the app's design and layout would be nice.

Evaluation

The participant was a bit confused about the design and what I needed from him to do. He often asked if I could repeat the task description. He was a bit impulsive and performed the tasks without thinking. But, with some improvements, he thinks that the app has a good purpose and could be helpful.

A.2.2 Second testing

Tasks score

Task	1	2	3	4	5	6
Score	3/5	5/5	4/5	5/5	3/5	4/5

Table A.4. Overall score of participant 2 in testing 2

Issues found

- After the evaluation, there is no confirmation that results have been saved.

Observations

The participant was uncertain about what had changed from previous testing. However, he felt that the design and layout were updated, and he navigated through the app more smoothly than before. At first, he was skeptical about the YouTube challenge because the child would send him back with this request, and he did not want to do it. He liked the blog posts section even if he did not notice it as a new feature at the beginning of the testing.

A.3 Participant 3

- **Age**: 45 years old
- **Number of Children**: 2
- **Place of residence**: Středočeský kraj
- **Form of testing**: in person

■ **A.3.1** **First testing**

■ **Tasks**

- ■ **Task 1 (create a new child)**: The participant tapped on the child's name in the top left corner, opened the drawer, and was looking for the option of adding a new child. When he did not find it, he went to the settings and created a new child smoothly.
- ■ **Task 2 (change the current child)**: The participant was on the correct screen from the previous task and only clicked on the option of changing the current child.
- ■ **Task 3 (add a kitchen and bedroom to the list of screen-free zones)**: At first, the participant did not know what to do and what to look for. But when he opened the correct tab, he managed to add both rooms to the list.
- ■ **Task 4 (add a new custom screen-free zone to the list)**: The participant was looking for the option on the correct screen but did not see it. He tried to find the option in the settings but was unsuccessful. He returned to the correct screen and managed to click on everything on that screen, including the 10k button. The label was not translated into Czech, but he understood that he needed to fill in the name of the new zone.
- ■ **Task 5 (go through all sessions)**: The participant went through all sessions without major issues. The only thing he did not get was that items in activities were clickable. However, participant instantly realized that already marked options were from the previous task.
- ■ **Task 6 (find out risks in the game Temple Run 2)**: The participant navigated straight to the game screen and searched for Temple Run 2. He even mentioned that there is a search bar where he could enter the game's name.

Task	1	2	3	4	5	6
Score	4/5	5/5	4/5	2/5	5/5	5/5

Table A.5. Overall score of participant 3 in testing 1

■ **Issues found**

- ■ Typo in the Start Session button.
- ■ The 10k button in adding a new screen-free zone should have a different icon.
- ■ Missing Czech translation in adding a custom screen-free zone.
- ■ The icon "Sensitive content" is not translated into Czech.

■ **Observations**

- ■ When specifying a name or nickname during onboarding, it should be made clear that it is the child's name, not the parent's name.
- ■ In the setting, we should display an option for adding and changing a child above the language change.
- ■ Poor language choices in the Czech language.
- ■ Session 1 - favorite activities: we need to specify that the parent should click on the items to mark them.
- ■ It would be great to have the option to return to the sessions that have already been finished.

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- The participant was confused about video time - does watching television count as video time?
- We should add an option for creating a custom screen-free zone in the session (now there are only pre-defined options).
- The participant was confused what is the meaning of time above the sessions.
- The term lootbox should be explained earlier.
- Placeholder "wait for next session" should be removable.
- The participant would welcome the option for exporting schedules and screen-free zones to PDF or at least have all infomation on one page.
- It would be nice to have the option of setting the same limits for both children.
- Some of the sessions were too detailed.

Evaluation

The participant really liked testing and the app itself, and he can imagine using it regularly, but he pointed out a few downsides and suggested improvements. He misunderstood that the limits were only a guideline for a child, not real limits on the device. He really appreciated that the app is in the Czech language, but the name is in English. "It would be great if we could also have the name translated into Czech."

A.3.2   Second testing

Tasks score

Task	1	2	3	4	5	6
Score	4/5	5/5	5/5	5/5	3/5	4/5

Table A.6. Overall score of participant 3 in testing 2

Issues found

- The settings button is not translated into the Czech language.
- The participant would modify the way statistics are displayed. When evaluating, the user will choose a text representation, but in the statistics section, he sees percentages.

Observations

The participant enjoyed the new app's design. Initially, it was difficult to pinpoint the changes from the previous testing, but he eventually identified them. He particularly missed the ability to generate PDFs, and now he appreciates this feature. The blog posts about AI were impressive. He would add a challenge related to this topic of AI. On the other hand, he did not appreciate the challenge with YouTubers because he distances himself from YouTube, even though his children are watching it. According to this participant, the best part of the app is the evaluation, even though the evaluation needs improvement.

A.4   Participant 4

- **Age**: 38 years old

■ **Number of Children**: 2
■ **Place of residence**: Moravskoslezský kraj
■ **Form of testing**: online via Google Meets

A.4.1   First testing

Tasks

■ **Task 1 (create a new child)**: The first thing that the participant did was go through all the screens to familiarize himself with the app's layout and screens. He found the option on the profile screen. However, he seemed to be surprised that the option was there.
■ **Task 2 (change the current child)**: The option was right under the add child option on the same screen. He only mentioned that the label "Change child" is not descriptive.
■ **Task 3 (add a kitchen and bedroom to the list of screen-free zones)**: The participant opened the correct tab (Rules) but pressed the incorrect button. He navigated to screen-free activities instead of screen-free zones. When he could not find the desired options, he realized he was in the wrong section and navigated to the correct section.
■ **Task 4 (add a new custom screen-free zone to the list)**: He was looking for the add new screen-free zone button but accidentally clicked on the 10k button, which allowed him to create a new custom zone. He completed the task overall but admitted that he unintentionally clicked the button.
■ **Task 5 (go through all sessions)**: The participant managed to go through all sessions without major complications.
■ **Task 6 (find out risks in the game Temple Run 2)**: The participant managed to complete the last task also without complications.

Task	1	2	3	4	5	6
Score	4/5	5/5	3/5	2/5	5/5	5/5

Table A.7. Overall score of participant 4 in testing 1

Issues found

■ The scroll is not always visible.
■ The app has inconsistencies in font size, color, and graphics.
■ The plus sign in session 2 is on the left side. It is good practice to have it on the right side.

Observations

■ "Change child" should have different name. It suggests that parents want to change their children to different ones.
■ When the screen-free zones or activities list is empty, the participant does not know if the page is empty or loading.
■ He attempted to close the bottom panel used to add new screen-free zones or activities by clicking somewhere else on the screen.

- Session 1 - favorite activities: the participant did not know if the activities should be his or his child's.
- Which activities are related to the child's education? The description is misleading.
- The participant nearly missed session 1 and was changed to session 2. He suggested using images in session screens.
- There was an issue with presenting too much information at once, especially regarding child internet safety rules.
- The participant suggested displaying or mentioning PEGY ratings for games.

Evaluation

The participant appreciated the app's approach of explaining and discussing digital media topics with children instead of imposing restrictions and monitoring. He would appreciate more straightforward rules for communicating with children. However, the app's design could be more consistent, and the language choices could be improved in the future.

A.5 Participant 5

- **Age**: 47 years old
- **Number of Children**: 1
- **Place of residence**: Praha
- **Form of testing**: in person

A.5.1 First testing

Tasks

- **Task 1 (create a new child)**: The participant clicked on the name that opened the drawer. He was looking to add a new child button but was unsuccessful. The second guess was to open the profile tab, and here he added a new child without complications.
- **Task 2 (change the current child)**: He already knew where the option for changing the child was (the drawer). The sessions' screen was immediately refreshed without loading, which caused his minor confusion.
- **Task 3 (add a kitchen and bedroom to the list of screen-free zones)**: After searching the app a bit, the participant found the correct screen and added both screen-free zones to the list.
- **Task 4 (add a new custom screen-free zone to the list)**: The participant thought that the custom screen could be added from the bottom overlay. He energetically clicked on everything, including the 10k button, but the popup was not well described, so he closed it, and I moved to the next task.
- **Task 5 (go through all sessions)**: The participant completed all sessions without major issues. He made a few suggestions, which are described in the observations section below.
- **Task 6 (find out risks in the game Temple Run 2)**: The participant went straight to the games section and found the correct game. However, he was confused by the description and warnings' iconography.

Task	1	2	3	4	5	6
Score	3/5	4/5	4/5	0/5	4/5	4/5

Table A.8. Overall score of participant 5 in testing 1

Issues found

- The Loading indicator in the game screen is broken.
- The warnings in the game details are not aligned, and the description is confusing.
- There are font inconsistencies in the app.
- Poor language choices in the Czech language ("zpovzdálí", "paří hry", "prosedí", etc.).
- The white colors in the active session background and progress bar background are not the same.

Observations

- The color of icons in games' warnings is not self-descriptive.
- The participant wanted to understand which aspects of games are major problems and which are minor issues.
- The participant wanted the ability to change the child's properties, specifically the name.
- The term lootbox is not well described.
- A session counter would be appreciated.
- During the onboarding, the participant should fill in their name. However, the participant is unsure whether to provide their own name or the name of their child.
- The participants thought that the information filled in the sessions would not be saved.

Evaluation

The participant sees that ensuring children's safety on digital media and the internet is a concern. However, he does not know what is beneficial and harmful for his children and needs a tool to guide him. The mobile app should be a good tool for that, but in this state, it does not have too many functions and is not that straightforward to him.

A.5.2 Second testing

Tasks score

Task	1	2	3	4	5	6
Score	3/5	5/5	5/5	5/5	3/5	5/5

Table A.9. Overall score of participant 5 in testing 2

Issues found

- The tabs' icons in the bottom menu look like they are disabled or deactivated.

Observations

The participant was a bit confused when describing what changed in the app. He thought that some items from the home screen had disappeared. In fact, some items were added to the home screen, not removed. He thought that the blog section was presented in the first iteration of user testing. Finally, he noticed the changes in the profile screen and new design features in the testing process. Although the app's navigation was reported to be intuitive and smooth, the participant struggled to find the evaluation results. He appreciated the experts involved in the process, but he suggested collecting data about some statistics: how successful children use their phones, which games they play, etc.

A.6 Participant 6

- **Age**: 37 years old
- **Number of Children**: 2
- **Place of residence**: Středočeský kraj
- **Form of testing**: in person

A.6.1 Second testing

Tasks score

Task	1	2	3	4	5	6
Score	-/5	5/5	4/5	5/5	4/5	3/5

Table A.10. Overall score of Participant 6 in testing 2

Issues found

- The participant might change the language in the `Choose language` section. Each language should be displayed in its respective language.
- The participant missed the neutral rating in the evaluation section.

Observations

The participant interacted with the app for the first time, so he was initially unsure where to click, which was in contrast to participants who saw the app for the second time. Due to this reason, we skipped the first testing question. He liked the design overall and the app's layout.

The participant spent more time figuring out where the rules section is and what all the rules and screen-free activities and zones represent. He mistook the session for the challenges in the last task; therefore, I helped him navigate back.

Appendix B
Questionnaires

B.1 Questionnaire 1

1. How would you rate the graphical design of the application? *Mark only one option. From the worst to the best.*

   - 1 2 3 4 5 6 7 8 9 10

2. How would you evaluate the content of the individual sessions in terms of quality? *Mark only one option.*

   - Well prepared
   - Good
   - Only some sessions were of good quality
   - Poor
   - Unsatisfactory

3. Which session did you like the most? *Check all that apply.*

   - Monitoring screen time
   - Limiting screen time
   - Screen time zones and activities
   - Media content
   - Internet safety
   - Safe games

4. What new topics would you add/missed in the sessions? *Open-ended question.*

5. Which functionality do you consider the most beneficial? *You can select any number of functionalities (none to all).*

   - Sessions
   - Game ratings
   - Reflection on screen time
   - Activities without screens
   - Screen-free zones
   - Internet safety rules

6. Which functionality do you consider unnecessary? *You can select any number of functionalities (none to all).*

   - Sessions
   - Game ratings
   - Reflection on screen time
   - Activities without screens

- Screen-free zones
- Internet safety rules

7. What did you miss in the application / how would you improve it? *Open-ended question.*

8. Do you know how your children behave in the digital environment? (How they spend screen time, what they do on screens, how much they share about themselves, with whom they communicate, etc.)? *Mark only one option.*

  - I have a complete overview
  - I have a general overview
  - I have a little overview
  - I have no overview

9. What worries you the most about your children's behavior in the digital world? *Open-ended question.*

10. Have you used or are you currently using any parental control application? *Mark only one option.*

  - Yes
  - No

11. Would you use our Digital Parenting application regularly? *Mark only one option.*

  - Yes
  - No

12. Do you perceive the digital world as a potentially risky environment for your children? *Mark only one option.*

  - Yes
  - No
  - Other: (specify)

B.2 Questionnaire 2

1. How would you rate the graphical design of the application? *Mark only one option. From the worst to the best.*

  - 1 2 3 4 5 6 7 8 9 10

2. Which of the following modules did you like the most? *Mark only one option.*

  - Challenges
  - Evaluation
  - Blog

3. What topic would you add as a blog post? *Open-ended question.*

4. How did you like the YouTube challenge? *Mark only one option. From the worst to the best.*

  - 1 2 3 4 5 6 7 8 9 10

5. What games does your child play on the phone? *Open-ended question.*

6. Would you use our Digital Parenting application regularly? *Mark only one option.*

- Yes
- No

7. Would you recommend our Digital Parenting application to your friends? *Mark only one option.*

- Yes
- No

Appendix C

Figma design