Exploring a Design Space of Digital Interventions for Early Adolescents' Disengagement from Technology Overuse

by

Ananta Chowdhury

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Department of Computer Science
University of Manitoba
Winnipeg, Manitoba, Canada

Abstract

The widespread use of digital devices among children and teenagers has raised concerns about overuse, particularly for early adolescents (ages 11–14), who have unique developmental needs and reportedly spend more time with technology than any other age group. While numerous parental control tools exist to mitigate technology overuse, most overlook early adolescents' perspectives. As a result, these tools often face resistance, contribute to parent-child conflicts, and may even be abandoned. Despite research on various mediation strategies, limited work has focused on designing digital interventions that actively incorporate early adolescents' perspectives, particularly in the context of tech disengagement.

This thesis addresses this gap by investigating early adolescents' perceptions of suitable interventions for managing their tech use and evaluating existing solutions against their preferences. Through a co-design study, we examine their conceptualization of tech disengagement and the design factors they prioritize. Building upon these insights and synthesizing prior relevant literature, we then introduce an initial design space for digital interventions tailored to this demographic. To further explore areas of alignment and divergence between early adolescents' and their parents' viewpoints, we conduct an elicitation study comparing their preferences within this design space. Finally, we systematically review prior research on tech

disengagement interventions and analyze existing parental control applications to assess how well current solutions align with the needs and expectations of early adolescents, identified within our proposed design space.

This research contributes to the field of child-computer interaction by revealing early adolescents' perceptions of tech disengagement, defining and exploring an initial design space for early adolescent-centric digital interventions, and systematically analyzing existing research and current solutions to identify gaps and areas for further development. These insights can be leveraged by HCI researchers and practitioners to ground future design explorations of digital interventions that better support early adolescents in managing their tech use.

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Dedication

To Biswa, for always being by my side, with me, for me, through every step — for your love, patience, and presence…

Publications

Certain portions of this thesis have been previously published in conference or workshop proceedings or are currently under peer review. Permission to include these works in this dissertation has been granted by the respective publishers. A list of these publications, organized by chapter, is provided below.

Chapter 3

Ananta Chowdhury and Andrea Bunt. 2023. Co-Designing with Early Adolescents: Understanding Perceptions of and Design Considerations for Tech-Based Mediation Strategies that Promote Technology Disengagement. *In Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23)*. Association for Computing Machinery, New York, NY, USA, Article 198, 1–16.

Ananta Chowdhury and Andrea Bunt. 2023. Reflections on Online Child-Centric Participatory Design Approaches: Two Case Studies with Children and Early Adolescents. *In Proceedings of the ACM CHI 2023 Workshop on Bridging Distances for Global Participation: Conducting and*

Theorizing Participatory Design and Research in Hybrid Contexts. Interact Publication Series. (In press)

Chapter 4

Ananta Chowdhury and Andrea Bunt. 2024. Exploring A Design Space for Digital Interventions Facilitating Early Adolescents' Tech Disengagement: A Parent-Child Perspective. *In Proceedings of the 13th Nordic Conference on Human-Computer Interaction (NordiCHI '24).* Association for Computing Machinery, New York, NY, USA, Article 47, 1–17.

Ananta Chowdhury, Timmy Wang, and Andrea Bunt. 2024. Promoting Early Adolescents' Tech Disengagement: Designing Digital Interventions by Involving End Users in Meta-design. *In Proceedings of the First International Workshop on Participatory Design & End-User Development - Building Bridges (PDEUD2024)*. October 2024, Uppsala, Sweden.

Chapter 5 and Chapter 6

Ananta Chowdhury, Ariful Islam Anik, Timmy Wang, and Andrea Bunt. 2025. The Landscape of Digital Tech Disengagement Solutions for Early Adolescents: Insights from a Systematic Review and App Analysis. *In Proceedings of the 28th ACM Conference on Computer-Supported Cooperative Work & Social Computing (CSCW '25)*. Association for Computing Machinery, New York, NY, USA.

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Chapter 1

Introduction

In this digital era, our everyday lives and technology are deeply intertwined. This regular exposure to various digital devices such as smartphones, tablets, computers, televisions, and gaming consoles has heightened concerns about technology overuse, especially among children and teenagers. A 2022 US survey reported that nearly all teens have access to a smartphone and close to half of the teens indicated using the internet "almost constantly" [157]. According to another survey in the United States, children's (8-18 years) screen usage has increased by 17% since the COVID-19 pandemic started [162].

Although the availability of the Internet and media applications can offer many benefits to children other than recreation (e.g., education, socialization), unrestrained use of digital devices can have severe adverse effects. According to the Canadian 24-hour movement guidelines for children and youth, the recommended screen time limit for recreation is a maximum of 2 hours per day [167]. Excessive screen time (e.g., more than 6 hours daily [27]) is associated with detrimental

effects on children's social and cognitive development, can cause sleep disturbances, and can create health issues [70,145,184]. If not monitored and controlled, children's urge to use digital devices and online media excessively can turn into an addiction, which can lead to daily-life disturbances [31], aggressive behavior [7], and symptoms of withdrawal [92]. Therefore, children's increasing use of technology has become an alarming issue for parents, and naturally, they often attempt to play the role of a gatekeeper of their children's media usage [35,144].

A substantial body of research has looked at parents' involvement and attitudes toward children's media usage [15,19,54,101,152], as well as the mediation strategies parents employ [31,126,141,144,151,175,176]. Studies have also explored how children engage with technology at home [92] and their perspectives on parental mediation [7,77,139]. Despite applying various measures, parents often struggle to manage their children's tech usage [7,139], and mediation strategies can sometimes create conflicts between children and parents [18,34,48,109,124]. While this is a complex, multifaceted problem, one potential issue is that children might not have had sufficient voice in developing these mediation strategies. Prior research suggests that considering children's opinions while developing rules can encourage adherence by fostering a sense of ownership and collaboration [69,82,97,100].

Research indicates technology-assisted mediation has the potential to be more successful in limiting children's screen time than parental mediation alone [91]. Consequently, researchers have proposed different approaches that combine technology with parental strategies to limit children's tech overuse and help them follow parent-defined device usage rules [91,99,110,114,214]. In this thesis, we explore the design of child-oriented digital interventions for tech overuse by actively involving children in the design process, investigating how they envision potential solutions for self-regulating their technology use and which design aspects and

attributes of mediation strategies resonate with them. Through this work, our goal is to establish and investigate a child-centric design space to identify potential promising solutions and design approaches for developing digital interventions that cater to children's needs.

We focus our investigation on early adolescents (ages 11-14), an age group where tech overuse is especially prevalent, as they tend to spend more time with technology than other age groups [103]. Research in Developmental Psychology indicates that during this stage, early adolescents develop a sense of autonomy and begin to understand that their actions can have long-term consequences [53,66]. As their independence grows, they often resist parental restrictions, making it increasingly difficult for parents to maintain rules and boundaries [168], which can lead to frequent parent-child disagreements [53,66]. Despite these challenges, early adolescents are capable of practicing self-regulation [66,75], making them well-suited to participate in designing solutions for managing their tech use. At the same time, their increasing autonomy presents unique design considerations [64], underscoring the need for further research into age-appropriate digital interventions for this demographic.

1.1. Thesis Objective and Research Questions

The primary objective of this thesis is to define and explore a design space for digital interventions aimed at addressing early adolescents' tech overuse, and to identify promising design solutions. Given that these mediation solutions will ultimately be used by early adolescents, it is crucial that their needs and expectations are considered. Therefore, our research places a strong emphasis on early adolescents' perspectives. The overarching goals of this thesis are threefold: 1) to highlight the needs and priorities of early adolescents with respect to digital mediation, 2) to determine the alignment and differences between the preferences of early adolescents and their parents, and 3)

to identify potential solutions and reveal any gaps in both existing relevant research and deployed interventions in this area, drawing on the insights gained from exploring early adolescents' perspectives.

In this thesis, we answer the following research questions:

1) How can we involve early adolescents in the design process of child-centric digital mediation strategies?
2) What kind of design solutions do early adolescents propose for managing excessive technology use and what factors do they prioritize in their designs?
3) What dimensions should be considered when formulating an initial design space for digital interventions targeting early adolescents' technology overuse?
4) Where do early adolescents' preferred solutions for tech disengagement lie within this design space and why? Where do differences emerge in parent-child views?
5) To what extent do researcher-recommended design mechanisms from prior literature align or misalign with early adolescents' and parental preferences, as identified through our design space exploration?
6) How well do existing parental control apps align with the preferences of early adolescents, and where do potential misalignments exist?

1.2. Approach

This thesis aims to contribute novel insights regarding the design of digital interventions for supporting early adolescents' technology disengagement. To this end, we conduct four studies. First, we carry out a co-design study with early adolescents to explore their attitudes toward

designing digital interventions for their own tech disengagement and the design solutions they generate. Second, we define an initial early adolescent-centric design space for digital interventions and conduct an elicitation study with both early adolescents and their parents to explore this space and identify parent-child preferences. Third, we perform a systematic review of existing current research on tech disengagement solutions relevant to early adolescents, to uncover common themes and reveal underexplored areas within our proposed design space. Finally, through a systematic analysis of existing parental control apps, we assess whether there are any discrepancies between current implemented strategies and the desired solutions of our target audience identified from our elicitation study. In this section, we provide a brief overview of these studies along with how they are connected to each other. The first and second studies have been published in two different conferences and the material presented in this document is a revised and adapted version of the content from those publications [37,38].

1.2.1. Co-Design Study

To answer our first two research questions, we involve early adolescents in the co-design of digital interventions given the benefits of co-designing with children to better understand their perspectives [132,195]. By actively engaging early adolescents in a multi-session group-based online co-design study, we investigate their attitudes toward designing digital interventions for their own disengagement from technology overuse. Findings from our study reveal insights into how early adolescents conceptualize the issue of technology overuse and what design factors they perceive to be useful to foster healthy tech usage.

1.2.2. Elicitation Study & Design Space Exploration

While our initial study uncovers key design factors for digital mediation strategies that early adolescents perceive as useful for their tech disengagement, how to effectively translate these high-level factors into design requires a deeper exploration. Moreover, it is important to understand how early adolescents' design preferences and perspectives might align or diverge from those of their parents, given that any digital intervention will be used within a family context. Therefore, to answer our third research question, we propose and investigate an initial design space for child-centric digital interventions, by adopting a Research through Design approach (RtD) [217]. As our first step, we identify four relevant design dimensions and create three design concepts as video prototypes demonstrating ways to exercise them. With an elicitation study with early adolescents and their parents, we then probe their perceptions of the design concepts. Our findings provide insights into common preferences within the design space as well as areas of disagreement between early adolescent and parental views.

1.2.3. Systematic Literature Review on Tech Disengagement Solutions

Our elicitation study identifies areas of preferred solutions for both early adolescents and their parents within our proposed design space. To evaluate how well design mechanisms proposed in prior research for children's tech disengagement align with these preferences, we systematically review the academic literature to address our fifth research question. This review involves identifying relevant studies and analyzing their proposed design solutions within the context of our design space. By characterizing researchers' design recommendations and assessing their applicability to early adolescents, we provide synthesized design guidelines that support the development of early adolescent-centric tech disengagement interventions.

1.2.4. Systematic Analysis of Parental Control Applications

To gain a comprehensive understanding of the landscape of current solutions, we complement our systematic literature review with an analysis of existing parental control apps. We perform an environmental scan to collect these apps and then identify distinct features aiming to facilitate technology disengagement through a feature analysis, to answer our sixth research question. We map these current solutions onto our design space to determine any design gaps and misalignments from the parent-child preferences identified in our elicitation study. Furthermore, we assess the extent to which these apps align with the researcher-proposed design recommendations identified from our systematic literature review. These findings could be leveraged by HCI researchers to ground future explorations of digital interventions that promote healthy tech use by early adolescents.

1.3. Summary of Contributions

This thesis contributes the following to the field of child-computer interaction: 1) Our co-design study reveals insights into how early adolescents conceptualize the problem of tech overuse and envision appropriate mediation strategies, along with identifying important design considerations. 2) We present an initial early adolescent-centric design space, outlining four key design dimensions for digital interventions and illustrate three distinct design concepts grounded in these dimensions. 3) Our elicitation study provides insights into how early adolescents and their parents perceive effective mediation strategies, unveiling areas of both agreement and divergences. 4) Our systematic review and app analysis characterize the current state of digital interventions for early adolescents' tech disengagement, assess their alignment with our proposed design space, and

suggest important design implications for creating more acceptable and suitable interventions that support this age group balance their technology use.

1.4. Reflexivity Statement

Since a significant portion of this thesis relies heavily on qualitative and subjective research methods, I acknowledge how my background and personal experiences might influence the way I conducted the studies and interpreted the findings.

I am originally from Bangladesh, a developing country, and bring a unique cultural and socio-economic perspective to this research. As a woman from Bangladesh, my views on family dynamics, caregiving roles, parental authority, and technology use may differ from those in Canadian or other Western contexts. Although I did not have children at the time of this research, I was closely involved with children through extended family networks, community settings, and research activities. These experiences provided me with valuable insights into children's behaviors, needs, and interactions, both within traditional family structures and in broader social contexts. Studying and conducting research in Canada further allowed me to integrate insights from both my home culture and global perspectives, enriching my understanding of how diverse cultural norms can shape family dynamics and child development.

To minimize any potential biases, such as assumptions about "appropriate" parenting style or "healthy" technology use, I actively aimed to broaden my perspectives by engaging with literature and learning directly from parents and children through conducting user studies. I made a conscious effort to approach the data and research process with an open mind, focusing on understanding participants' views without imposing my own cultural perspective.

Drawing on my past experiences of conducting studies with children [36], I always attempted to think from participants' perspectives throughout my research process, ensuring that their voices were central in formative design activities. Additionally, to promote inclusivity, I have involved participants from different countries including Bangladesh, Canada, France, India, Netherlands, Pakistan, Philippines, the United Arab Emirates, the United Kingdom, and the United States.

As a non-native English speaker, I needed to adjust my communication style while studying in Canada. I made sure to speak clearly, repeat myself when necessary, and ensure that participants from non-English-speaking backgrounds felt comfortable and understood. Furthermore, given that the issue of children's tech overuse can often lead to conflicts between parents and children, I approached the subject with mindfulness and sensitivity. Considering the growing sense of agency among early adolescents, I aimed to minimize power imbalances while designing the study sessions to respect and maintain their autonomy.

My interpretations of the data have been shaped by feedback from other researchers. Men and women from diverse backgrounds in HCI provided valuable insights that helped me ensure my research remained culturally sensitive and methodologically sound throughout.

1.5. Thesis Outline

Chapter 2 provides background on parental mediation strategies and early adolescents' self-regulation abilities, along with prior literature that informs my research approach. Chapter 3 details the co-design study, while Chapter 4 covers the elicitation study and our design space exploration. Chapter 5 presents our systematic review of existing literature relevant to early adolescents' tech

disengagement, and Chapter 6 offers a systematic analysis of available parental control applications. Chapter 7 reflects on the findings and approaches used throughout these studies, providing considerations for future research based on these insights. Finally, Chapter 8 concludes the thesis, summarizing key takeaways and exploring potential directions for further investigation.

Chapter 2

Background and Related Work

This chapter reviews related literature in several key areas that collectively inform our research. It begins with a discussion of research related to mediation strategies for limiting children's tech overuse (section 2.1). Next, it explores research that aims to foster early adolescents' self-regulation strategies and how the research insights can be leveraged to support tech disengagement among this age group (section 2.2). Finally, this chapter concludes by discussing literature on research methods employed in this thesis (section 2.3).

As mentioned in Chapter 1, this thesis focuses on early adolescents (11-14 years), an age group characterized by increasing autonomy [53,66], resistance to parental restrictions [168], and emerging self-regulation abilities [66,75]. However, this chapter also includes literature that addresses children more broadly, since we found limited prior work specifically targeting early adolescents' tech use and mediation strategies.

2.1. Approaches to Mediating Children's Tech Use

In this section, we first discuss strategies parents adopt to limit overuse, followed by an overview of technical approaches that complement parental mediation.

2.1.1. Parental Mediation Strategies to Limit Children's Tech Overuse

To protect children from the risks of using online media and the negative impact of overusing technology, parents apply different kinds of mediation strategies, which include restrictive mediation, active mediation, co-using the media, supervision, and monitoring [143]. In restrictive mediation, parents impose restrictions on children's digital engagement, which includes controlling the kind of content they will have access to and limiting the time spent on those activities [100]. In the case of active mediation, parents discuss appropriate content and usage with children in order to promote awareness and understanding of the positives and negatives of technology use [15,100,144]. Another approach is co-using media purposefully with children to use screen time mindfully [26,97,144], which can positively impact children's prosocial behavior [124]. To monitor or control children's tech use, many parents also employ different kinds of technological interventions, a mediation strategy known as technical mediation [15]. Different mediation strategies are often combined based on parents' own perceptions of technology use or their children's needs [15,176].

While prior literature discusses a range of different mediation strategies, there are conflicting findings on their effectiveness, particularly for early adolescents [104]. For instance, the restrictive approach can be effective for young children [101], however, as children transition to adolescence and start to experience a sense of autonomy, it can be perceived as controlling

[110,176]. On the other hand, previous research has indicated that co-monitoring with parents, even though it empowers early adolescents, can create tensions due to family power imbalances [1]. A recent study highlighted the positive effect of parental co-use in mitigating adolescents' smartphone overuse [104], while others have suggested a combination of active and restrictive mediation [151,181,208]. These conflicting findings indicate that how to design an effective mediation strategy for early adolescents remains an unsolved problem.

Although parents employ diverse mediation strategies for their children's betterment, there are often conflicts in the family due to the discrepancy between parents' and children's expectations and perceptions of the appropriate use of technology [18,34,46,101]. Moreover, conflicts can arise between parents in a family about how to manage their children's technology engagement due to different individual expectations, and parenting values [34,54]. Conflicts can also occur when parents misinterpret children's reasoning behind using technology [109]. Furthermore, if children observe their parents spending a lot of time with technology, they may perceive it as unfair to restrict their own usage [7,34,73]. Prior research has shown that enabling children to voice their opinions while making the rules regarding technology use [97,100], or allowing them to negotiate with their parents about the rules to some extent [77,109] can help them to adhere to the rules. Motivated by these previous studies, which stress the importance of considering children's perspectives, we actively engage early adolescents in our design process to better understand their needs, perceptions, and the factors they prioritize when designing digital solutions.

2.1.2. Technical Mediation

The previous subsection provided an overview of research related to parental mediation strategies in general. This subsection shifts focus to a more specific aspect—technical mediation, exploring the reasons behind parents' adoption of technical mediation and the attitudes of both children and parents toward this approach.

Despite applying various parental mediation strategies, children often find ways to navigate around parent-set boundaries [170]. Often parental rules for children's tech usage lack proper guidance and consistency and enable children to find ways to escape from the rules [144]. Children's rule-breaking strategies include hiding the devices, continuing to play beyond the specified time, ignoring the surroundings to focus on the devices, and exploiting grandparents' or caregivers' leniency [7,139]. This problem intensifies with age, as parents find it more difficult to maintain rules and boundaries [168]. To reduce parental stress, parents often turn to parental control apps to regulate their children's tech usage [16]. Technical mediation has the potential to protect children from tech overuse and reassure the parents by sharing the burden of managing the overconsumption issue [16].

To enable parents to monitor, supervise, or control their children's technology usage, researchers have focused on designing various technical mediation strategies [76,101,170,206]. In practice, commercially available applications, such as Google Family Link [219] and Net Nanny [220], provide parental monitoring and control features for managing children's digital media use. While some parents see merit in using technical mediation to facilitate children's healthy device use [101], others find these digital interventions unsuccessful in limiting children's tech usage [170], and children also feel that the tools overlook their needs [206]. For instance, in one study,

parents of young children reported that children's transition from engaging with technology to disengaging is often problematic and that a tech-mediated transition is more effective than a parent-mediated transition [101]. However, another study with parents of teens stated that parents mostly find the parental control tools ineffective as children easily navigate around these tools [170]. Given these varying findings across age groups, it is important to investigate what strategies and tools are appropriate for meeting the needs and preferences of early adolescents, who present unique design challenges due to their growing autonomy and need for independence.

Furthermore, several studies on digital interventions have found that many tools disregard teens' perspectives and emphasize parental needs for device control [32,77,198,206]. For instance, Wisniewski et al. conducted an analysis of 75 parental control apps for teens' online safety, revealing that 89% of these apps support parental control, but do not prioritize promoting teens' self-regulation [206]. Research indicates that children strongly dislike the apps due to their overly restrictive and invasive nature [2], as they force compliance and undermine teens' strong desire for autonomy [32], leading to rule-breaking tendencies, parent-child conflicts [80], and even discontinuation of the interventions [170]. These findings highlight the importance of considering early adolescents' perspectives along with their parents' when designing digital interventions, in order to enhance compliance with the mediation strategies. This approach of involving children in the design of such interventions mirrors the research discussed at the end of subsection 2.1.1, where studies advocate for the inclusion of children's voices in the formulation of tech usage rules—a theme consistently emphasized in earlier studies.

2.2. Promoting Early Adolescents' Self-Regulation

This section focuses on research related to self-disengagement from technology, which informs our approach of seeking early adolescents' opinions on regulating their own tech disengagement. It begins with a discussion of self-regulation strategies and then provides a brief review of existing digital interventions from prior literature that aim to foster children's self-regulation of technology use (subsection 2.2.1). Additionally, this section touches upon the utilization of persuasive technology to support children's self-regulation in various domains, highlighting the potential to leverage persuasive techniques in the design of early adolescents' tech disengagement solutions (subsection 2.2.2).

2.2.1. Self-Regulation Strategies

From early adolescence, children start to develop a sense of autonomy and privacy. If the features of digital interventions are not child-focused, instead of developing self-awareness, they might feel forced to comply [32,77,206]. Parents who practice a parenting style that ignores children's autonomy in tech use can deprive their children of the benefits of technology and can also increase the chance of causing peer problems, for instance, being left out by peers who primarily socialize through digital platforms [78]. These research findings highlight the importance of developing early adolescents' self-regulation abilities to promote healthy tech use [32].

Self-regulation, defined as the ability to initiate control over our thoughts, emotions, and actions to achieve a certain goal [216], involves three phases consisting of self-observation, self-judgement, and self-reaction [11]. Therefore, digital interventions promoting self-regulation of tech use should focus on empowering early adolescents to monitor their own usage, evaluate their

progress, and support them in adjusting their behaviour accordingly. Several strategies have been proposed to facilitate children's self-regulation of technology use, including self-planning, feedback and reinforcements, journaling, self-directed speech and boundaries, and repeated reminders [7,22,55,110,121,133,169,206]. In addition to these strategies, there is a range of external factors that can impact early adolescents' development of self-regulation, which need to be considered while designing tech disengagement solutions. These factors include parental involvement, peer influence, autonomy support, and parent-child relationships [22,61,135,156,161,173,211]. We leverage this existing literature to map out our design space and create design concepts for supporting early adolescents' tech disengagement (see Chapter 4). We further extend this literature by exploring how the self-regulation strategies and external factors align with the unique needs and preferences of early adolescents in promoting self-regulated tech use, with the goal of identifying suitable design strategies for digital interventions tailored to this demographic.

As discussed earlier, restrictive strategies might not always be effective in limiting children's device usage. To address this, researchers have looked at designing systems that aim to promote self-regulation among children [91,99]. These systems seek to develop intrinsic motivation in children to limit their own device use, for example, by allowing them to plan their own entertainment with parental guidance [99], and by using augmented reality to practice self-regulation [91]. Additionally, researchers have explored involving both children and parents in joint activities to limit technology use [110,114]. Despite using various strategies, prior research has shown that transitioning from using a device to discontinuing its use can be often problematic for children while ending screen time [101]. To make screen withdrawal easier and to support

children's self-regulation, researchers have designed physical screen peripheral device interfaces that seamlessly navigate children's attention away from the screen [214].

While there are many digital interventions aimed at regulating children's media use, limited research has explored how children's perspectives can shape the design of these interventions, particularly in the context of fostering self-regulation. Since an early adolescent's needs and expectations can be vastly different from an adult's perspective, it is important to understand early adolescents' views when designing child-centric technology. This thesis extends the self-regulation literature by investigating the design of digital interventions tailored to early adolescents' specific needs, identifying design factors that they perceive as potentially beneficial for supporting self-regulated tech use, and distinguishing their preferred strategies from those of their parents.

2.2.2. Persuasive Technology to Support Self-Regulation

To support self-management and regulation in various domains, including health, education, and tech use, researchers have highlighted the benefits of using persuasive technology to foster positive behavior change [4,119,129,153,192]. Many of these technologies integrate data visualization and motivational elements (e.g., gamification) to promote behavior change by supporting self-management and regulation [59,125,204]. Since practicing tech disengagement might require behavior change for many early adolescents due to their potential tendency to overuse technology, adapting elements from persuasive technologies could be useful in designing effective mediation strategies. We use insights from this literature to inform our design concepts for supporting their tech disengagement.

2.3. Research Methods

This section reviews the research methods applied in this thesis. First, it discusses child-centric co-design techniques (subsection 2.3.1) which we use to explore how early adolescents can be involved in the design process of digital interventions and what design solutions they propose (RQ1 & RQ2). Next, this section addresses the 'Research through Design' approach (subsection 2.3.2), which informs our approach to formulating a design space for tech disengagement and exploring early adolescents' and their parents' preferred solutions (RQ3 & RQ4). Finally, it summarizes methods from prior work related to our research focus that have characterized academic literature and analyzed digital interventions (subsection 2.3.3), which we apply to evaluate the alignment between researcher-recommendations, existing parental control apps, and our target users' preferences for tech disengagement interventions (RQ5 & RQ6).

2.3.1. Children as Co-Designers of Child-Centric Technology

While designing technology for children, HCI researchers have proposed and investigated a number of approaches to involving children in the design process [17,52,85,87,88,95,132,172,195]. Co-design is a form of participatory design where every participant in the design process has an equal opportunity to contribute and express their perspectives [196]. Co-designing with children enables them to voice their opinions and direct researchers toward child-centric design choices along with identifying age-specific requirements. In light of these benefits, prior research has involved children of different age groups in co-design, ranging from young children [33,52,87] to teenagers [28–30,47]. However, to our knowledge, no research has involved children in designing interventions to limit their overuse of technology.

Researchers have involved early adolescents and teens in co-design in a range of different domains including the co-design of personal informatics tools [159], mobile online safety applications [47], digital badge systems [158,183], interactive technologies to enhance museum experience [28–30], tools to support parent-teen communication [187], and games to raise privacy awareness [117]. To facilitate co-design in these studies, researchers have combined different methods including group discussions, scenario creation, developing narratives, designing memes, brainstorming, drawing mock-ups, and prototyping. As the first step of our research, we investigate how to apply these techniques in the context of a new application domain: involving early adolescents in co-design for digital interventions to facilitate technology disengagement.

Our co-design approach in Chapter 3 mostly borrows elements from the 'Collaborative Design Thinking' (CoDeT) framework [132]. CoDeT supports co-design in groups with a high child-to-adult ratio, where the target age range is 9-10-year-olds [132]. Ensuring effective collaboration among 15-20 children in a co-design setting (e.g., schools, makerspaces) with 1-2 adult researchers requires independent effort from the children in addition to strong self-regulation abilities [132]. Since the CoDeT framework was shown to be useful in facilitating children's collaboration in co-design despite the aforementioned challenges, we were motivated to use elements of this framework in our first study design.

In light of the COVID-19 pandemic, in many cases, co-design with children has shifted from the traditional in-person setting to an online setting [36,44,60,122]. Online co-design brings some advantages, for example, the ability to include participants from all over the world with diverse languages and cultures, which would be otherwise not feasible due to geographical barriers [60]. On the other hand, transitioning to online presents new challenges, such as maintaining online engagement, providing logistical support, and managing technical difficulties. Considering these

new challenges, Lee et al. developed a conceptual model that identifies the complexities of conducting co-design studies online and provides suggestions to promote engaged participation [122]. For example, the authors discuss the importance of improvisation to balance the expected and unexpected factors during synchronous online co-design sessions [122]. Researchers have also explored how different co-design groups approached online co-design, documenting unforeseen challenges and comparing different design tools and logistics decisions [60]. We drew on these insights to adapt the CoDeT framework for the online co-design setting in our first study, which was conducted during the pandemic.

2.3.2. Research Through Design

Research through Design (RtD) is an approach that integrates design methodologies, techniques, and procedures to create and assess artifacts as potential solutions for the purpose of advancing new knowledge [217]. While there are some similarities between RtD and traditional design practices, RtD follows a more structured approach, with the objective of offering novel perspectives on complex issues, rather than concentrating solely on the development of successful commercial products [217,218]. In RtD, the design space surrounding the problem is explored through iterative design and evaluation of research artifacts, demonstrating how different elements are incorporated to generate a novel contribution to solving a complex problem [94,218]. These artifacts or prototypes are used as probes to elicit insights from end users to assess the feasibility of the solutions [8].

RtD is particularly useful when multiple stakeholders hold conflicting perspectives, making it challenging to accurately model their needs for addressing the issue [217,218]. Regarding the challenge of limiting children's technology overuse, prior literature has indicated

that current solutions do not effectively address the diverse viewpoints of early adolescents and their parents [2,41]. Therefore, a deeper exploration of the design space of early adolescents' digital interventions using the Research through Design approach can contribute new knowledge on how to generate solutions acceptable to both groups of stakeholders.

Encouraged by the effectiveness of RtD in addressing complex problems, many researchers have employed this approach when investigating design solutions for children [8,14,57,67,68,94,189,194,197,210]. Informed and motivated by this body of work, we also apply Research through Design to explore and define the design space of digital interventions that promote disengagement from technology overuse among early adolescents (Chapter 4), while capturing the differing perspectives of both early adolescents and their parents.

To elicit user insights in Research through Design (RtD), prior work has conducted elicitation studies where prototypes are intentionally designed to represent different combinations within a design space [6,81,191]. These prototypes act as probes to reveal users' thoughts and preferences. Such studies differ from gesture elicitation studies [190,193,203], where functional prototypes are used to derive user-defined interaction techniques [203]. In contrast, design space elicitation studies focus on presenting distinct and contrasting ideas to provoke discussion [81].

While both elicitation studies within RtD [6,81,191] and design probe studies [20,51,58,130] employ probes, they differ in purpose and form. Design probe studies are typically conducted early in a research process, where the probes are deliberately ambiguous or open-ended to spark new ideas and uncover unexpected insights, often through long-term engagement [130]. By contrast, elicitation studies use prototypes that are intentionally designed to represent specific combinations of diverse points within a design space, with the goal of provoking reflection and

eliciting users' preferences and trade-offs. In our case, we first conducted a co-design study with early adolescents to uncover users' perspectives and novel ideas about tech disengagement, serving a role similar to design probe studies. Building on those insights, as a next step, we explore a design space of digital interventions for early adolescents. We employ prototypes that illustrate different points within the space, which makes an elicitation study an appropriate method for our RtD approach.

2.3.3. Characterizing Academic Literature and Analyzing Digital Solutions for Children's Tech Disengagement

Given the abundance of digital interventions designed to address children's technology overuse, an in-depth review of these existing tools can provide a comprehensive understanding of the current landscape of solutions—what they offer and to what extent these existing solutions align with our target users' preferences. This subsection focuses on research that has systematically reviewed relevant literature on digital interventions for managing children's tech use and analyzed digital solutions.

Researchers have conducted systematic reviews of prior literature focusing on the development of tools that enable parents to supervise and control their children's online media usage [5,106,136]. For instance, Monteiro et al. reviewed literature on parental control apps and educational interventions designed to enhance children and adolescents' awareness of online safety [136], and Altarturi et al. conducted a comprehensive bibliometric analysis of cyber parental control tools, offering a taxonomy and insights into current research practices [5]. While these studies concentrated on the tools themselves, Iftikhar et al. focused on reviewing the underlying frameworks and design approaches used to develop parental control tools within HCI research

[106]. Most of these reviews centered primarily on the topic of children's online safety, whereas our research focuses on children's disengagement from technology. In contrast to solutions designed for children's online safety, which often prioritize protective measures like content filtering, our emphasis lies in systematically reviewing solutions that aim to support children in managing and limiting their device time.

In addition to systematically reviewing the relevant literature, researchers have analyzed existing parental control applications to assess their features and effectiveness [3,80,198,205,206]. While these studies offer valuable insights into existing mediation tools, they also primarily focus on online safety and do not analyze specific aspects contributing to children's tech disengagement. This thesis will complement the research work in this direction by conducting a systematic analysis of tech disengagement features based on direct insights from early adolescents and parents to assess how well the current features meet their needs and expectations.

Beyond parental control tools, another line of research on children's digital autonomy has examined the role of self-regulation in digital contexts. For instance, Wang et. al reviewed prior literature on enhancing children's self-regulation of screen time, promoting online safety, and developing literacy to conceptualize digital autonomy for children in HCI [200]. Although this work included research on self-regulation, it focused on supporting children's broader digital autonomy rather than addressing tech disengagement. Additionally, it did not target a specific age group [200]. Building on this work, our research specifically addresses early adolescents' tech overuse by examining both relevant academic literature and applications. Our analyses identify key design concepts and offer insights into how well they align with the preferences of our target audience, contributing to a more comprehensive understanding of this landscape.

2.4. Summary

In summary, this thesis extends existing knowledge on designing digital interventions for early adolescents' technology overuse. This chapter highlights research gaps in directly involving early adolescents in intervention design, which we address in Chapter 3 by incorporating their perspectives through co-designing tech disengagement solutions. Chapter 4 extends the literature on self-regulation and persuasive techniques by integrating these insights to formulate an early adolescent-centric design space for interventions that promote self-regulated tech use. Chapter 5 addresses the lack of systematic reviews focused on digital interventions for early adolescents by synthesizing existing design recommendations and assessing their relevance to this age group. Chapter 6 further complements this work by analyzing how existing parental control apps align with early adolescents' and parents' preferences, identifying trends and gaps in user-centered design. Together, these studies advance the understanding of digital intervention design for this demographic, highlighting both opportunities and limitations.

Chapter 3

Understanding Early Adolescents' Perceptions of and Design Considerations for Digital Mediation Strategies that Promote Technology Disengagement

In our first study, we used co-design methodology to involve early adolescents in the design of digital interventions, aiming to investigate how they approach the issue of technology overuse. Through a multi-session, group-based, online study, our goal was to understand how early adolescents perceive self-disengagement from technology and explore what kinds of digital solutions they believe could help with disengagement. Specifically, we explored the following research questions:

1) How can we involve early adolescents in online co-design for child-centric digital mediation strategies?
2) What kinds of design solutions do they create and what factors do they consider while designing?

To address these research questions, we conducted co-design sessions with participants where we engaged them in focus-group interviews, collaborative story creation, brainstorming, and sketching. Findings from our study reveal insights into how early adolescents conceptualize the issue of technology overuse, what design solutions they perceive to be useful, and key design considerations. Additionally, we share our reflections on how the study method and co-design approach encouraged active collaboration and high-quality contributions from our participants.

This section outlines our study approach, presents the study details, and shares the findings from our co-design sessions with early adolescents. See Appendix A.1 for approval from the University of Manitoba Research Ethics Board for this study. This work was presented at the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23) and was published in its proceedings [37].

3.1. Study Method

Our approach to involving early adolescents in co-designing digital interventions was inspired by the 'Collaborative Design Thinking' framework [132]. This framework incorporates 10 steps to promote productive and creative collaboration including: introduction, sensitization, scaffolding collaboration, reflection on collaboration, defining a design goal, ideation, grouping and selection, elaboration through making, peer jury and presentation, and iteration or wrap-up. While we

followed this general sequence, we made some adaptations to suit the online nature of the study and the fact that we were working with slightly older children (11-14 vs. 9-10). For example, in the CoDeT framework's 'elaboration through making' step, each group works together to create a visual representation of their concepts using low-tech prototyping materials. We adapted this step by first asking participants to sketch a design solution individually offline and later to collaborate online to produce a visual representation. Below, the details of our study method are presented.

3.1.1. Participants

We recruited 21 participants (7 girls, 14 boys) who were 11-14 years old (mean age: 12.5, SD: 1.06). Our sample size was informed by prior HCI studies involving children in co-design [28,33,87], where relatively small samples (e.g., 11-15 participants) have generated rich insights into design needs and preferences. Similarly, we prioritized engagement with each participant to elicit nuanced perspectives rather than aiming for statistical generalizability. Our sample size was also influenced by the richness of data gathered from each participant, and practical considerations, such as participant availability.

The eligibility criterion to participate in the study was that the participants should have experience in using any kind of digital media frequently, for at least 2 hours per day. This criterion was based on the recommended recreational screen time limit of 2 hours per day for children and youth [160], with usage exceeding 6 hours daily considered excessive [27]. We did not define "digital media" in our recruitment material, leaving its interpretation criterion flexible. We recruited via advertisements posted on online media channels (e.g., Facebook, Slack), throughout our university campus, and through snowball sampling [83] and word of mouth. Our recruitment approach resulted in participants from seven different countries (Canada: 9, Bangladesh: 3, France:

3, India: 3, the United Arab Emirates: 1, Netherlands: 1, Philippines: 1). Table 1 lists details about participants

Although our inclusion criteria did not specify any language requirement, all participants, except the Bangladeshi ones, communicated in English during the sessions. Since the study was conducted by researchers at a Canadian university, participants may have anticipated that English would be the primary language of communication. For sessions with Bangladeshi participants who preferred to speak in Bengali, I translated and transcribed the recordings into English for analysis.

Table 1: Participants' Demographic Information.

Group#	Participant#	Age	Gender	Country
G1	p1	11	Boy	Bangladesh
	p2	11	Girl	Bangladesh
	p3	12	Girl	Bangladesh
G2	p4	12	Boy	India
	p5	12	Boy	India
	p6	11.5	Girl	India
G3	p7	13	Girl	France
	p8	14	Girl	France
	P9	13	Boy	France
G4	P10	13	Boy	Canada
	p11	14	Boy	Canada
	p12	13	Girl	Canada
G5	P13	12	Boy	Canada
	P14	11	Boy	Canada
	P15	14	Boy	Canada
G6	P16	11	Boy	Netherlands
	P17	13	Boy	UAE
	P18	13	Boy	Philippines
G7	P19	14	Girl	Canada
	P20	14	Boy	Canada
	P21	11	Boy	Canada

We informed the participants that their participation is voluntary and that they could withdraw from the study at any time. In appreciation of their time, the participants received $10 for attending each session as an honorarium. We offered participants who completed all three sessions an additional $10.

Since the goal of co-design is to promote collaborative creativity [132], we opted to form groups rather than hold individual sessions. Collaboration tends to encourage creativity in children more than working individually [149], and the sense of accountability while working as a team can motivate contributions to design tasks [132]. We opted for groups of three, which led to seven groups in total. Given the challenges of recruiting and scheduling a multi-session study, we formed the groups based on participants' availability. If participants disclosed existing relationships (e.g., siblings, friends, classmates), we kept them in the same group since they contacted us at the same time. Other than the parents' or caregivers' convenience, keeping familiar participants together ensured that any offline discussions about the study (if any) were confined to a particular group so as to limit cross-group contamination. Among the seven groups, one group consisted of participants who knew each other prior to the study. For the remaining six groups, at least one participant did not have an existing relationship with the other two participants. The groups remained the same throughout all three sessions.

3.1.2. Study Tasks and Procedure

After obtaining written consent from a parent and the participant, we scheduled three sessions (see Figure 1 for an overview). Each of these sessions was conducted remotely via Zoom. Through these three sessions, we involved participants in activities to conceptualize the problem, discuss

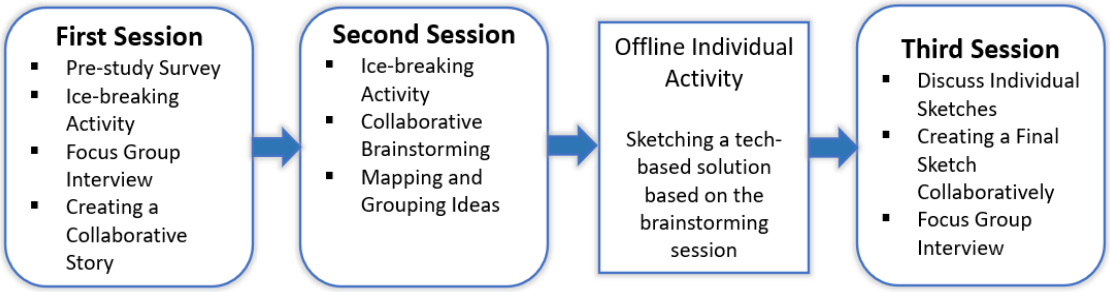

Figure 1: Co-design Study Procedure.

the problem with their peers, collectively brainstorm ideas, and produce a final design solution. Dividing the study into three sessions allowed participants to spend sufficient time on each of these activities and provided the opportunity to reflect on the problem of tech overuse individually in between the sessions. All the sessions were conducted by me, and no other researcher participated in or facilitated any of the sessions. Each session lasted approximately 60-90 minutes and was recorded for data analysis purposes. Below, the details of each study session are described.

3.1.2.1 Session 1: Focus Group & Collaborative Story Creation

The objective of the first session was to learn about participants' current tech practices, how they conceptualize the issue of tech overuse, and how they perceive the concept of tech disengagement. Before starting the first session, I administered a short individual online survey to collect information on participants' current technology usage (see Appendix A.4). Then participants introduced themselves and engaged in a team-building activity, where they came up with a name for their group. Then, I introduced the research problem by discussing how digital devices have become an integral part of our daily lives and by asking the participants if they knew about any negative consequences of spending too much time with digital devices. Then I stated the design problem to participants as follows: "*Even though we know the negatives, sometimes we still find it hard to stop spending too much time with these devices. In this study, together, we will try to find*

a way to help control the urge to use devices when you are not supposed to. We will think of different solutions that might work for you and at the end of the workshop, you will design a technological solution that you feel will help you easily stop using technology whenever you want to or help you follow your parents' rules more comfortably." While framing our research problem, we did not specifically mention 'technology addiction'. Studying digital addiction in children is complex [40] and we were cognizant of the fact that adolescents might distort the truth about an addiction to avoid stigmatization [86]. Therefore, we did not ask our participants to self-report childhood addictions or attempt to investigate addiction patterns.

After introducing the research problem, I conducted a focus group interview where participants discussed their media usage patterns, their parents' restrictions, and their responses to those restrictions. Next, I asked participants to create a story collaboratively about an early adolescent who struggles with limiting their device use. For this activity, participants used Google Slides, where they worked within a template that we populated with icons of sample characters and different objects that they could copy and paste as necessary while creating the story.

As part of their story, participants were asked to come up with a character of their age who sometimes has trouble controlling their tech use and to describe a situation where the main character did not stop using devices when the character was supposed to disengage. Participants were also asked to think about how the character would feel about this situation and about finding a mitigating solution. The intention of this exercise was to enable the participants to express their thoughts on tech disengagement through the characters of the story.

3.1.2.2 Session 2: Collaborative Brainstorming & Mapping Ideas

The goal of the second session was to investigate what kind of solutions participants would generate to address the problem of tech overuse, and what aspects of the solutions they saw as being potentially helpful. To this end, I asked participants to collaboratively brainstorm different ideas and map similar ideas together using Google Jamboard. During this activity, I reminded participants to focus on digital solutions. Additionally, participants were prompted to think about child-centric solutions (i.e., strategies that would be favorable for children and would not make them feel forced, upset, or angry) instead of popular parent-oriented solutions (e.g., parental lock, timeout app). I also prompted them to think about what would work for them, or the character of their story. At the end of this session, the participants were encouraged to complete an individual offline task in preparation for the final session: to create a rough sketch of a digital solution based on ideas from this brainstorming session. Prior research has demonstrated that incorporating both individual and group ideas can enhance the ideation process [116].

3.1.2.3 Session 3: Focus Group & Generating a Final Solution Collaboratively

The objective of the third session was to observe how the participants collaboratively converged to a final solution, including which ideas they preferred and why. In this session, the participants worked together to sketch a final design solution based on their previous discussions, brainstorming, and individual sketches. I started this session by having each participant share and explain their individual sketch. From there, participants discussed the ideas they liked most and how to combine or include them in the final solution. They then worked on a final solution in Google Jamboard, where they could sketch collaboratively, add annotations and upload images of hand-drawn sketches. To encourage participation and collaboration, I informed participants that

their final sketches would be entered into a design competition at the end of the study, to be voted on by fellow participants.

After sketching their final solution, participants took part in another semi-structured focus group interview where I asked them to describe their sketch and discuss why they think it might help children disengage from excessive tech use, what aspects of their solution might not work, and whether they felt the solution would work for them.

3.1.3. Data Collection & Analysis

Our primary data came from the recordings of the semi-structured focus group interviews and the participant-generated artifacts. I transcribed the study sessions and read through the transcripts and artifacts multiple times to familiarize myself with the data. Then I applied Reflexive Thematic Analysis [21], starting with multiple rounds of coding of the data. In the next phase, I generated initial themes and subthemes by identifying patterns and then grouping the codes together. Then along with another HCI researcher, we refined and defined the themes collaboratively while revisiting the data frequently to ensure that our themes are grounded in the raw data.

3.2. Key Findings

Our study findings are divided into three subsections. First, findings from our survey and our initial focus group interviews are shared, including participants' device usage patterns and their family experiences with technology. Next, findings regarding participant engagement in the co-design activities are discussed. Finally, important design factors that emerged from our thematic analysis are explored. The findings are supported with sample participant quotes and images of participant-

generated artifacts. Participant data is labeled as coming from a group (e.g., G2 indicates Group 2), or an individual participant (e.g., P2-G1 indicates Participant 2, a member of Group 1). While discussing the findings, participant counts are not presented to avoid making assumptions about participants' agreement or disagreement regarding a theme [43]. For example, our data collection techniques cannot confirm that if a participant did not express their opinion about a certain theme, they did not agree with it [43].

3.2.1. Participants' Device Usage Patterns and Family Experiences with Technology

Through the online survey and initial focus group interviews, we elicited information on participants' device usage patterns, parental rules and regulations around their technology use, and their perceptions of technology overuse. The surveys revealed that all our participants owned at least one digital device (e.g., smartphone, laptop, desktop, tablet, gaming console), and on average, they reported using 3 different devices at home (SD: 1.23). Other than for schoolwork, on average, the amount of device time was 3 hours 11 minutes per day (SD: 2.01). The majority of our participants mentioned that their parents had enforced rules about their device usage. In most cases, the parental rules involved enforcing time limits for device use (e.g., 2 hours on weekdays, after schoolwork is done), where rules tended to be more flexible during weekends or vacations. Only one participant indicated that their parents use a parental control app to limit their device use. Another participant mentioned that their parents would block the Wi-Fi after a certain period to restrict internet access. While the majority of our participants said that they comply with the rules, nine participants admitted to breaking the rules sometimes. Reasons for breaking the rules included boredom, losing track of time, being distracted by notifications, being excited about an upcoming

movie/game, etc. Another common reason was the urge to complete the activity they were performing (e.g., finishing the match):

> *P13-G5: "And sometimes like, if you are playing a video game, and you're so close to completing a level, you can think it's 5 more minutes. But this '5 more minutes' can turn into 15-20 minutes."*

When asked about the consequences of breaking the rules, most of the participants said that their parents would just ask them to stop using the devices or give warnings, whereas a few participants talked about more serious consequences (e.g., no device for a day, grounded for a week). Even though some of our participants admitted that they break parental rules sometimes to use technology, when asked, all participants could offer negative consequences of using technology excessively. These negative consequences included adverse effects on the brain, health and eyes, negatively affecting performance in school, obesity, anxiety, depression, exposure to inappropriate content, cyberbullying, dependency on devices, and technology addiction.

3.2.2. Engagement in Co-Design Activities

Prior work has found that involving early adolescents in HCI research can be challenging [63,64]. For example, early adolescents can be difficult to motivate, particularly when it comes to research participation [64]. Moreover, early adolescents spend more time online and on devices than other age groups [103]. It was unclear how these factors would interact in a co-design study in terms of how stimulated participants would be to contribute perspectives and ideas. Overall, we observed a high level of engagement in the study activities. Participants contributed actively to discussions, and the groups proposed a wide range of ideas and solutions to promote disengagement from the

overuse of technology. This subsection discusses how our participants engaged in the study activities, highlighting particular aspects of the study method that appeared to facilitate design contributions and discussion.

3.2.2.1 Story Creation Helped Understand How Participants Conceptualize the Problem of Tech Overuse

Our participants created collaborative stories that appeared to capture how they conceptualized the problem of tech overuse. While generating their stories, they discussed different examples of technology overuse and its consequences. For example, the participants talked about how the main character of their story suffered from loneliness and depression, withdrew from other activities, and avoided socializing (See Figure 2A). Participants also depicted how the main character realized the detrimental effects of overusing technology on their health, including tiredness, sleeping disorders, headaches and burning/blurry eyes.

Through their stories, participants also illustrated children's attitudes toward parental rules regarding tech use. For example, in two stories, the main character felt upset and angry at their parents for not being able to continue playing (See Figure 2C). Also, participants sometimes felt that their parent's rules were not fair, which was reflected in their stories. The following quote illustrates this sentiment:

> *P11-G4: "So, he [the story character] knows even if he finishes homework, he won't be able to play. He'll be very sad, and the parents don't understand his emotions."*

Two groups talked about how the character was secretly playing with his devices in their stories. At the same time, one group depicted the main character as feeling guilty about not

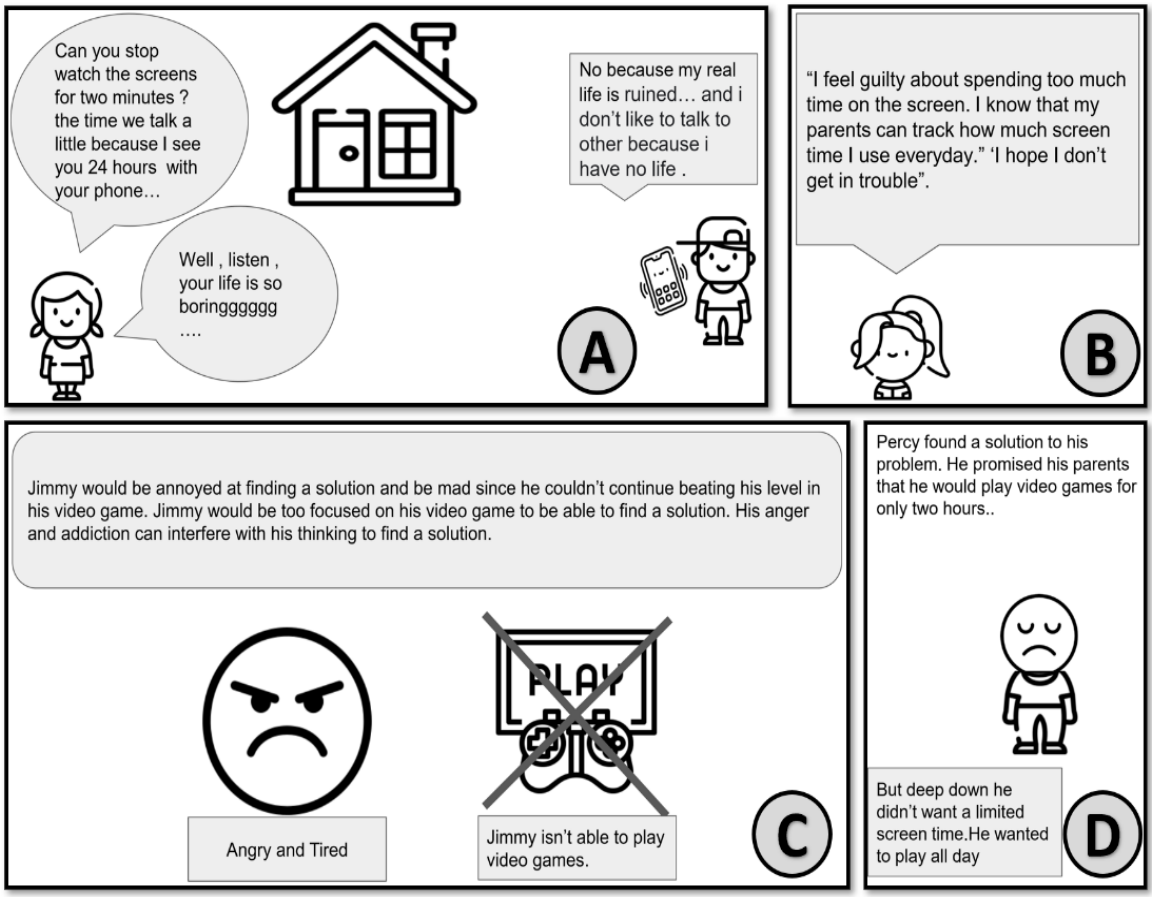

Figure 2: Excerpts from some of the collaborative stories created by our groups of participants. (A) G3 is describing a situation where a boy addicted to his phone is expressing his lack of interest in anything else when his friend asks him to have a conversation. (B) G7 describes how the main character feels when she fails to follow her parents' rules. (C) G5 explains a situation where the main character does not want to find a solution to his tech overuse. (D) G2 depicts a scenario where even though the main character agrees to follow the new rules created by his parents, in his mind, he feels the opposite.

following their parents' rules (See Figure 2B). This indicates that our participants attempted to demonstrate different emotions related to tech use and parental rules through their stories.

The groups ended their stories with the main character agreeing to follow the rules through self-realization, coming up with a fair rule for their tech use, or getting help from their parents or friends. However, even after agreeing to follow the rules and attempting to practice disengagement, the main character in one story kept feeling the urge to break the rules and enjoy unlimited play time (See Figure 2D). Interestingly, even though we did not mention "technology

addiction" while framing the design problem, some participants talked about "addiction" while discussing the story scenarios with their group members. One group mentioned how addiction to devices could prevent the main character from disengaging (See Figure 2C). Thus, even after realizing the negative consequences of tech overuse or agreeing to practice disengagement, participants felt that children with a severe addiction to technology might have difficulties restricting their tech use.

Along with sharing their own experiences, participants referred to the character of their story multiple times in the subsequent sessions. Thus, the character of their story appeared to work as a persona [182] for whom the participants attempted to design different solutions in the next two sessions of the study.

3.2.2.2 Participants Generated a Range of Ideas to Support Disengagement

Participants enthusiastically participated in the brainstorming session, generating a wide range of ideas for different mediation strategies to facilitate tech disengagement. Figure 3 depicts Group 2's ideas from their brainstorming session, which ranged from parent-oriented solutions to child-centric solutions, and from digital solutions to ideas that do not involve technology. They also tried to group ideas based on similar concepts. For example, in Figure 3, all motivating factors are grouped together on the left and parent-oriented solutions are grouped together in the upper-right corner. The total number of ideas produced from all 7 groups was 101, where the mean number of ideas per group was 14 (SD: 5.06). Table 2 shows a collection of ideas that illustrate the range that participants generated. Below, key concepts that emerged from the ideas are discussed.

Figure 3: Ideas Generated by Group 2 during the Brainstorming Session. (Enlarged snapshot of this image can be found in Appendix A.2.)

Encouraging Other Offline Activities to Limit Device Time

To disengage early adolescents from overuse of technology, instead of just restricting use, our participants saw value in promoting other activities to reduce screen time. Since replacing digital sources of entertainment with just any other offline activity might not seem intriguing, our participants came up with a range of ways to engage early adolescents in other activities. These ideas included discovering a new hobby or a passion for something that would not involve technology (e.g., sports, music, reading books) and engaging in joint activities with friends and family. Participants felt that if early adolescents are too engrossed in interacting with their devices, prompting them with suggestions of other activities could help remind them to disengage:

Table 2: Examples of ideas generated by our participants during brainstorming.

Idea Category	**Example**
Finding Another Interest	P17-G6: "Start a new Hobby", P20-G7: "Start a super long project that will distract you."
Outdoor Activity	P4-G2: "We can play outside so that our mind is distracted from the online world."
Joint Activities with Parents/Friends	P20-G7: "Schedule more family/friends' activities."
Showing Negative Consequences	P16-G6: "Scare them up by showing a video about effects on too much device time. Show some scary stuff 😊"
A Mentor/Companion to Raise Awareness	P1-G1: "Using a small robot to help them convince!"
Keeping Track of Time	P13-G5: "It shows how many minutes are remaining to play video games."
Constant Reminders to Interrupt	P1-G1: "Set a reminder to not use too much! Keep repeating it until he gets annoyed and stops!"
Extrinsic Motivation	P19-G7: "Achieve goals that you created which will grant you rewards."
Intrinsic Motivation	P4-G2: "If they stop, the device can give an applauding sound."
Gamification	P14-G5: "There could be an app where it would tell you what to do outside of the technology world, and the more you do, you get points."
Competition	P11-G4: "Inspire competitiveness among classmates/friends?"
Seamless Transition from Screen	P3-G1: "Nice theme or pictures to make it less tough for them to stop using."
Allowing the Activity to Conclude	P13-G5: "To make the kid not upset, the game can shut down once it ended."
Planning their Own Usage Time	P19-G7: "Set a schedule."
Balancing Usage Time with Study/Work Time	P15-G5: "There could be a system where the longer you use technology for entertainment/recreational purposes the longer you have to work/study."
Parent-Oriented Solutions	P5-G2: "The parents can lock the password of the device."
Enforcing Disengagement	P17-G6: "Hack their pc." P3-G1: "Set a limit with a software app and then lock the phone (will force him to stop using the device)"
Healthy Life Habits	P21-G7: "More sleep."
Socialization	P18-G6: "Get a Social Life."

P15-G5: "Honestly, like when I feel like getting out of an addiction, I feel like finding another passion. Like maybe a sport. It can be anything else that he likes. Other than device and games."

> *P13-G5: "If the child has played for a long time, the app can prompt them with many suggestions on what to do instead of playing games; like playing board games, playing the piano, or biking."*

Educating Early Adolescents about the Issue of Tech Overuse

Participants believed that educating early adolescents about the issue of tech overuse was an important component of supporting disengagement. They felt that if early adolescents understood the gravity of this problem, then they might become self-motivated to control the temptation of using technology excessively. As a medium to raise awareness about tech overuse, participants wanted to have some sort of digital companion or mentor who could guide them toward healthy tech habits by sharing negative consequences and motivational stories, and reminding them to disengage when required:

> *P2-G1: "If we could try to make him [the story character] understand in a friendly manner, then he won't be upset… Like in a device, little kids like us could help them understand in a friendly manner."*

Awareness Tools to Keep Track of Spent Time

Participants identified the need to use different kinds of awareness tools to guide disengagement behavior. Since children can lose track of time while using devices for entertainment, keeping track of their spent time and reporting it with an alarm or reminder was considered useful by our participants:

> *P5-G2: "Maybe an alarm clock which will keep track of the screen time. Coz sometimes you keep playing without knowing what the time is."*

A common way to enforce disengagement is to track time and automatically restrict access once the time limit is up. However, since this sudden withdrawal might be upsetting for children, participants preferred using multiple reminders to make children aware of how much time is left. The following is a snippet of a short conversation between members of Group 1 addressing this issue:

> *P3-G1: "It [screentime limiting app] won't turn those off suddenly. If it happens to you, you'd be angry too."*
>
> *P1-G1: "It will give 3 different warnings. – 1st – 15 minutes, – 2nd – 15 minutes, – 3rd – turn off."*

Further, if an early adolescent is just starting to practice disengagement, getting used to time limits could be difficult. In that case, participants felt that enforcing time limits gradually could be easier to adjust to. For example, participants discussed how an application can decrease their screen time by 10 minutes each week, so that children can easily get accustomed to the reduced screen time.

3.2.2.3 Generating the Final Solution Helped Participants Identify Priorities

Before the final session, participants were asked to create an individual sketch by independently selecting and combining ideas they perceived as potentially effective to control tech overuse from their brainstorming session. Of the 21 participants, 18 completed this task, which enabled them to contribute to the group discussions by demonstrating their sketches to others. Participants chose the components they liked most from the individual sketches and combined those to generate the final design solution (See Figures 4, 5, and 6 for examples). This phase of our study allowed the

participants to express their thoughts on the advantages and disadvantages of each member's chosen ideas, trade-offs between different combinations of ideas, and identify ideas they would like to prioritize. For example, the majority of the ideas from Group 6's brainstorming were related to engaging in outdoor activities and socializing. However, in the final session, they began to focus quite heavily on gamification and rewards. The following depicts part of their interaction:

> *P16-G6: "So, the kid has to control himself, choose not [the] screen. How do you do that? Maybe you give them after-school activities. So, maybe we can do a calendar thing."*
>
> *P18-G6: "Maybe we make whatever they have to [part of] a game. So, make life into a game. Like do these things and get points. And make levels, like level of smartness, level of tidiness, level of everything. What level you are, like the 'King's Legacy' (an online game)?"*
>
> *P16-G6: "I like P18's message, when you do something productive, you get some rewards. So, I guess we put that in."*
>
> *P17-G6: "Yeah, that's pretty good."*

3.2.3. Participant-Perceived Important Design Factors

As discussed in subsection 3.2.2.2, participants produced a range of ideas to address the issue of tech overuse, and each group developed one "final" design solution based on those ideas. These participant-generated final design solutions and their surrounding discussions revealed key design factors that participants were inclined toward to facilitate their tech disengagement. This subsection describes each of these design factors with examples from our sessions.

3.2.3.1 A Balance between Giving Children More Agency & Parental Involvement

During early adolescence, children develop a sense of autonomy [53], which is reflected in our participants' final design solutions. Participants preferred less parental control and more independence. They discussed ways to help children act with agency to control their tech use which included preplanning usage time, tracking their own time and progress, independently choosing what kinds of offline activities they would like to engage in, and setting goals for those activities. Since considering children's opinions in rule-making is known to encourage adherence [69,82,97,100], allowing early adolescents some autonomy over their tech use might motivate them to practice disengagement. For example, in our study, participants wanted to preplan their usage time to mitigate conflicts as sometimes their usage time clashes with their parents' plans. They also understood the importance of balancing their usage time with their study time – usage time can be used as an incentive to study and children will only be allowed to play if they spend some time studying. These examples indicate that given the freedom of making independent choices, early adolescents might show responsible behavior regarding tech use:

> *P9-G3: "I was thinking about planning their own time and tracking their own time."*

> *P14-G5: "For me, it'd be like uh, doing this [study/work] would give you like a reward. So, after, you'd basically get like one hour of playing, and then you could do some studies and then you can play the rest of your games. But if you don't do your studies, then you won't be able to play any more games until you study for the rest."*

Although participants wanted more autonomy in practicing tech disengagement, interestingly, most of them wanted to give some sort of control to their parents. In most cases, they wanted the parents to set the duration of their screen time. Further, while discussing rewards, they

realized that the parents would be responsible for choosing appropriate rewards for their children. For example, not every parent would be comfortable giving away money as a reward to their child. Even though they decided that children themselves should independently choose offline activities to disengage from technology, some participants mentioned that those activities would have to be approved by their parents. The following interaction between P13 and P15 illustrates how they wanted to balance both early adolescents' autonomy and parental control in their design solution (depicted in Figure 4):

> *P13-G5: "The parent will have to approve the activity so the child can't just think and put an activity that they didn't do to get more points."*

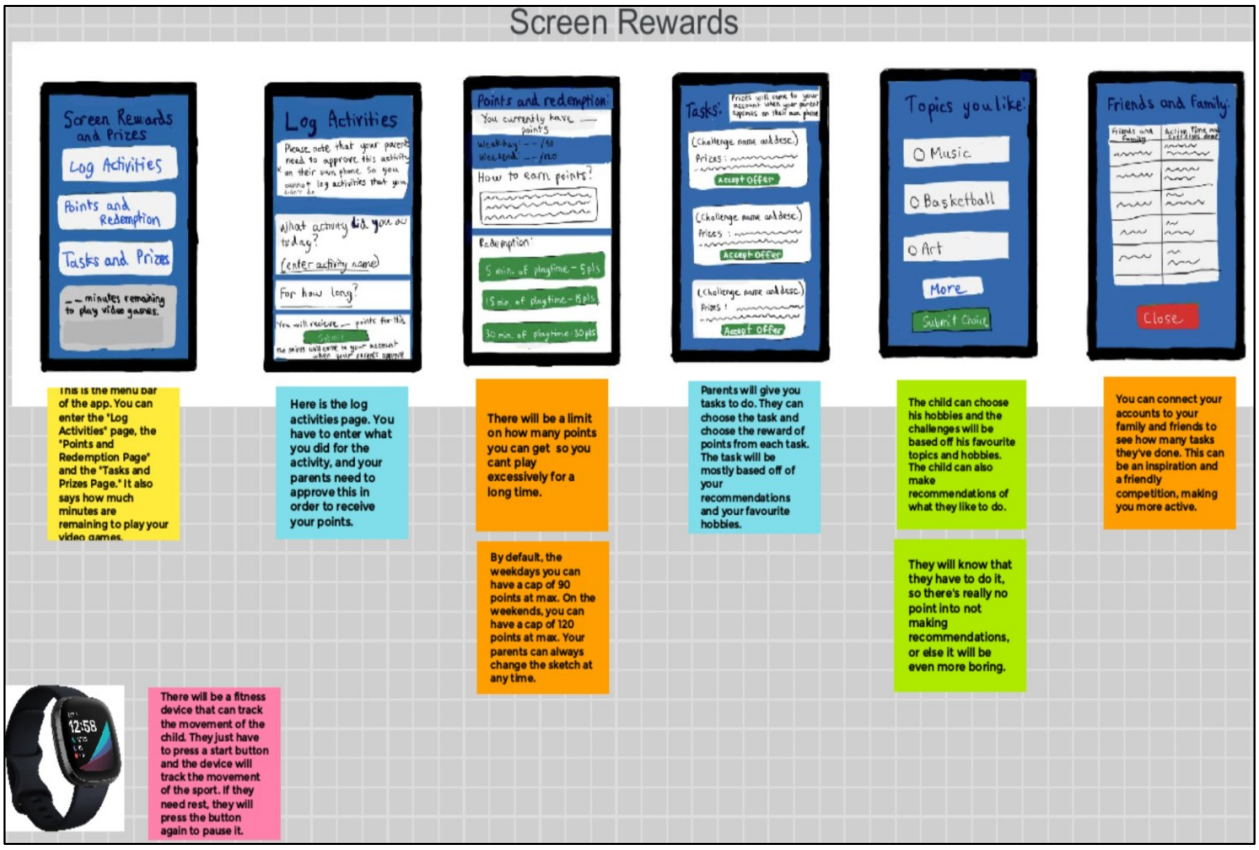

Figure 4: Final Design Sketch by Group 5 (G5); This is an app that will reward the children with screen time if they complete the tasks chosen by their parents. Children can suggest tasks that they are interested in doing. Parents will evaluate the performance before approving the rewards. There is a leaderboard that inspires friendly competition among friends and family members. (Enlarged snapshots from this sketch can be found in Appendix A.3.)

P15-G5: "I think we should have both options, help the child to be independent and the parents have some control. I think the sketch already has some of it, like the chat and the options to choose and the parents can redeem tasks."

Additionally, they brainstormed ways to involve children in joint activities with their parents so that they could enjoy completing the tasks collaboratively. An interesting idea was to borrow elements from online games (e.g., Minecraft) and design real-life activities based on those elements so that children can easily relate to the offline tasks and enjoy completing those tasks together with their parents. These findings relate to the Individuation-Separation Theory stating that while early adolescents seek independence from parental control, they also seek parental involvement and a supportive relationship with their parents [166].

P20-G7: "Since they spend a lot of time doing screen time, they are not spending that much time with their parents. So, they can do this with their parents and probably spend some quality time doing it."

Participants pointed out that for some children, self-disengagement can be especially challenging, particularly for those who are addicted (according to our participants' understanding of addiction). Without parental supervision and support, they might exploit their independence and might not practice disengagement. However, since early adolescents can show resistance to parental rules [65], our participants discussed ways to disguise parental control with interesting technologies. For example, in the following quote, P3 implies that an already addicted early adolescent might not want to follow parent-enforced rules. In that case, using a parent-controlled robot companion to limit their tech use could be more effective:

P3-G1: "The robot will be connected to [the story character's] devices, and [the robot] can control those. But Tamal [the story character] wouldn't know that [the parents are controlling the robot] [...] If they are already addicted, I think it wouldn't be possible to find a solution by themselves. They might need to seek help from their parents."

Similarly, members of Group 5 discussed the necessity of parental involvement to prevent an early adolescent from finding ways to navigate around digital interventions:

P15-G5: "Well, I think, my original idea was to have a child being independent with the app, but I think if the parents are controlling the app too, they also want the best for the children. So, maybe the children might find a way to cheat. And if you have the parents, then it prevents that. I mean they could be addicted enough to just cheat."

P13-G5: "For the parent's controlling, honestly, if the kids are getting addicted to it, they might not stop. Maybe if the parents tell the kids multiple times, they really want that to happen, if they're good kids, they'll try to make their parents happy. And honestly, a lot would do that. And the app would also boost this."

3.2.3.2 Considering Children's Emotions while Designing Mediation Strategies

While designing solutions, our participants expressed empathy toward the different emotional challenges early adolescents might encounter while trying to disengage from technology. They identified instances where early adolescents might feel upset, forced, or mistrusted, and tried to address those emotions through their design solutions. For example, participants realized that it can be challenging for children to disengage from a source of entertainment and withdraw from screens to shift to an offline activity suddenly [214]. To make this transition easier, participants

came up with solutions such as distracting them from their current task by showing attractive themes and saying encouraging words.

During the study sessions, our participants also realized that sometimes the interventions might make early adolescents feel a lack of trust from their parents:

> *P7-G3: "My dad told me about an app his boss uses for his son, which tracks how much time he spent studying and playing. But I don't think it makes him feel good. If my dad had this, I will be very sad."*

As discussed before, participants did want parents to be involved to some extent to ensure that children with addiction would not escape the rules. However, they stressed the importance of feeling trusted in the process and expected the parents to reassure and console the children. For example, Group 5's final solution requires an early adolescent to submit evidence of activity completion to the parents to earn screentime (See Figure 4). In the following interaction between G5 group members, P13 acknowledged that their solution might create a trust issue in early adolescents and P14 believed that it should be the parent's responsibility to ensure their children's emotional wellbeing:

> *P13-G5: "But here's the thing, if you did give a video, would the child lose motivation, thinking that even if they did it [the assigned offline tasks], they are upset because their parents won't trust them?"*

> *P14-G5: "I think the parents can reassure the kids that they don't have trust issues."*

3.2.3.3 Positive Reinforcement to Motivate Participation

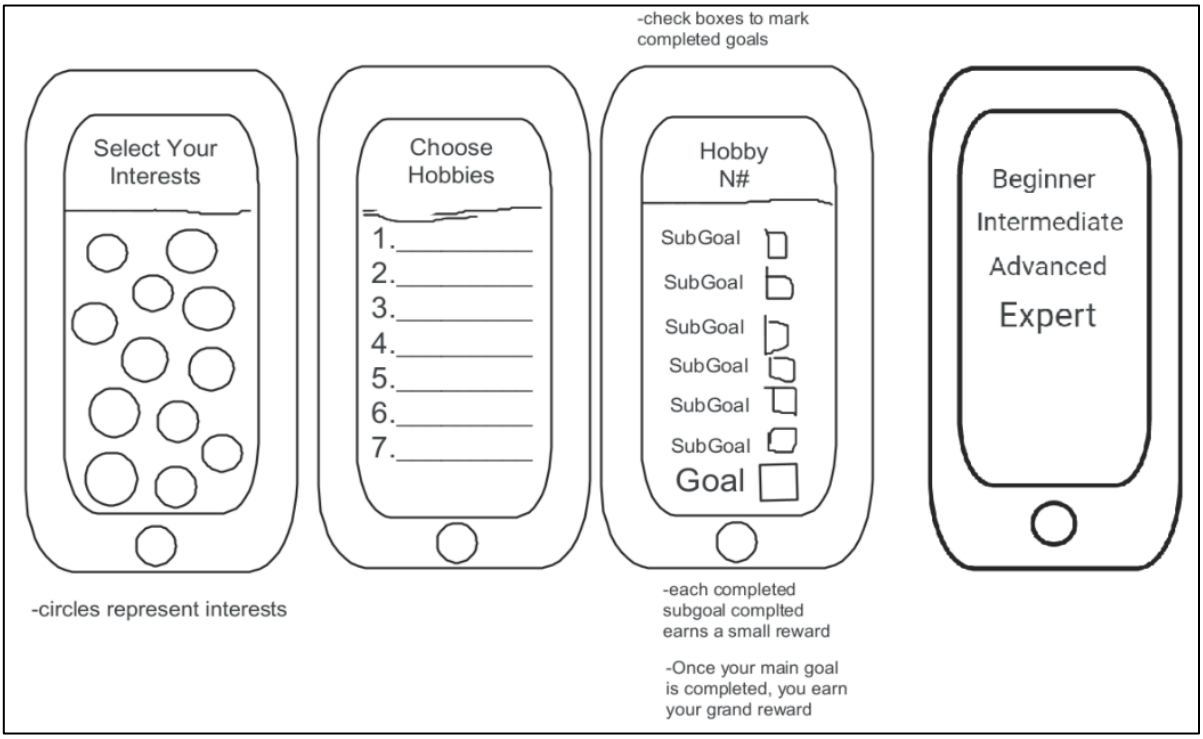

Figure 5: Final Design Sketch by Group 7 (G7); This is an app that enables children to find a new hobby. There are goals that they will accomplish collaboratively with their parents. Upon achieving a goal, they will be rewarded.

One design factor found in almost all of our participant's final solutions was the incorporation of positive reinforcement (see Figures 4 and 5). To motivate early adolescents to practice tech disengagement, they discussed both intrinsic and extrinsic motivators. Upon complying with the rules, participants wanted to appreciate them with rewards (e.g., money, game currency, screen time) and with words and gestures of encouragement. They felt that this might help cultivate positive emotions regarding tech disengagement by making the children feel that their efforts were recognized and appreciated.

P3-G1: "Give them creative tasks! Give reward points and say good things to encourage."

Gamification is a well-known technique to motivate users' participation [174] and reinforcement is a key component of a well-designed gamification experience [163]. A previous

study with middle-school youth demonstrated the effectiveness of gamification for behavior change in case of preventing substance abuse and relationship violence [171]. To encourage offline activities to limit tech use, our participants also wanted to incorporate gamification into real-life activities. The following is a short interaction between two participants of Group 2 about gamifying household chores:

> *P5-G2: "An app can have different levels with different chores. It will show messages like go to that part of the house and do this, and they will be rewarded with points."*
>
> *P4-G2: "Like a treasure hunt!"*

Competition is known to encourage participation in gamification tasks [174]. Our participants also talked about involving children in competitive games, where they could see each other's progress and the ones using less technology would win rewards. For example, in Figure 4, Group 5 added a leaderboard in their final solution to create competition among the users. Our participants believed that having a sense of competitiveness along with the gamification of offline activities might influence early adolescents to practice tech disengagement:

> *P13-G5: "Everyone is gonna see how much the person is doing...They'll be like, 'Oh no! Everyone is seeing that I didn't do that much exercising. I should do it!'"*

3.2.3.4 Relatedness and Novelty to Make Interventions Engaging

From the participant-generated design solutions, we observed that participants gravitated toward design elements that are either relatable or novel. For example, while talking about a motivational companion who could educate, it seemed that participants wanted this information to come from someone relatable, preferably from children of their own age. This is consistent with the finding

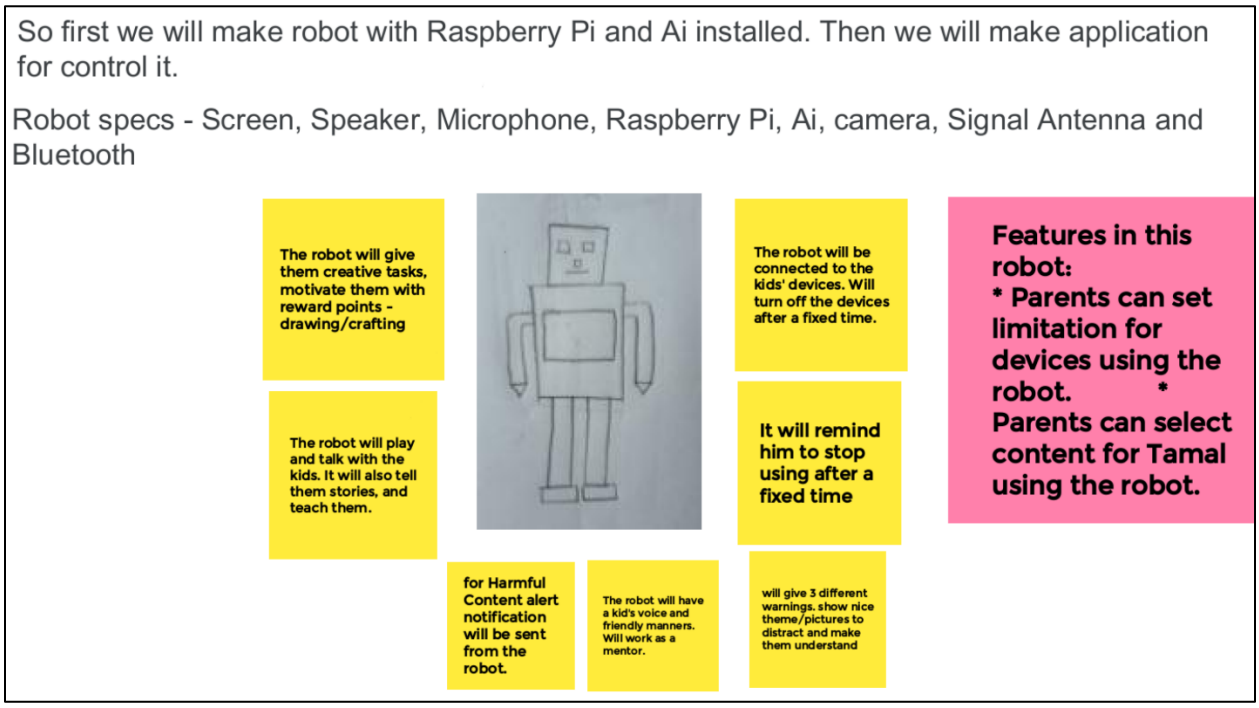

Figure 6: Final Design Sketch by Group 1 (G1); A companion robot to help children educate about the issue of tech overuse and support them in disengaging from technology.

that early adolescents often seek elements of trust and support from their peers [142]. If a peer mentor or companion was not possible, they wanted an animated version of children, or a friendly robot with a child's voice. For example, Group 1's final solution involves such a robot companion with characteristics that children can relate to (e.g., in Figure 6, one of the sticky notes mentions that *"The robot will have a kid's voice and friendly manners"*).

While the ideas mostly centered on a peer mentor, Group 2 talked about having a motivational adult character representing someone that early adolescents idolize (e.g., an action hero, a sportsperson). Early adolescents start to develop a sense of autonomy, which often leads to not wanting to follow parental rules [65]. However, this group seemed to feel like they might accept guidance from an influential figure that would appeal to an early adolescent. The following

quote illustrates how Group 2 incorporated the idea of a holographic representation of a popular character in their final solution:

> *P4-G2: "There can be an application where a hologram of the child's favorite hero or sportsman can appear and remind him about the screen limit. The child will love to see their favorite person."*

Thus, while participants preferred the digital companions to be relatable, they also seemed excited to have the opportunity to interact with novel and interesting technical components (e.g., a robot or a holographic character). One potential pitfall of using these techniques is that the novelty factor might wear off. To introduce an element of surprise in the interaction, Group 2 thought about randomizing the character of the companion over time. These examples speak to the novelty-seeking tendency that is common in adolescence [179].

3.3. Discussion

Our study findings provide insights into digital mediation strategies and potential design factors that early adolescents perceive as useful to limit their technology overuse. Through the co-design activities, participants in our study emphasized the need for a balance between early adolescents' sense of autonomy and parental control, to motivate tech disengagement by incorporating positive reinforcement and to consider early adolescents' emotions. Our participants also proposed mentoring and messaging from relatable characters and the inclusion of novel technical components that might attract interest. These key design factors along with examples of related design ideas suggested by participants are summarized in Table 3. We see support for many of these perspectives in the literature. For example, according to developmental psychology, children

Table 3: A summary of key design factors and associated design ideas proposed by participants throughout the study sessions.

Key Design Factors	Example Design Ideas
A Balance between Giving Children More Agency & Parental Involvement	Keeping track of time Planning their own usage time and balancing it with study/work time Joint activities with parents/friends Enabling parents to have some control (approving tasks/rewards) Masking parental control with technology in cases of problematic tech use
Considering Children's Emotions while Designing Mediation Strategies	Feeling trusted by the parents Seamless transition from screen to avoid sudden screen withdrawal Allowing the activity to conclude
Positive Reinforcement to Motivate Participation	Raising awareness about tech overuse Engaging in creative tasks and creating own goals Incorporating rewards, encouraging words and gestures Gamification of offline activities Competition with friends or family members
Relatedness and Novelty to Make Interventions Engaging	A mentor/companion to raise awareness Relatable design elements in the intervention Interesting/novel technological components Introducing elements of surprise in the design of the intervention

in early adolescence start to develop a sense of autonomy but still seek support from their parents [166]. Previous research states that teens feel that most of the existing interventions to control tech use overlook their needs and expectations [206], which likely relates to our participants stressing that early adolescents' emotions should not be ignored while applying mediation strategies. Like our participants, prior research also suggested incorporating playful gamification, customizability, parents' involvement, and collaboration [170]. That we have observed early adolescents considering and designing for these factors suggests an interesting level of introspection and awareness of the core issues. We hope that hearing these perspectives directly from early adolescent designers can serve as a further motivator for HCI researchers and practitioners working to tackle these complex considerations to create new digital interventions.

Throughout the process of generating a design solution, one interesting observation was that, initially, most of the participants started with traditional parent-oriented strategies (e.g., setting strict time limits for children, tracking their activities, forcing them to disengage if they cross the limits). During the timespan of our three sessions, we observed how participants shifted their focus from those restrictive solutions to more child-centric solutions. Instead of focusing on a restrictive approach, participants selected solutions that provide early adolescents with some sort of agency with design elements that aim to motivate them to practice disengagement on their own. Given that early adolescents are capable of practicing self-regulation [66,75], this shift also makes sense from a developmental standpoint.

Another goal achieved through this study is demonstrating ways to give early adolescents more of a voice in the design process, a goal motivated by prior findings that enabling children's voices in determining parental rules can encourage better adherence [69,82,97,100]. Our study method enabled high-quality collaboration and contribution from the participants, which speaks to the strength of the co-design approach to elicit feedback from early adolescents regarding their technology use and disengagement. Participants in each group collaboratively generated a range of different ideas and mutually created one final solution with their preferred ideas. The combination of our co-design tasks, team-building activities, and focus group discussions appeared to help motivate and scaffold participants' creative collaboration. There are some open questions regarding the story creation process. On one hand, we found that the story creation helped contextualize the problem of tech overuse, and we observed participants using the main character of their story as a persona when considering design solutions in the following sessions. On the other hand, it is possible that asking participants to create multiple different personas could further stimulate design ideas and provide useful tools for idea comparison and critique. When analyzing

the data, we also had some difficulty discerning the degree to which participants were grounding their thoughts and ideas in their own experiences or rather they were making assumptions about how the fictitious character might feel. Furthermore, there is a possibility that participants might have sometimes been hesitant to fully express their opinions to avoid appearing as a "tech addict".

Conducting the study online meant we had to rely on virtual tools for the co-design process (e.g., Zoom, Google Slides, and Google Jamboard), which sometimes introduced additional concerns. For example, since drawing is more cumbersome online, we populated the Google Slides with icons of sample characters and different objects. While these elements allowed participants to focus on story creation immediately as opposed to spending time figuring out what elements to draw and how to do so within the application, they might have limited participants' artistic expression. Both Google Slides and Google Jamboard supported effective synchronous collaboration by showing real-time changes made by the participants, however, one limitation of using Google Jamboard for sketching the final solution was that participants who were using a mouse had difficulties sketching in the application. Hence, they preferred to sketch on paper, take a picture of their sketch and attach it to the Jamboard. While this allowed participants to communicate their ideas, other groupmates could not build on their ideas by editing the sketch directly and would instead provide verbal suggestions for the participant to incorporate into their paper sketch. Despite these extra steps, our overall experience with Google Slides and Jamboard was positive. Although a few participants did not have previous experience with these tools, we did not observe any real difficulties owing to tool complexity. After our demonstration prior to the co-design activities, when participants had any confusion about the tools, their group members would help them out. All participants seemed comfortable using Zoom, possibly because many attended classes online during the height of the pandemic.

3.3.1. Limitations and Generalizability

Our online study allowed us to include participants from seven different countries, which introduced diversity to our sample. However, our sample size was not large enough to identify any patterns in how participants envisioned design solutions based on their backgrounds. Additionally, given that our study was solely focused on early adolescents' perceptions of technology disengagement, we did not involve their parents in our study. We wanted participants to feel that their opinions and ideas were the sole focus of our study to increase their sense of importance in our design process. Thus, we did not conduct any surveys or interviews with the parents and consequently, were not able to collect their background information (e.g., parent/caregiver's educational background, socio-economic, and marital status). Given that socioeconomic factors can impact parental mediation strategies in children's tech practices and parent-child relationships [164,186], having information on participants' parents and family backgrounds could help contextualize participants' individual perspectives about technology use and disengagement.

As discussed in our study method, our group formation led to some groups consisting of participants with previous relationships, which is known to affect collaboration [108]. Studies with different group dynamics might produce different ranges and types of design contributions. Similarly, since we formed groups based on participants' availability, we did not control the gender distribution in the groups, which might have influenced the collective decisions of the team. For example, while thinking about an early adolescent for their story, most groups chose a boy character. This might be due to the gender dynamics in our groups – two groups had two girls and one boy participant, three groups had one girl and two boy participants, and the rest were all-boy groups. Since male participants in a group typically have a stronger position [120], if there were

more all-girl groups, we might see more stories with girl central characters. Given that the groups used these characters as personas, this might have impacted the diversity of ideas.

3.4. Summary

Through our multi-session, group-based, online co-design study, we explored early adolescents' perceptions and opinions regarding the issue of tech overuse. Findings from these co-design sessions offer insights into how early adolescents envision appropriate tech-mediated solutions, and what factors they think might be helpful to support their disengagement from excessive use of technology. Our study methods encouraged active participation from our participants and facilitated valuable contributions during the online co-design sessions. Our study findings, directly grounded in the perspectives of early adolescents, serve as both justification and motivation for our next study, which involves exploring the design space of child-centric tech mediation solutions.

Chapter 4

Exploring A Design Space for Digital Interventions Facilitating Early Adolescents' Tech Disengagement: A Parent-Child Perspective

In this chapter, we define a design space informed by insights from our co-design study and literature on parental control tools, mediation strategies (e.g., co-use, active mediation), and early adolescents' self-regulation abilities, to investigate the design of digital interventions for addressing excessive tech use among early adolescents. While our previous findings revealed key design factors that early adolescents deemed important for interventions promoting tech disengagement, how to effectively translate these overarching factors into actionable designs requires more in-depth exploration. Additionally, given that digital interventions are ultimately

implemented within a family setting, it is essential to understand the viewpoint of parents alongside early adolescents' design preferences and perspectives. To this end, we defined and explored an early adolescent-centric design space for digital intervention, which involved identifying diverse design solutions and assessing them by incorporating insights from both early adolescents and their parents. In doing so, we investigated the following research questions:

1) What dimensions should be considered when formulating an initial design space for digital interventions targeting early adolescents' technology overuse?
2) Where do early adolescents' and their parents' preferred solutions for tech disengagement lie within this design space, and why?

This chapter shares our approach to defining an early adolescent-centric design space, outlines a study eliciting the preferences of early adolescents and their parents regarding tech mediation, and presents its findings. See Appendix B.1 for approval from the University of Manitoba Research Ethics Board for this study. This work was presented at the 13th Nordic Conference on Human-Computer Interaction (NordiCHI '24) and was published in its proceedings [38].

4.1. Approach

In this phase of the research, we aimed to formulate a design space for digital interventions addressing early adolescents' tech disengagement. A design space refers to the range of possible design solutions and alternatives that designers explore to address specific design problems, structured by key dimensions that capture various strategies, features, and approaches considered throughout the design process [93]. This concept is important because it supports designers in

making decisions, understanding the impact of changes, and reflecting on their choices [177]. Additionally, a design space facilitates communication within design teams and helps guide future explorations or adaptations [128].

In defining and exploring an initial design space, we were inspired by the Research through Design approach, which utilizes design artifacts to elicit individual attitudes and perceptions [218] (discussed in section 2.3.2). As our first step, we outlined an initial design space which identifies four key dimensions: early adolescents' agency, supportive parental engagement, motivation type, and mentorship approaches (see section 4.1.1). Next, we developed three contrastive design concepts as video prototypes, each focusing on different points along the dimensions (see section 4.1.2). We then conducted an elicitation study with 26 participants, 13 pairs of an early adolescent and a parent, where we probed their perceptions of the design concepts (see section 4.2).

4.1.1. Formulating Design Space Dimensions

To formulate a design space for digital interventions targeting early adolescents, we consulted literature on existing mediation strategies and parental control tools (e.g., co-use, active mediation, technical mediation) [10,77,78,104,106,114,151,169,181,186,208], early adolescents' self-regulation abilities (e.g., self-planning, journaling) [61,66,75,135,156,161,173,206,211], and early adolescent-perceived important design factors identified in our co-design study (e.g., positive reinforcement, agency). From this literature and our prior study findings, we created a set of design dimensions with the potential to influence early adolescents' tech disengagement practice. After several rounds of iteration, we refined this set to four core design dimensions, focusing on those that the literature suggests are important, yet lack clarity as to where the most desirable solutions lie. We describe these dimensions below.

4.1.1.1 Level of Early Adolescents' Agency: Low Agency --- High Agency

In our co-design study, early adolescents expressed a need for increased agency while practicing tech disengagement (section 3.2.3.1), likely due to their growing sense of autonomy [53]. Encouraging self-awareness and allowing them to take charge of their disengagement practices might motivate them to adhere to the mediation strategies. The question is how to strike the right balance between giving early adolescents agency and maintaining appropriate parental control. While giving full autonomy might lead some early adolescents to misuse their freedom, complete parental control can hinder their sense of independence and ability to self-regulate. With this dimension, we aim to explore the desirable level of agency for early adolescents. At one end of the spectrum is low agency, where parents would determine and enforce early adolescents' device usage rules. On the opposite end, early adolescents take responsibility for setting their own rules and tracking their progress. The middle of this dimension represents a balance, with a moderate level of both early adolescents' agency and parental control.

4.1.1.2 Level of Supportive Parental Engagement: Limited Parental Engagement --- Active Parental Engagement

The literature indicates that supportive parental engagement in early adolescents' tech disengagement practice is crucial, especially for maintaining their emotional well-being [206,214]. Not being considerate of early adolescents' emotions while monitoring or enforcing tech usage rules can lead to frustration and mistrust toward parents [206,214]. While early adolescents prefer more independence, they also desire a supportive relationship with their parents and some level of parental involvement [37,166], as highlighted in our co-design study (see section 3.2.3.1). Conversely, parental overinvolvement can create attachment issues, social problems, and anxiety [50]. To explore this dimension, on one end, we have limited parental engagement, where the

parent refrains from interfering or participating in their child's tech disengagement process. On the other end, there is active parental engagement, where the parent is significantly involved in their child's tech disengagement process, e.g., by practicing the rules themselves along with the early adolescent and having daily discussions about their progress. The middle point of this dimension represents a moderate level of supportive parental engagement, which may include interactions with early adolescents about their progress and addressing any negative emotions or challenges regarding their tech disengagement process, but not co-practicing disengagement with them. This dimension differs from the "level of early adolescents' agency" in that high engagement does not necessarily mean controlling early adolescents' tech usage by enforcing rules.

4.1.1.3 Type of Mentorship: Peer-based Mentorship --- Parental Mentorship

While parental mentorship is a common approach to guide children's tech disengagement [90,134,186], peer-based mentorship might also have advantages given that peers have a significant influence during early adolescence [142]. Since early adolescents often rely on their peers, promoting supportive accountability among peers has the potential to motivate the use of behavioral interventions [102]. In our co-design study, participants suggested that a mentor with peer-like, relatable characteristics could help manage tech overuse (section 3.2.3.4). Based on these insights, this dimension explores the spectrum between peer-based and parental mentorship.

4.1.1.4 Type of Motivation: Intrinsic Motivation --- Extrinsic Motivation

In our co-design study with early adolescents, incorporating motivation to encourage adherence to tech usage rules was a common element of their designs for digital mediation strategies (section 3.2.3.3). Two well-recognized forms of motivation, intrinsic and extrinsic, play important roles in promoting behavior change [98]. Intrinsic motivation is the internal drive to do an activity for only the enjoyment or satisfaction of doing the activity, whereas extrinsic motivation is the motivation

to do an activity for some other goals, which can include external rewards or pressure (e.g., praise, fear of punishment) [98,165]. Incorporating both intrinsic motivation (e.g., engaging in interesting offline activities) and extrinsic motivation (e.g., rewards) was perceived useful in limiting tech overuse to early adolescent participants in our co-design study. Therefore, in this dimension, we aim to explore different types of motivation. On one end, we have designs that leverage primarily intrinsic motivation, which emphasizes self-motivation and internal satisfaction. On the other end, we have designs that leverage primarily extrinsic motivation, which relies on external rewards and incentives. The middle point on the spectrum represents a balanced integration of both types of motivation.

While other design dimensions may also be relevant, we focused on the aforementioned dimensions for our initial early adolescent-centric design space, as they have significant potential to impact early adolescents' tech disengagement but lack clarity on the most desirable solutions. Among the four design factors identified in our co-design study – balancing children's autonomy with parental involvement, considering children's emotions, incorporating positive reinforcement, and relatedness and novelty – we did not directly include the fourth factor as a standalone dimension. Instead, we integrated elements of "relatedness and novelty" into specific design concepts that explore unique combinations of the dimensions (e.g., tracking parents' tech disengagement progress, social interaction with peers, virtual character), as described in Section 4.1.2. Additionally, we modified and expanded the second factor, "considering children's emotions", by embedding it within the dimension of "supportive parental engagement", due to literature highlighting its importance in supporting early adolescents' emotional well-being and promoting effective tech disengagement [206,214].

4.1.2. Generating Design Concepts

Utilizing our design dimensions and drawing on prior research employing "Research through Design" in design space exploration [6,81,89,191], we generated design concepts and transformed them into artifacts to use as probes to solicit insights from end users. Through iterative ideation and sketching, we aimed to uncover innovative solutions based on early adolescents' perspectives that demonstrate contrasting ideas by exploring interesting and unique combinations along the abovementioned design dimensions. During this process, we purposefully extended the dimensions in certain directions and did not explore combinations that involved unreasonable trade-offs. For example, our first study findings indicate that early adolescents want at least some autonomy in their tech disengagement practice. Therefore, we did not include a design concept that incorporates very limited agency. Additionally, only incorporating intrinsic factors might be ineffective for those who do not value tech disengagement, whereas only including extrinsic factors could diminish their intrinsic motivation [165]. Hence, our design concepts aim for a balance, avoiding these extremes (e.g., using only extrinsic or intrinsic factors), while exploring combinations with different relative weights. During this process of exploring concepts covering different *multidimensional combinations,* we also noted interconnections among our dimensions; for example, designing for a high degree of agency might naturally lead to enhanced intrinsic motivation.

Our exploration of the design dimensions led us to three design concepts for which we generated three medium-fidelity prototypes using the Pencil prototyping tool [221]. Screenshots of all the features of these prototypes are included in the Appendix B.2. While translating our design concepts into tangible prototypes, we borrowed elements from early adolescent-generated design solutions from Chapter 3, persuasive technologies [59,125,204], and various self-regulation

strategies proposed in prior literature [7,22,55,91,121,133,169,175,206]. The design concepts are described below, followed by a visual representation of their estimated placements on the dimensions to highlight the diverse areas they explore within the design space (Figure 10).

4.1.2.1 Prototype 1: Parent-Child Unplug (PCU)

This design concept explores allowing early adolescents and their parents to practice tech disengagement together, inspired by the advantages of practicing joint mediation within families [110,114]. In the Parent-Child Unplug prototype (Figure 7), both a parent and their child will have their own set of device rules that they have discussed and determined together. The rules include a list of daily offline activities that they have agreed to complete (Figure 7A, 7B), a list of time limits for device usage, and a list of reminders programmed into the intervention to prompt them to follow the rules. They also have the option to set new weekly goals. These features were based on recommendations to allow children to set self-directed boundaries to manage their own tech

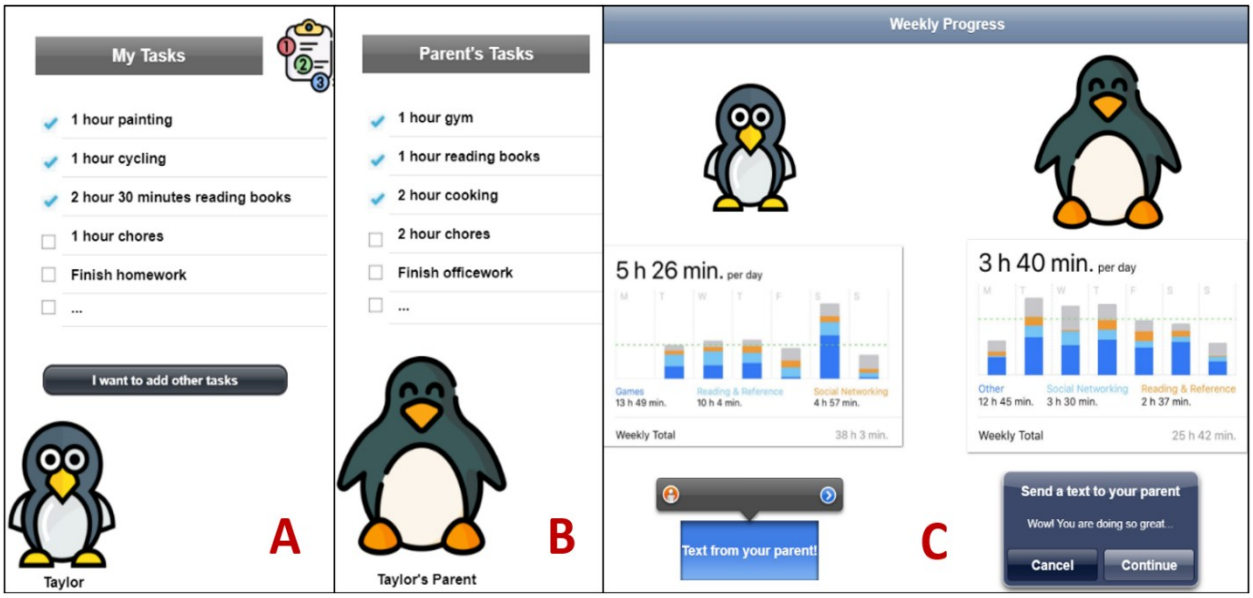

Figure 7: A few screenshots from Parent-Child Unplug; (A) The early adolescent will have a list of tasks that they can edit according to their interests. (B) The parent will have their own list of tasks. (C) Both can view each others' progress and message each other to remind and encourage (screenshots of the other features can be found in Appendix B.2.1).

usage [110], and negotiate rule-setting with parents [77,109]. The prototype enables the parent and the early adolescent to remind each other about their mutually established rules, view each other's progress and exchange encouraging messages (Figure 7C). These features serve as forms of reinforcement, which, according to early adolescents, can motivate their disengagement practice (section 3.3). There is a 'My Journal' feature (included in Appendix B.2.1), which serves as a reflective self-evaluation tool [121], allowing early adolescents to express their feelings regarding the device rules and their tech disengagement experiences. They can share these notes with their parents, with the aim of facilitating open communication [10,79].

This design concept emphasizes parent-based mentorship and active parental engagement since the parents are regularly supervising their children's progress and co-practicing tech disengagement with them. The rules are also mutually established with the parents. Here, the level of agency is medium. While the early adolescent can have a voice in deciding rules and setting goals, the ultimate decision-making requires collaboration with a parent. Regarding the type of motivation, this design concept combines both intrinsic and extrinsic motivation, with a stronger emphasis on intrinsic motivation. For example, setting own goals, tracking progress, and engaging in self-reflection through the journal feature aim to foster self-motivation to manage overuse. The sense of accountability and encouraging messages from parents might act as extrinsic motivators to adhere to mutually defined rules [185].

4.1.2.2 Prototype 2: TechBreak Buddies (TBB)

This design concept emphasizes peer support, leveraging its potential to promote higher levels of active engagement among early adolescents compared to a traditional parent-child support model [178]. In this prototype, early adolescents and their peers have individual profiles for managing daily offline tasks, sharing any interesting activities with friends, and tracking weekly device usage

(Figure 8A), aiming to support self-monitoring and digital autonomy [112,200]. Through features like viewing each other's task lists, sharing pictures or texts related to offline tasks, leaving comments (Figure 8B), and sending reminders about tasks to each other (Figure 8C), the prototype encourages social interaction and mutual engagement in physical activity to reduce device time. These design decisions are based on research suggesting that children learn and strengthen behaviors by observing the outcomes of others' behaviors and imitating them through indirect reinforcement processes [12]. Additionally, the peers can schedule joint activities (Figure 8C) to promote peer collaboration. To foster a positive atmosphere and avoid negative emotions of competition [188], the prototype does not share an early adolescent's progress in tech disengagement with others.

The primary focus of this design concept is peer-based mentorship. There is no parental engagement, and the early adolescents' agency is high. For example, they have the autonomy to make their own decisions regarding what offline tasks they want to engage in and share those with their friends, track their own progress, and create events with peers. The type of motivation is a combination of intrinsic and extrinsic motivation, with a stronger emphasis on intrinsic motivation

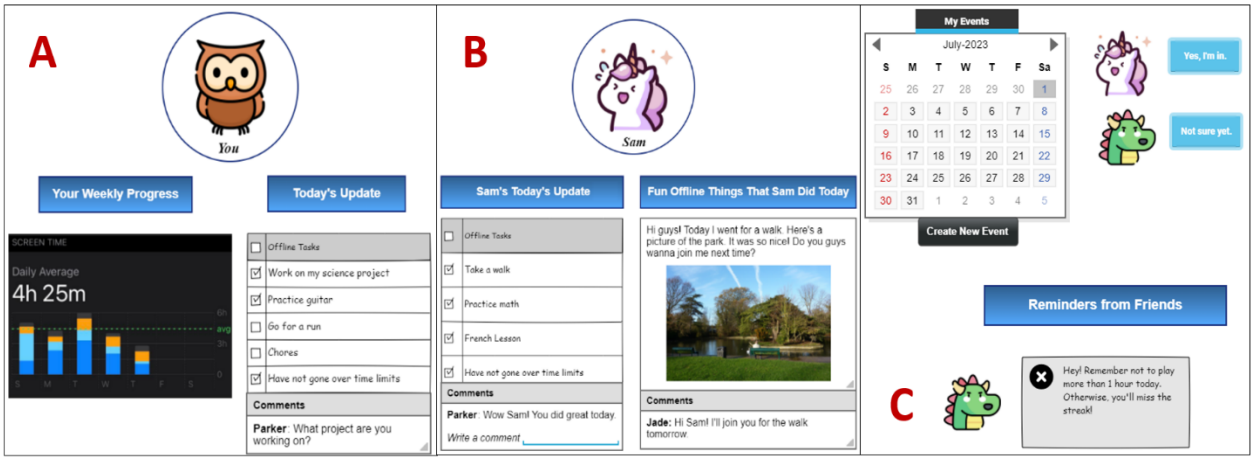

Figure 8: Screenshots from TechBreak Buddies; (A) The early adolescent will have their own profile where they can track their own progress. Their task update will be shared with their peers. (B) The early adolescent can view their peer's profile, see their updates, and leave messages. (C) They can create events for joint activities and remind each other about the rules. (screenshots of the other features can be found in Appendix B.2.2).

than the previous design concept. For example, creating personal lists of tasks empowers them to pursue their own interests. Engaging in a joint activity for the sheer enjoyment of cooperating with others can also create interpersonal intrinsic motivation [98]. On the other hand, sharing activities with peers promotes a sense of accomplishment in that their effort is recognized, which implies extrinsic motivation [98]. Leaving comments and encouragement from peers can foster a sense of social support, which contributes to both intrinsic and extrinsic motivation [188].

4.1.2.3 Prototype 3: ScreenSavior (SS)

The third design concept integrates a motivational companion as a mentor (Figure 9). Due to their growing sense of independence, early adolescents often resist parental rules [65]. According to our co-design study findings, guidance from an influential figure with relatable or early adolescent-like characteristics might encourage adherence to tech disengagement intervention. This prototype allows early adolescents to choose their preferred character from a range of different options (Figure 9C). This character will help them create a list of offline tasks by suggesting different

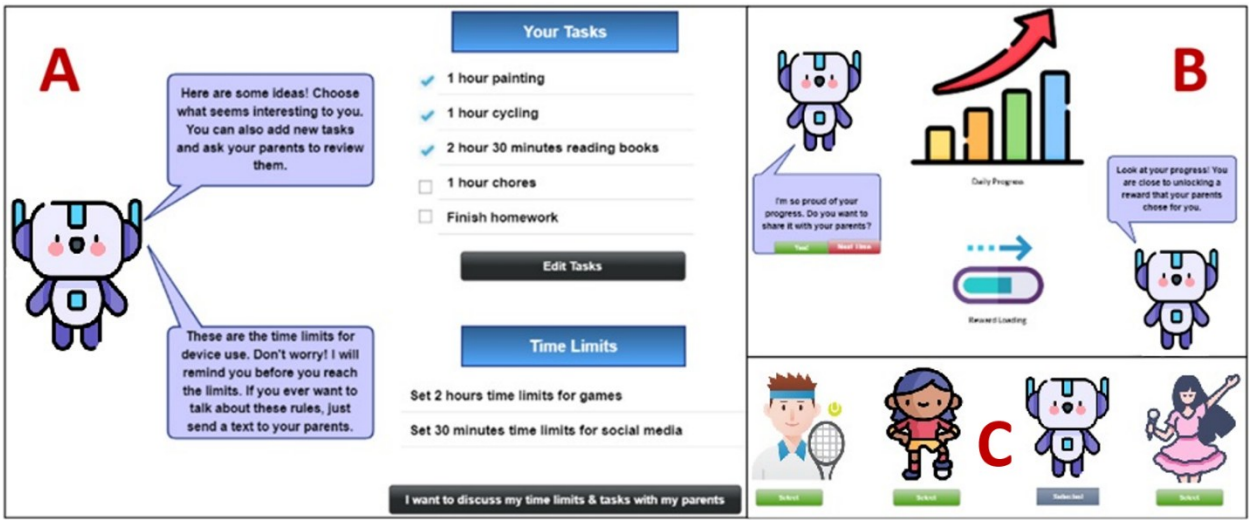

Figure 9: Screenshots from ScreenSavior; (A) A virtual character will remind the early adolescent about their rules. (B) The character will share their tech disengagement progress and updates about rewards, and encourage them to follow the rules. (C) The early adolescent can customize the character according to their liking (screenshots of the other features can be found in Appendix B.2.3).

ideas, facilitating self-planning for tech usage [22,99]. The character will also provide a list of time limits (pre-approved by parents) and remind the user to follow those rules (Figure 9A). The character will periodically check in with the early adolescent about their experience, and if they feel uncertain about any tasks or the rules, it will encourage them to discuss these issues with their parents. The companion character acts as an intermediary between parents and their early adolescent, by encouraging rule following and facilitating communications [10,79]. The character informs the early adolescent of their progress and provides words of encouragement to motivate their adherence to the rules (Figure 9B). If the parents have chosen to reward rule-following, the prototype will display how close the early adolescent is to unlocking rewards based on their achievements. These elements of gamification and data visualization are known to promote behavior change and motivate participation [59,125,163,174,204].

This design concept has a different mentorship approach compared to the previous two, which is a motivational character with peer-like relatable characteristics. Given that the virtual character has external influence from parents, there are also some elements of parent-based mentorship. The level of early adolescents' agency is on the lower end compared to the first design concept. Even though they can choose their favorite character, create personal task lists, and track their progress with the help of the companion, the pre-approved time limits and reward criteria set by parents indicate a certain level of external control. In contrast, in Parent-Child Unplug, parents and early adolescents were equally involved in the process. Supportive parental engagement is also relatively limited, with the parents relying more on the motivational character to guide their child's disengagement practice than being actively involved in the process. This concept emphasizes extrinsic motivation. For example, encouragement from the motivational character and rewards

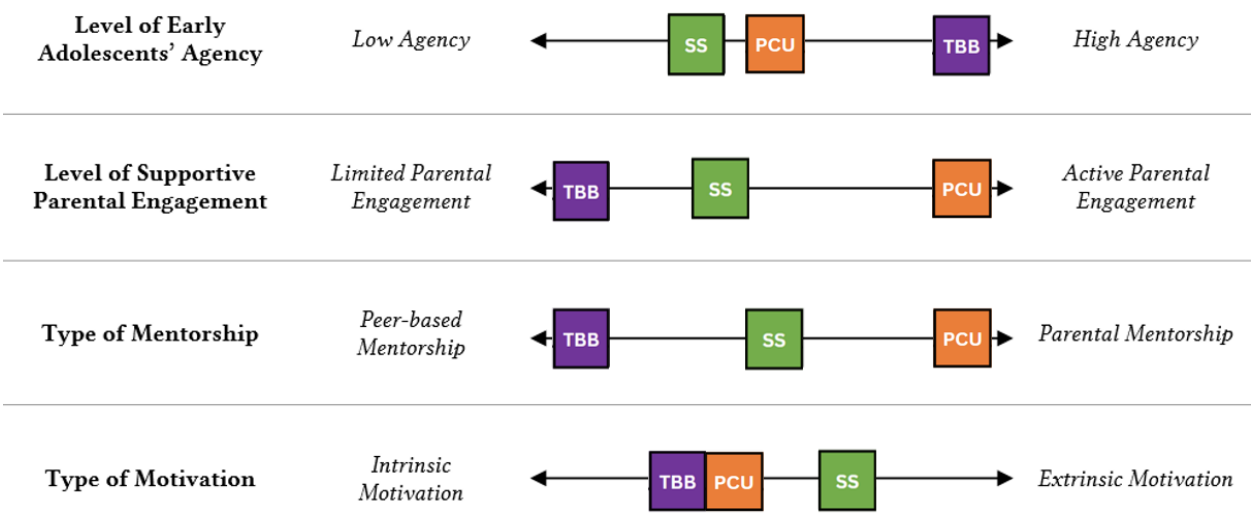

Figure 10: Visual representation of our estimated placements of the design concepts on the continuum of the design dimensions.

play a more prominent role than the intrinsic motivators (e.g., selecting interesting tasks from the suggested list, self-monitoring).

4.2. Elicitation Study

We used the medium-fidelity prototypes described above in an online elicitation study with early adolescents (11-14 years) and one of their parents to investigate their reactions toward the design concepts. To ensure consistency while demonstrating the prototypes, we created short video demonstrations for each prototype. Prior work has shown that utilizing videos as design artifacts can provoke open dialogues about the use and acceptability of technology in various contexts [6,24,81,191]. Creating video demonstrations also has the advantage of allowing us to elicit perspectives on multiple points on the design space without investing considerable time on detailed implementations [81].

4.2.1. Participants

We recruited 26 participants; 13 early adolescents (4 girls, 9 boys) who were 11-14 years old (Mean: 12.5, SD: 1.2) and one of their parents/legal guardians (9 women, 4 men) as pairs. None of these early adolescents had previously participated in our co-design study. Our sample size was informed by other studies exploring design spaces with children [94,189,194,197], the depth of data obtained from each participant, and pragmatic constraints (e.g., access to participants). Based on a recommended daily screen time limit for recreation of 2 hours for children and youth [167], with more than 6 hours daily considered excessive [27], our eligibility criteria for early adolescent participants required experience using digital media for more than two hours daily — similar to our co-design study. "Digital media" in our recruitment material was intentionally not defined to make its interpretation flexible, also consistent with our previous study. We recruited by posting advertisements on social media channels (e.g., LinkedIn, Slack, Reddit, Facebook, Instagram) and throughout our university campus and community. Additionally, we relied on snowball sampling [83] to expand our participant pool. All participants were Canadian residents except one pair from the UK. The participants came from diverse cultural backgrounds (e.g., Africa: 2, East Asia: 2, Europe: 2, Indigenous: 2, Latin America: 2, Middle East: 1, South Asia: 2). Most of the parent participants were married or partnered (12/13), held a university degree (12/13), and had an annual income of more than $75,000 CAD (8/13). Among the participants, there was a pair of siblings, who attended the study in two separate sessions, each with a different parent.

To appreciate their time and effort, we offered $15 to both the early adolescent and their parent as an honorarium. We informed the participants beforehand that their participation was voluntary, and they could withdraw from the study anytime without any negative consequences.

We obtained written consent from the parents/guardians and written assent from the early adolescents before scheduling the study sessions. All the sessions were conducted by me, and no other researcher participated in or facilitated any of the sessions.

4.2.2. Study Tasks & Procedure

Before attending the study session (Figure 11 summarizes our study design), we asked the parent participant to complete a pre-study background survey. The survey (adapted from [138,148]) collected participants' demographic information including nationality, ethnicity, educational background, socio-economic, and marital status.

The parent and the early adolescent attended the study session together. This allowed us to observe relationship dynamics and prompted interesting and spontaneous dialogue. The study sessions lasted approximately 60 to 90 minutes and were recorded for the purpose of data analysis.

I started the session by introducing our research problem. Then I asked both participants to complete a survey regarding the early adolescent participant's tech usage patterns and the household rules regarding their tech use (adapted from [137]). I then demonstrated the video prototypes discussed in the previous section. To gather detailed feedback regarding the design concepts, after each demonstration, I conducted a short semi-structured interview with each participant, always beginning with the early adolescent participant. I inquired about what elements

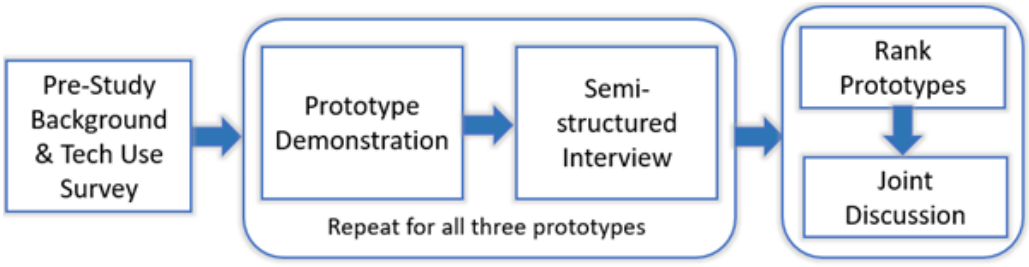

Figure 11: Elicitation Study Procedure.

they liked or disliked in the prototype, and whether they had any suggestions for improvement. To gain additional contextual insight, I asked them to think about a situation where the prototype would be useful to limit their device use and a situation where it might not be helpful. I counter-balanced the order of the prototype demonstrations to mitigate order effects.

After demonstrating all three prototypes, I asked both participants to rank the prototypes according to their preferences, recording their opinions individually on separate sheets of paper. I ended the study session with a joint discussion to gain more insights into participants' overall rankings and thoughts on the design solutions. During this discussion, I asked both participants to reflect on their reasonings behind their choices, whether they would use any of the solutions in real life and to share their thoughts on the other participant's (e.g., parent or child) preferences.

4.2.3. Data Collection & Analysis

Our primary source of data is the recordings of the study sessions which captured participants' reactions toward our video demonstrations, their responses during the semi-structured interviews and joint discussions, and their rankings of the design concepts. I transcribed the sessions and applied Reflexive Thematic Analysis [21] to the transcribed data. I began by thoroughly reviewing the transcripts multiple times to better understand the data and used iterative open coding to interpret participants' quotes. Once all relevant data items were coded, I uncovered initial patterns by identifying codes capturing the overarching narrative of the data or combining codes that share similar underlying concepts, which were then presented as preliminary themes or subthemes [25]. Later, through several rounds of iterations, a second HCI researcher and I worked together to fine-tune these themes, while always cross-referencing with the original data to maintain its

authenticity. We discussed our interpretations of the quotes and themes over multiple meetings and revised them until an agreement was reached.

To understand participants' preferences for the design dimensions discussed above, we performed a targeted analysis on the transcripts, specifically looking at participants' comments on the dimensions as previously done in studies exploring design spaces [81]. For this analysis, we concentrated on the joint discussions, as they provided insights into participants' comparative thoughts on the dimensions after seeing all design concepts. I identified comments related to each design dimension from the transcripts and rated them subjectively within a range of low, low-medium, medium, medium-high, and high. These ratings were then reviewed and refined in discussions with the second HCI researcher. For the purpose of this analysis, we discretized the dimensions rather than considering them as continuums, as determining the exact level of granularity for each comment can be challenging. We then positioned these comments accordingly within the dimensions to illustrate the range of responses and highlight areas of consensus (see Figure 12).

4.3. Findings

This section outlines our findings, beginning with a summary of the survey data to provide context on participants' technology usage patterns and household rules. It then discusses themes regarding participants' attitudes toward various aspects of our design concepts. Finally, it presents the findings from the targeted analysis regarding participants' preferences for specific areas within the design dimensions.

4.3.1. Participants' Technology Use and Family Device Rules

Our survey findings provide insights into the device usage patterns and parental rules regarding our participants' technology use. The same set of questions was asked to both the parent and their child to identify potential discrepancies in their views. Participants reported that the early adolescents' most used devices included smartphones, tablets, video game consoles, computers, and televisions. The most common parental rules included screen-free times (9/13), time limits for different device usage (7/13), and internet content rules (7/13), with three parents having no specific boundaries for device usage. We observed numerous disparities between parental perceptions and early adolescents' awareness and interpretation of technology-related rules. For instance, while nine parents reported enforcing screen-free times, five of the early adolescents were completely unaware of this rule in their family. We also saw notable differences in responses of 10 out of 13 pairs about perceived conflicts and rule-breaking frequency, e.g., six parents reported a higher frequency of rule-breaking incidents than their children. Overall, these discrepancies in perceived rules, early adolescents' adherence, or conflicts might indicate potential areas of miscommunication which could arise from unclear or inconsistent parental rules, or early adolescents covertly bypassing the rules.

4.3.2. Parents' & Early Adolescents' Reactions toward Different Aspects of the Design Concepts

This subsection presents findings from our thematic analysis. To support our findings, sample participant quotes are provided, labeled as data from an early adolescent participant (e.g., E1) or their parent participant (e.g., P1). As in Chapter 3, participant counts are not specified in our

findings to prevent assumptions about agreement or disagreement, as a lack of comment on a theme does not necessarily indicate disagreement [43].

4.4.2.1 Most early adolescents favored increased agency, but those with low self-regulation skills may require parental control

Consistent with existing literature and our co-design findings, early adolescents demonstrated a strong desire for increased autonomy when it comes to managing technology use [37,77,206]. They discussed various aspects of the design concepts that allowed them more agency as being desirable, e.g., having their voice in setting device rules, choosing their own offline tasks, self-monitoring progress, and deciding when to share their progress with parents. They believed the agency provided by these features might increase their self-motivation and lead to more compliance with the device rules. Many parents also believed these autonomy-granting features might promote self-regulation while offering the sense of independence early adolescents seek at this age.

> *E1: "I like that the parent is not controlling it. I like that the kid can choose what to do. [...] I think that if they could have more freedom then they actually might listen to the rules instead of the parent keep on reminding them."*

> *P2: "Actually, personally I don't believe in micromanagement. So, if I give her a task, I'll have to rely on her. That'll make her more confident, and she'll monitor herself and make herself better."*

While most parents understood early adolescents' growing need for autonomy, many of them also wanted more parental control in the demonstrated design concepts to ensure that their

child could not exploit their freedom and navigate around the device rules. They wanted to monitor their child's tech disengagement progress and see tangible evidence of engagement in offline activities, suggesting a lack of trust in their child's self-regulation abilities.

> *P3: "I think he's going to put the app aside and do whatever he wants, and then put a checkmark, 'Yes, I went outside to ride my bike. I read the book for 5 hours, and I was working.' But in the end, he was playing video games all day."*

Interestingly, some early adolescents also acknowledged that a lack of parental control might allow them to misuse their autonomy over their tech disengagement practice and wanted to incorporate some level of parental control.

> *E1: "If I use this (TBB), I don't think I would listen to the rules, because if my parents are not there and they don't know if I'm listening to those or not."*

According to the literature, low levels of self-regulatory skills can be linked back to high levels of permissive parenting, particularly when the permissive parent is of the same sex as the child [155]. This suggests that early adolescents with underdeveloped self-regulation abilities might benefit more from an authoritative parenting approach, since autonomy-granting parenting might even lower their self-regulation abilities. Moreover, a few early adolescents expressed that keeping parents informed about their activities could foster trust and reduce the need for extensive parental monitoring.

> *E13: "[...] If she (parent) has no involvement in it, I think she'd be so curious that she would go into my device if I'm not there. Which I already know she does, and she'd be looking through and see what I've been doing. Like a little bit of parent involvement would be nice. Cause then she'd be less curious."*

4.4.2.2 Both groups valued supportive parental engagement, yet negative parent-child dynamics have the potential to discourage it

Many of the parent and early adolescent participants highlighted the importance of supportive parental engagement. They believed that engaging parents in a non-controlling way might make the tech disengagement process easier for early adolescents, improve relationships, and reduce distrust and conflicts. For example, "Parent-Child Unplug" allows parents to co-practice tech disengagement with the early adolescent and have frequent discussions and open communication (e.g., by enabling the early adolescent to journal their emotions regarding tech disengagement and sharing with the parents) while safeguarding agency. Most participants favored these features since they shift the parents' role from an enforcer to a collaborative partner and a supportive guide. We observed that the early adolescent participants who contributed to the joint discussions with their parents in a positive and friendly manner showed more inclination toward increased parental engagement in their tech disengagement process.

> *E11: "I like the first one (PCU) more because I found that it has more involvement with your parents. And it's more of a fair app. And it's not just your parents challenging you and they're on the phone 12 hours a day watching TikTok."*

> *P3: "I like the interaction...well, not even the communication part, but just there being the parent and the child side of things. Like, I really like seeing both tasks for the parent and the child. Like they had their own tasks, and that they can encourage themselves to keep going, and things kind of like making your child your good friend."*

While most of the early adolescent participants wanted some level of parental engagement, we also observed negative reactions from a few while discussing aspects of parental engagement in their tech disengagement practice. The underlying reasons for these sentiments might relate to negative relationship dynamics or harsh parenting style, which were evident from repeated disagreements during joint discussions. Literature suggests that such dynamics might link to poor self-regulation skills in early adolescents [61].

4.4.2.3 Parental mentorship approaches aligned with agency preferences

Most of our participants, including both parents and early adolescents, preferred parental mentorship over the other mentorship approaches. Many of the early adolescent participants in our study believed that their parents' guidance would be more reliable than mentorship from their peers or virtual companions since parents have a deeper understanding of their child's needs and wellbeing, and have a consistent presence in the child's life, enabling them to provide support and guidance whenever needed.

> *E13: "I know my friends are always there to help me, but I just feel like having your parents help you is more reliable…because, you don't live with your friends. Maybe if you're in college, maybe you do, but like you live with your parents, so they know you better."*

While many liked this approach, a few early adolescents pointed out that if the parents do not show good tech habits themselves this could potentially lead to conflicts.

> *E5: "If the parent is telling you, 'Hey, you should do your tasks!' and they haven't done any this week, and you didn't either. And then they get an argument."*

Some participants in our study preferred the other mentorship styles, indicating the diverse needs of early adolescents. For example, those who highly value autonomy gravitated toward the peer-based approach, since it has very low parental control. Many parents also felt positively about this approach given that early adolescents often rely more on their peers than their parents [142]. On the other hand, some early adolescents with a greater sense of autonomy preferred a virtual mentor since it could be less intrusive than peer or parent-based mentorships. This might indicate that the two design dimensions – "Level of Agency" and "Type of Mentorship" might be highly intertwined.

E2: "I'll probably be more motivated if it's like my friends talking to me rather than my parents (TBB). Cause like they're more around my age, so they probably have the same kind of problems, or like the same likes and dislikes like me."

E13: "Like you don't have your parents pressure reminding you. So, you feel more at ease. And so, I feel like I could focus more if I just have like that AI companions (SS). So, I could focus more on doing something offline."

The participants who did not prefer peer-oriented mentorship realized that this approach relies largely on the motivation and involvement of the peers, like most group-based interventions that require equally motivated participants to be effective [115]. The early adolescent participants discussed how their peers, who lack the motivation to self-regulate, might be a negative influence. Parents expressed concerns about how the peers' different family rules (e.g., if the peers have more flexible device rules) could result in conflicts and dissatisfaction with their household rules.

P10: "Friends one (TBB) is also good. But some friends can be a positive influence, some friends can be a negative influence. I know which ones (looks at E10). So, some

folks can say, 'Okay, let's not do it today. It's all right.' So, depending on the friends and how they are feeling, they might encourage or discourage."

When participants preferred virtual mentorship, it was often owing to their individual inclination toward specific virtual characters. A couple of participants who had strong admiration for such characters and felt a connection, expressed interest in following guidance from them.

E2: "If it's like a character that… like from Deadpool, that I really like… If it's like that character, reminding me that, I might be more encouraged to, and like more motivated to follow it."

4.4.2.4 Co-disengagement acting as both intrinsic and extrinsic motivation

Participants appreciated the presence of both types of motivations (extrinsic and intrinsic), particularly when it stemmed from practicing co-disengagement. Many participants believed that collaborative efforts would be more motivating than self-directed activities alone. For instance, "TechBreak Buddies" encourages early adolescents to plan joint activities with peers and fosters interpersonal intrinsic motivation from the joy of collaboration [98]. On the other hand, "Parent-Child Unplug" involves both the parent and the early adolescent in co-disengagement which promotes a greater sense of fairness and focuses on equal participation. The inherent value of working together was highly appreciated by many participants, with a few valuing it even more than extrinsic rewards.

E5: "If you're doing it alone (tech disengagement), you may not want to use it as much. But if you're doing with friends, for like a fun activity, you could do with them."

P12: "So, this one (PCU) has no reward function built in. This is more like two people doing it cooperatively. Yeah, that's really the core motivator as opposed to the reward system (SS)."

Both parents and early adolescents felt that the sense of accountability could enhance extrinsic motivation. For example, unlike traditional parental control apps, participants liked that "Parent-Child Unplug" does not place accountability solely on early adolescents. Additionally, early adolescents expressed enthusiasm toward the ability to interact with their parents and peers while using digital interventions (e.g., both in PCU and TBB). They believed that being able to view each other's tech disengagement progress or updates on offline activities and receiving encouragement from others to engage with the digital intervention might work as extrinsic motivators.

E6: "...It can be great for accountability. Because I won't say I did it, and I didn't do it with something that is tracking, so I'll make sure that I work hard to be accountable, and I make sure I'm really doing it, not just for you (P6)."

E2: "Probably the fact that, like you could see each other's progress. And they comment on it and stuff. Because, you know, like the comments could encourage it, encourage each other to keep doing it and stuff."

4.4.2.5 Early adolescents valued external rewards more than parents

The idea of achieving rewards upon accomplishing goals (e.g., in the design concept of "ScreenSavior") appealed to all early adolescent participants, as they thought it would compel them to follow the rules even when they do not inherently want to comply. While many parents

also believed that extrinsic rewards could be a good incentive, some were concerned that rewards might undermine early adolescents' intrinsic motivation to limit their technology overuse and might not help them develop self-regulation.

> *E5: "You can get rewards for doing your tasks…like not pressure you, but it would push you in your own way, like, 'Ooh! What am I gonna get? I need to want to do more stuff!' You want to finish all your boring tasks!"*

> *P10: "I am not 100% sure about the reward thing. Because it depends on the parent, but sometimes some parents might not want to equate good behavior with reward. For example, like pay for something that could feel transactional instead of learning. For me, all this, all sort of activity is to learn about self-regulation. And it could become out of hand also."*

4.4.2.6 Adapting mediation approaches for diverse individual differences

Our findings emphasize the importance of tailoring mediation strategies to the diverse needs of early adolescents and their families. Participants spoke to a range of factors that may require personalizing the intervention, including an early adolescent's level of tech dependency, level of self-motivation to regulate tech use, family dynamics, and parenting approaches. For instance, a few parent participants discussed how their children with low self-motivation might need a different approach than what our design concepts offered. For those early adolescents, forced use of the digital intervention might be required to initiate the tech disengagement process. Furthermore, a few parents thought that the design concepts might not work for their children with high levels of tech dependency or tech addiction. This might suggest the importance of addressing

addiction with professional help before attempting to practice self-disengagement since individuals with addiction cannot regulate their behavior [111].

> *P8: "If a child who has a lot of motivation to reduce his or her use of the other technology devices, it will help him or her a lot, but without… like my son, without any motivation, to reduce his or her technology limits…. I think it does not help the children a lot. I think the motivation is very important."*

> *P12: "I'm leery of how motivated our kids are. We're already using technology a lot. I can certainly like it or driven to it. You know, we observe the effects of the extreme dopamine dump in our home with all of us, and how difficult it is. And I say, I think certainly I don't know how many times here I've seen you (E12) or your friends, like when it comes to video time, they're just getting to start playing."*

Parent participants also discussed the importance of adaptability to promote consistent use in a family setting. For example, they highlighted that features such as easy parental overrides might be necessary when different situations demand rule changes.

> *P10: "Sometimes we can just on the spot decide to have a cheat day. and it would be like an extra effort to just to turn off the app or change the rule, or whatever...because sometimes, this sort of decisions are spontaneous."*

4.3.3. Determining Participants' Preferences Regarding the Design Space Dimensions

The above findings provide insights into our participants' perceptions of different aspects of the design space and concepts. This subsection further explores participant preferences by presenting

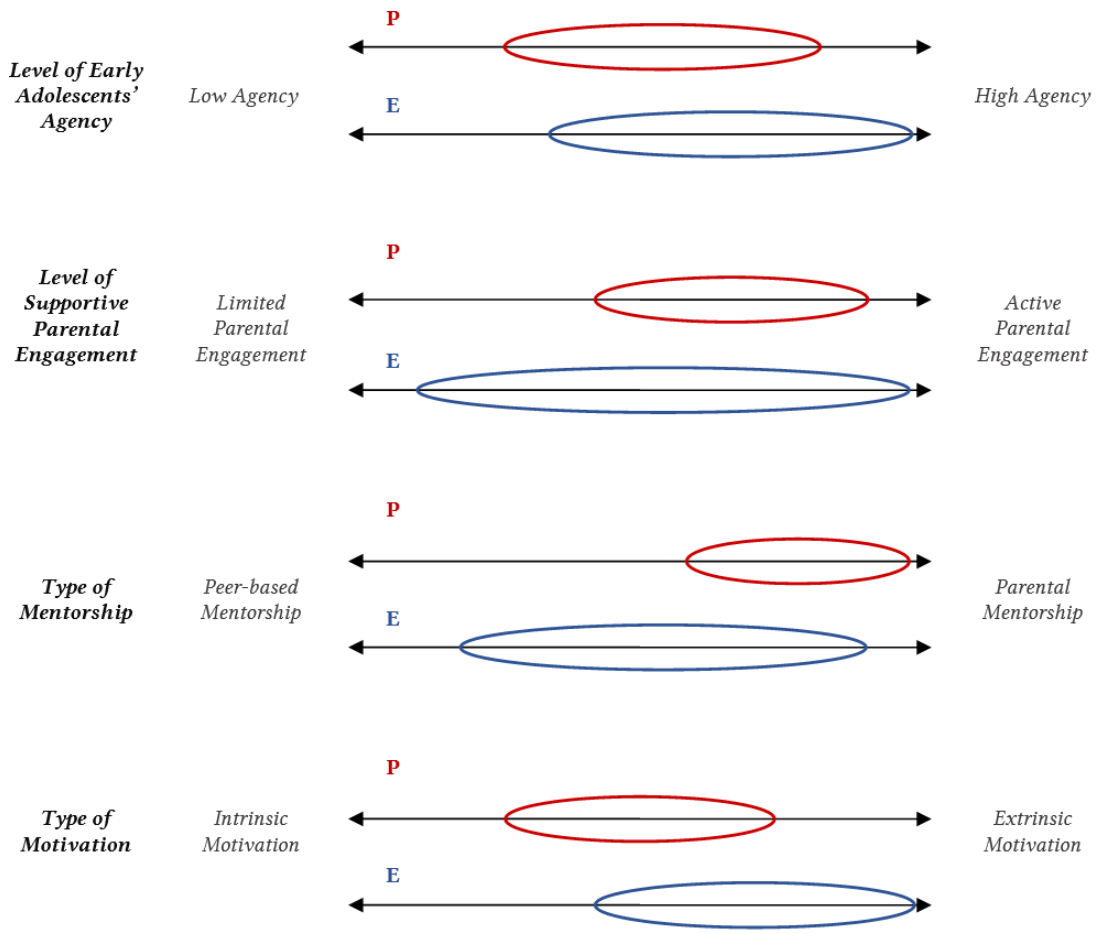

Figure 12: A visual representation of the estimated variability in participants' preferences for each design dimension. The width of the ellipses demonstrates the divergence in views, while 'P' and 'E' denote the preference of parents and early adolescents, respectively.

findings from our targeted analysis (discussed in section 4.2.3), where we mapped participant comments onto preferences within the design space. In this analysis, we identified both early adolescents' and parents' comments related to the design dimensions and then positioned them onto our proposed design space to highlight areas of consensus. For example, E2's comment "If I don't like it now [the rules], I will try and change it, and if I can't change it, then I probably won't use it [the intervention]." indicates that their preference for the "Level of early adolescents' agency" is high. Figure 12 is an estimated representation of the mapped responses across the design space, illustrating ranges in the dimensions where most responses are situated.

Our analysis revealed that most of the parents' preferences for the "Level of early adolescents' agency" lie on the mid-range of the dimension leaning toward the higher end, where the early adolescents showed stronger preferences for the higher end. Neither group showed primary preferences for low levels of agency. Parents demonstrated inclinations for engaging actively in their early adolescent's tech disengagement process, as evident in their highlighted preferences for both "Parental mentorship" and "Level of supportive engagement". However, we did not see a clear preference for either end of these spectrums for early adolescents. For example, their preferences ranged from a medium level of peer-based mentorship to a higher level of parental mentorship, with the majority preferring a combined approach. Similarly, while no early adolescent completely disregarded parental support, their opinions varied from the high to the lower end of the dimension. A clearer pattern emerged for the "Type of motivation", where both parents and early adolescents mutually preferred a combination of intrinsic and extrinsic motivation, however, early adolescents showed a stronger inclination toward extrinsic motivation.

4.3.4. Overview of Participants' Preferences for the Design Concepts

While our targeted analysis provides a sense of participant preferences within the dimensions, it does not reveal the relative importance of these dimensions. As an indication of relative importance, we looked at participants' rankings of the design concepts (see Figure 13). Slightly more than half of the participants ranked "Parent-Child Unplug" as their top choice (14/26), especially the parents (8/13). This might be primarily due to their strong preference for parental mentorship within this design concept. Six early adolescents also ranked it as their top choice since it provides parental support without undermining their agency while fostering a sense of

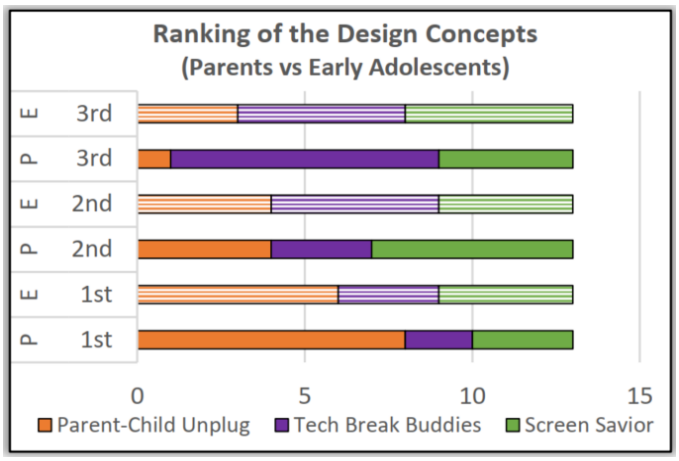

Figure 13: Parents' and Early Adolescents' rankings of the design concepts.

accountability. For these participants, parental mentorship and supportive parental engagement might be considered more important than the other dimensions. We observed some support for the other two design concepts as well. For example, "ScreenSavior" was ranked either first or second by 17/26 of the participants (including 9/13 parents). Since this concept allows parents to have some level of external parental control, it accommodates those parents who did not favor high levels of early adolescents' agency. While "TechBreak Buddies" was ranked as the last choice by more than half of the parents (8/13), early adolescents had a more mixed response. Early adolescents' positive responses might be due to their different individual needs for higher levels of agency, lower levels of parental engagement, and reliance on their peers. The varying preferences for all three concepts suggest the potential for customization to allow for personalized strategies.

4.4. Discussion

Our study findings reveal insights into the perceptions of both early adolescents and their parents regarding important design aspects to address excessive tech use among early adolescents. While

participants did not always agree on the most promising points along the dimensions, all expressed strong opinions. This suggests that our four dimensions can serve as a foundational framework for researchers interested in leveraging this design space to develop interventions. Our semi-structured interviews and joint discussions also shed light on specific features within digital interventions that both early adolescents and parents in our study considered useful. For example, participants believed that features like goal setting, self-tracking, and journaling could promote self-regulation. They also showed enthusiasm for interventions where they could work on tech disengagement with their parents or peers, feeling that these approaches could foster a sense of collaboration and accountability.

Our analyses identified areas of consensus and divergence within the preferences of early adolescents and parents across our design dimensions. The dimension with the most consensus was the "level of early adolescents' agency", where all participants felt digital interventions should allow at least a moderate level of agency; however, many early adolescent participants wanted a higher degree of agency than their parents. In other dimensions, we observed more divergence between the two groups. While both wanted a combination of intrinsic and extrinsic motivators, early adolescents gravitated more toward including at least some external rewards. Moreover, while parents strongly favored active parental engagement and parent-based mentorship, early adolescents displayed more variability in their preferences. The diversity warrants further research to better understand these differences and how to effectively resolve tensions in opinions. One approach could involve identifying the overlap between both groups' preferences to design a balanced intervention. In situations of limited overlap, another approach might be to incorporate features that facilitate negotiations or compromises. Such features could potentially foster open

communication and allow parents and early adolescents to reflect on the intervention's effectiveness over time.

As discussed above, parental views generally converged, while early adolescents' opinions varied, likely due to their developmental phase involving changes in their thinking patterns, self-concepts, and achievement motivations [202]. Recognizing these diverse needs, both participant groups recommended customizing strategies. For instance, individualistic and self-motivated early adolescents might favor a virtual mentor, whereas those who rely more on peers might gravitate toward peer-based mentorship. There are also opportunities to investigate combined approaches, such as integrating peer-based strategies with parental mentorship, which could allow early adolescents to select peers as mentors for specific tasks while benefitting from regular parental guidance. Adjustable settings based on early adolescents' evolving needs or parental comfort levels might also be beneficial.

Although parents felt positively about using the mediation strategies demonstrated through our design concepts, they also raised concerns about their long-term effectiveness. For example, fostering a sense of accountability by involving both parents and early adolescents in co-disengagement might be initially motivating, but the effect of such extrinsic motivators might diminish over time. A longitudinal study with a deployable prototype could shed light on which aspects of the design dimensions are positively affecting early adolescents' tech disengagement over time. However, a challenge with such evaluations is that behavior change is a complex long-term process, which is particularly difficult to study in the context of HCI research, where intervention designs are often in their early stages [113]. Our design space exploration can serve as a guide for developing more complete and reliable technologies that are necessary for formal, large-scale validation with control measures [113]. For example, controlling for a consistent

duration of prototype use, levels of existing tech use among early adolescents and self-motivation for behavior change, as well as participants' socioeconomic backgrounds, would be useful when assessing the intervention impacts.

While motivating early adolescents for research participation can be challenging [64], our co-design study has shown that formative design activities can empower them to contribute responsible design ideas. Our elicitation study lends further support to the benefits of involving early adolescents in formative design, in this case by utilizing design concepts as artifacts to elicit their insights into various dimensions and their attitudes toward practicing tech disengagement, both independently and in social contexts (with peers or parents). The fact that early adolescents not only considered our design concepts for reducing tech overuse but also provided valuable feedback suggests their awareness of the issue and engagement in the study. Beyond "tech disengagement," there are other domains where involving this age group in formative design activities could be beneficial, especially in areas where their motivation and/or ability to contribute solutions may be uncertain (e.g., online safety, mental health). We also saw benefits to involving early adolescents and their parents in the same sessions. While tech overuse can be a topic of tension for some families, we observed many productive dialogues, including conversations about new disengagement strategies suitable for their specific needs.

4.4.1. Limitations and Generalizability

To broaden our participant pool beyond those who could physically come to our lab, we opted for online sessions. Given the challenge of controlling whether parent and early adolescent participants could overhear each other in separate sessions, we chose to conduct single joint sessions. While the joint sessions allowed us to observe parent-child dynamics and fostered

meaningful discussions between them, some early adolescents might have been hesitant to fully share their opinions in front of parents due to power imbalances or negative parent-child relationships. Future studies should therefore investigate the generalizability of our findings to situations where parent and early adolescent opinions are elicited separately.

Though our participants came from diverse cultural backgrounds, our sample size was too small to attribute any of the variability in opinions to cultural differences, similar to the co-design study sample in Chapter 3. In addition, most of our participants belong to families with relatively high socio-economic status and strong educational backgrounds, factors known to influence parent-child relationships and children's online media usage [73,164]. Furthermore, most of our early adolescent participants were boys. According to previous research, parents' intervention in teens' tech use is often gendered, leading to differing levels of confidence in teens' self-regulation skills, as parents tend to mediate girls' tech use more than boys [180]. A future study with a larger, gender-balanced sample, including diverse socio-economic backgrounds, is required to investigate the generalizability of our findings.

Informed by prior research exploring design spaces [6,81,89,191], we used video prototypes as design probes to elicit feedback on participants' preferences and priorities across various design dimensions along with facilitating parent-child discussions. While this approach ensured consistency in demonstrating the design concepts and streamlined sessions, direct interaction with the prototypes might have allowed participants to provide more grounded responses to different features. Future studies are required to assess whether preferences after actual use align with our findings.

4.5. Summary

Informed by early adolescent-perceived useful design factors identified in Chapter 3 and insights from prior literature, we introduced an initial design space for digital interventions aiming to address early adolescents' tech overuse. Our design space outlines four important design dimensions that could impact early adolescents' disengagement from an excessive use of technology. Our proposed design concepts demonstrate different aspects of these dimensions, serving as probes to elicit early adolescents' responses to various points in the complex space of possibilities. Our study findings offer insights into how both groups conceptualize effective mediation strategies, highlighting areas of consensus and considerable variability, suggesting important avenues for future research. This design space and our elicitation study insights can serve as a resource for researchers and practitioners interested in pursuing new digital mediation strategies that are grounded in the needs and perspectives of early adolescents.

Chapter 5

A Systematic Review of Existing Literature to Characterize Tech Disengagement Solutions for Early Adolescents

Designing appropriate digital interventions to target tech overuse among early adolescents requires tailored solutions that account for their unique needs. This calls for synthesized design guidelines and a clear understanding of the current state-of-the-art to identify which solutions are most suitable for this demographic, ensuring interventions build on existing knowledge and focus on underexplored opportunities. While our user studies (Chapters 3 & 4) revealed the design factors early adolescents perceive as useful and their preferences for digital solutions, further investigation is needed to determine whether existing strategies align with their desired solutions. To address

this gap, we conducted a systematic review of academic literature to identify and analyze current research on tech disengagement solutions relevant to early adolescents. For this investigation, we define tech disengagement solutions as those that promote a balanced use by reducing overuse of technology, as opposed to complete non-use. Our goal was to uncover common themes in researcher-proposed recommendations and identify underexplored areas within the design space of potential digital interventions.

Specifically, this review was guided by the following research questions:

1) What do researchers recommend in terms of intervention design for promoting disengagement from tech overuse among early adolescents?
2) To what extent do these design recommendations align or misalign with early adolescents' and parental preferences identified in our elicitation study (section 4.4)?

This chapter outlines our methodology for conducting the systematic literature review, detailing the process of collecting, screening, and analyzing research articles (section 5.1). The findings from the review are then presented, including an overview of the sampled articles (subsection 5.2.1), qualitative insights into the design recommendations proposed by researchers (subsection 5.2.2), and a discussion of how these recommendations align with target users' preferences (subsection 5.2.3). This work, combined with the work presented in Chapter 6, has been submitted to the 2025 ACM Conference on Computer-Supported Cooperative Work and Social Computing (CSCW'25) and is currently under review.

5.1. Approach

To identify HCI researchers' design recommendations for appropriate digital mediation strategies addressing early adolescents' tech overuse, we conducted a systematic literature review of existing

HCI literature from two prominent databases covering the past 10 years (2014-May 2024). Systematic reviews use a standardized, rigorous methodology to overview primary research by identifying, selecting, and synthesizing all relevant research evidence addressing specific research questions [42,118,140]. In contrast, traditional literature reviews provide a general overview of a topic by qualitatively summarizing the literature [118,160]. Recognizing these distinctions, our systematic review followed the PRISMA guidelines to ensure a transparent, complete, and structured reporting process [150].

5.1.1. Data Collection

We searched for peer-reviewed literature from ACM Digital Library and IEEE Xplore Digital Library databases as they cover high-impact research in HCI and computing-related disciplines. These databases also cover multidisciplinary research, making them the most relevant for our focus on the design and technical aspects of digital interventions. Our choice of databases was further informed by other systematic literature reviews in HCI, which included only one [13,74,154] or both databases [199]. The search was conducted in May 2024. I started by experimenting with various combinations of search keywords that produced relevant results, with guidance from our university librarian. To focus on regulating children's technology use, our search terms covered the target population, technology, usage, and intervention. We generated a search query using these terms as detailed in Table 4. We applied the query within the abstracts of the papers since the abstract typically highlights the research focus. Although our target population is early adolescents (aged 11-14 years), we included additional keywords to capture papers that may use different terms but include children in this age range. Filters were applied to include only conference papers and journal articles published between 2014 and May 2024. We selected a 10-year timespan following

Table 4: Keywords used for database search queries, with ‘OR’ between each keyword in the rows and ‘AND’ between the rows

Population related terms	child*, teen*, adolescen*, preteen, kid, kids, preadolescen*
Technology related terms	mobile, smartphone, media, online, digital, tech, technolog*, internet, game*, device*
Usage related terms	"screen time", screentime, playtime, "play time", use, overus*, usage, addict*, activities, activity
Intervention related terms	regulat*, mediat*, control*, limit*, disengage*, reduc*, interven*, moderat*

the approaches of similar systematic reviews on child-oriented technology and their design ideologies [199,200]. This approach aims to balance capturing recent trends in an evolving technology landscape in addition to current work that builds on established approaches utilized in prior literature. This search resulted in 1386 papers: 1188 from ACM and 198 from IEEE. We used Covidence software [222] to manage the review process, which removed 20 duplicates, resulting in 1366 unique papers.

5.1.2. Title and Abstract Screening

Initially, we screened 1366 papers based on their titles and abstracts. I independently screened the entire sample, while two other HCI researchers each also screened half of the full sample. Thus, each article selected in this phase was reviewed by two researchers and, upon agreement, included for full-text screening. We followed the exclusion criteria stated below during this title and abstract screening.

- Papers are excluded if they do not target/include children of any age between 11-14 years old (e.g., if the study only targets young children or university students). If the abstract does not specify an age group but does not meet other exclusion criteria, it is included for full-text screening.

- Papers are excluded if their titles or abstracts do not mention any findings on regulating or limiting children's technology use (e.g., through any system, strategy, survey, parental control app, or game).
- Dissertations (e.g., doctoral consortium), panels, special interest group (SIG) meetings, award talks, demos, keynote abstracts, workshop proposals and position papers, course proposals, books, book chapters, and editorials are excluded.

The independent screening revealed 40 conflicts, which were resolved through discussions with a fourth HCI researcher. The process resulted in 78 papers for full-text screening.

5.1.3. Full Text Screening

The full-text screening was comprised of two stages. I completed an initial round of screening to exclude 29 papers for the following reasons.

- Full text is not available.
- Full text is written in a language other than English.
- Paper is less than 3000 words, as short papers often follow different peer-review criteria and may lack sufficient methodological and contextual detail to assess their rigor and relevance.
- Paper does not target/include children of any age between 11-14 years old.

Then a second HCI researcher and I independently screened the full texts of the remaining 49 papers thoroughly for either of the following inclusion criteria:

- Papers are included if they provide a system, prototype, app, technology, or artifact offering strategies for regulating tech overuse.

- Papers are included if they present a design study, evaluation study and/or system that focuses on regulating technology use and/or provides design recommendations. Review papers are excluded. Survey, interview, or ethnography studies are excluded if no concrete design recommendations for a system to regulate tech overuse are provided; otherwise, they are included.

At this stage, we unanimously included 9 papers, and 14 papers had conflicts, which were resolved through discussions with the fourth researcher. Conflict resolution resulted in a final set

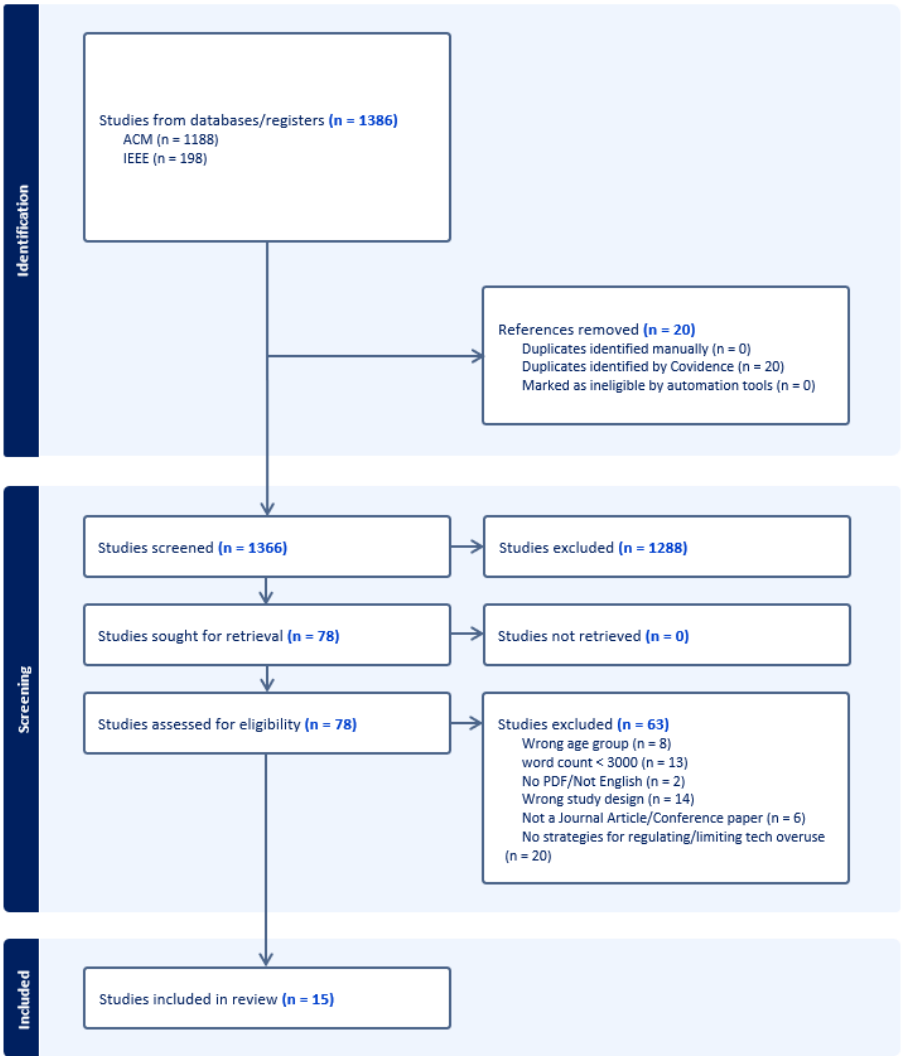

Figure 14: PRISMA Diagram.

of 15 papers (i.e., 63 papers were excluded from the initial set of 78, after full-text screening). The PRISMA Diagram in Figure 14 depicts the detailed workflow.

Our resulting sample of 15 papers included the paper presenting our work from Chapter 3 [37], as it met the inclusion and exclusion criteria during the independent screening process. Including this paper in our systematic review was necessary to ensure a comprehensive and unbiased analysis, as it was identified through our predefined search terms. Furthermore, we have recently submitted a paper based on the work described in Chapters 5 and 6 for dissemination and anonymous review. Including the Chapter 3 paper helps maintain methodological consistency and prevents any potential concerns during the review process.

5.1.4. Data Extraction

In this phase, a second researcher and I reviewed the 15 papers selected from the full-text screening phase to extract information relevant to our research questions. I collected manuscript metadata (e.g. title, authors, and year of publication), and documented the stated research goals, contributions, participant information, and study design. Both the second researcher and I independently extracted the stated design recommendations concerning the design of digital interventions. Our review considered recommendations that facilitate tech disengagement, either directly (e.g., self-tracking tools, rule-setting) or indirectly (e.g., fostering autonomy, family collaboration). While some design recommendations, such as promoting privacy or parent-child collaboration, could be seen as supporting engagement, we included them since they can enable early adolescents to develop autonomy in regulating their own tech use. Our extracted design recommendations included specific, actionable suggestions, often derived from practical experiences such as co-design or evaluation studies, as well as broader design insights derived

from interviews or surveys. While concrete suggestions can provide clear guidelines for intervention design, although potentially less mature, broader insights can offer new ideas and opportunities for exploration.

Researcher-suggested recommendations were typically found in the system design, study findings (e.g., from evaluations, interviews, or surveys), and/or discussion sections. For instance, for papers proposing systems (e.g., prototypes), we included the system's design, and any suggested modifications based on user evaluation as part of the researchers' recommendations. We did not extract statements related to future work if there is no discussion on why it is important or how researchers can incorporate them into design. After data extraction, we crosschecked each others' documentation to ensure accuracy and completeness.

5.1.5. Data Analysis

I conducted a thematic analysis [21] on all the extracted design recommendations. I started the analysis with a set of 239 design recommendations (including multiple instances of similar recommendations extracted from a paper). Through multiple rounds of coding and grouping, I identified initial themes, which were further developed through discussions with a second HCI researcher (discussed in 5.2.2). I also used a deductive approach to associate the coded data to specific design dimensions (see section 4.1) to identify researcher-recommended design mechanisms within the design space (discussed in 5.2.3).

5.2. Findings

In this section, we present the findings from our systematic review. We begin with an overview of the study designs and participant demographics reported across the included papers. We then synthesize the key themes in the design recommendations suggested by researchers. Finally, we relate these recommendations to our early adolescent-centric design space to assess their relevance for our target demographic.

5.2.1. Overview of Study Designs and Participant Demographics

Among the 15 papers in our final sample (see manuscript details of the included papers in Table 5), six papers implemented and utilized systems or prototypes specifically designed to regulate children's technology use [32,49,56,114,169,213]. Among these six papers, four gathered users' feedback prior to implementation and conducted further evaluations or field deployments to validate their designs [32,49,56,114]. The remaining papers focused on understanding users' practices, needs, and expectations related to technology use and regulation through methods such as interviews [54,56,71,105,110], surveys [72,96,100], co-design [37], and ethnography [131]. The papers focused on a range of different technological solutions, including various existing software and hardware tools aimed at limiting screen use [54,56,96], participatory parental control services [114,169], an app promoting collaborative outdoor activities to reduce screen time [110], an intervention combining wristbands with a diary reporting system [32], a wrapper application designed to shape social media entry experiences supporting self-regulation [49], as well as voice assistants [213], smart speakers and toys [72].

Table 5: Manuscript details of the papers included in the systematic review

Title	Authors	Year	Participants	Study Design	Explored Mediation Strategies
An exploration of rules and tools for family members to limit co-located smartphone usage	Hasan et al. [96]	2020	parents (children's ages 18 yrs or less)	crowdsourced survey	existing software or hardware solutions
Co-Designing with Early Adolescents: Understanding Perceptions of and Design Considerations for Tech-Based Mediation Strategies that Promote Technology Disengagement	Chowdhury et al. [37]	2023	early adolescents, 11-14 years old	group-based multi-session co-design, focus group	participant-generated design artifacts for tech-based solutions
FamiLync: facilitating participatory parental mediation of adolescents' smartphone use	Ko et al. [114]	2015	families (children's ages unspecified)	survey, implementation, evaluation study	FamiLync, a participatory parental control service
"It's hard for him to make choices sometimes and he needs guidance": Re-orienting Parental Control for Children	Dumaru et al. [56]	2024	Parents (children's aged < 13 years old)	semi-structured interviews, implementation, survey	low-fidelity prototype design for parental control
Not at the Dinner Table: Parents' and Children's Perspectives on Family Technology Rules	Hiniker et al. [100]	2016	parent-child pairs (children's ages 10-17 years)	survey	family rules regarding tech use
"Okay, One More Episode": An Ethnography of Parenting in the Digital Age	Mazmanian et al. [131]	2017	families (children's ages 2-16 years)	ethnography	parental rules regarding tech use
Supporting Teens' Intentional Social Media Use Through Interaction Design: An exploratory proof-of-concept study	Davis et al. [49]	2023	teens, 14-18 years old	co-design, implementation, field deployment	Locus, a *wrapper application* to shape entry experiences into social media apps
Teen-alyse: A Mobile Application for Parental control, Teen Self-Monitoring and Active Mediation	Sangal et al. [169]	2021	teens, ages unspecified	system study	Teen-alyse, an app to help balancing parental guidelines and teen self regulation
To Use or Abuse: Opportunities and Difficulties in the Use of Multi-channel Support to Reduce Technology Abuse by Adolescents	Hung et al. [105]	2022	adolescents (10-18 years), parents, and treatment experts	in-depth interview	discussed solutions to tackle technology abuse by adolescents
To Use or Not to Use: Mediation and Limitation of Digital Screen Technologies within Nuclear Families	Duckert et al. [54]	2021	parents (children's age unspecified)	interviews	screen technologies used at home and parental rules

Toward Usable Parental Control for Voice Assistants	Yang et al. [213]	2023	Parents (children's age unspecified)	online survey and implementation	Alexa and proposed design for Parent Dashboard in Alexa
Understanding Families' Non-/Use Practices and Choices: The Case of Smart Speakers and Smart Interactive Toys	Garg et al. 2021 [72]	2021	parent-child pairs (4-17 years olds)	survey	smart speakers and smart toys
Understanding Tensions and Resilient Practices that Emerge from Technology Use in Asian India Families in the U.S.: The Case of COVID-19	Garg et al. [71]	2021	parent-teen dyads (age 13-18)	mixed methods study: interviews with experience sampling	usage and rules for children and parents
When Screen Time Isn't Screen Time: Tensions and Needs Between Tweens and Their Parents During Nature-Based Exploration	Kawas et al. [110]	2021	parent-tween pairs (8-12 years old)	parent interviews, deployment study	*NatureCollections* app to encourage children to go outside and connect with natural world
This App is not for Me: Using Mobile and Wearable Technologies to Improve Adolescents' Smartphone Addiction through the Sharing of Personal Data with Parents	Chen et al. 2022 [32]	2022	Parent-child pairs (11-17 years old)	technology probe study, interviews	*TechLifeProbe,* combining a wearable wristband tracker, a diary reporting system, a mobile phone app

In terms of participant involvement, four papers engaged parents only [54,56,96,213], while two included entire families [114,131]. Six papers involved both parents and children [32,71,72,100,105,110] and three papers solely focused on children (range: 11-18 years) [37,49,169]. Only one paper specifically focused on early adolescents (aged 11-14) [37], while other papers included broader age ranges. Participant backgrounds also varied in our paper sample, including adolescents with tech abuse [105], smartphone-addicted adolescent patients [32], parents from nuclear families across a broad age spectrum (aged 25-58) [54], and parents from different socio-economic and cultural backgrounds [71,72].

5.2.2. Key Themes in the Researcher-Suggested Design Recommendations

This section presents the themes derived from the qualitative analysis of design recommendations identified in the research articles from our sample

[32,37,49,54,56,71,72,96,100,105,110,114,131,169,213]. To support our findings, selected quotes from these articles are included, illustrating specific recommendations by the researchers.

5.2.2.1 Involving Children in Rule-Setting & Self-Monitoring to Foster Self-regulation. Most research articles in our sample (13 out of 15) advocate for actively involving children in managing their technology disengagement [32,37,49,54,56,71,72,100,105,110,114,169,213], emphasizing that it can foster responsibility and accountability for their tech usage. This approach is seen as particularly relevant for adolescents, who have the capacity to practice self-regulation [37,105]. However, relying solely on self-control methods might not be effective for those struggling with willpower [105]. In such cases, incorporating metrics to assess the level of self-control can provide adolescents with a sense of self-efficacy while also allowing need-based timely parental interventions [32].

> *"It should be possible to establish constructive technology-mediated boundaries aimed at making the adolescent responsible for themselves while respecting their autonomy."*
> *- [105]*

Incorporating children's voices in rule-setting for tech disengagement helps them view these rules as fair and within their control, which can, in turn, increase adherence [37,49,100,105,110,114]. Recommended design elements to involve children in rule-setting include letting them choose disengagement durations, select offline activities [114], and negotiate restrictions with parents [169].

Several papers recommend enabling children to self-monitor device usage to help them understand and regulate their behavior over time [32,49,72,105,114,169]. Researchers also suggest incorporating manual reporting and tracking of lifestyle and well-being data alongside phone usage

data [32], as well as integrating reflection tools to help children set and identify their goals, promoting mindful technology use [32,49,110].

5.2.2.2 Respecting Children's Privacy. While monitoring children's tech usage is essential for ensuring healthy and age-appropriate behavior, it is equally important to respect their privacy as they develop autonomy [56,96,105,114]. Intrusive monitoring can create trust issues, negatively impacting parent-child relationships, and hinder their development of autonomy [96]. Although most papers advocated against such practices, one study suggested sharing real-time on-screen monitoring for parental awareness [96], while acknowledging the aforementioned trade-offs. The paper also mentioned offering varying levels of privacy based on children's ages, but did not provide age-specific recommendations [96]. Further, the granularity of personal information disclosure should be mutually agreed upon by both adolescents and parents, with adjustments made based on specific situations or comfort levels [105].

> *"Ultimately, the issue of data granularity should be discussed and mutually agreed upon by parents and adolescents. It might also be useful to adjust the level of granularity in accordance with the situation and wishes of the user." - [105]*

To respect children's privacy, researchers recommend avoiding sharing fine-grained data (e.g., personal detail, or media content), focusing instead on app-level or meta-level information (e.g., app usage duration) [56,105,114]. Suggested alternatives include sharing broad usage categories such as education or entertainment [32,56,105] or providing abstract representations of usage behavior by extracting topical interests through text-mining [114].

5.2.2.3 Promoting Family Collaboration and Parental Communication through Digital Interventions. Researchers recommend integrating both parental involvement and family-wide initiatives. Papers emphasize the importance of involving parents through open communication

about expectations [56,71,105,110,114,169], addressing children's emotions regarding tech use [32,37,72], and providing clear reasonings for restrictions [71,100,110]. Suggested design elements to facilitate such communication include in-app chatting features for discussing device rules and usage among family members [114], prompts to guide meaningful conversations [32,56,110], and scheduling discussions at convenient times [32,56].

> *"[...] designs could provide guiding prompts to parents to support conversations with tweens around their family's shared values and explanations for technology restrictions." - [110]*

Papers emphasize the importance of applying shared rules to parents and engaging in co-disengagement with family members rather than solely enforcing rules (4 out of 15) [54,100,114,169]. One suggestion is to allow parents and teens to collaboratively determine individual and family goals through a family interface to address tech-related tensions [32,71] and create usage patterns suitable for their family [71]. Social comparison features, such as a scoreboard displaying family members' progress, are also proposed to enhance awareness [114], while encouraging mutual support and accountability [100]. A few papers also recommend engaging in collaborative activities, such as cooperative learning or a competitive game with siblings and parents [37,72,110,114]. However, it might be difficult for busy parents to participate in such activities, as these often require considerable time and effort [105].

> *"This real-time update helps family members to know each other's limiting behavior and facilitates their collaborative effort: e.g., a father recognizes that a son set a one-hour limit to allow him to study, or the son notices that his mother set a two-hour limit for family time." - [114]*

To address tensions around rule enforcement and tech use, one suggestion is to track and display factors leading to rule breaking [71]. For example, the system could record that a rule has been broken due to a sudden school commitment and show it to parents and teens. Incorporating this type of awareness aims to reduce misunderstandings and conflicts [71].

> *"[...] enable parents and teens [...] to track and show situational demands that lead teens to break a pre-decided technology rule and parents to alter a restriction (e.g., teens' breaking a rule is not [to] undermine parents [personal disposition], but due to a critical message from school or friend; or parents' expecting teens to spend less time on technology as grandparents want to spend time with children during their visits)."*
> *- [71]*

5.2.2.4 Supporting Parents in Managing Tech Usage through Reflection and Community Guidance. Papers in our sample explore how digital interventions can support parents in managing family technology use. For instance, when parents' family tech goals are not met, leading to frustrations, Mazmanian et al. suggest a reflection tool that helps parents review and compare these goals with actual usage data to understand discrepancies and reasons for not achieving goals in different times and contexts [131].

> *"[...] parents could be randomly prompted to report how they currently feel about media use in the family while actual media use of all family members is tracked in the background. Over time, this would allow parents to reflect on how they feel about their family's media use across various times and situations by comparing this data to their family's actual usage data." - [131]*

In addition to these tools, apps could further support parents by integrating features that connect them with online communities for advice and emotional support [114]. However, social

comparison with families whose lifestyles differ significantly might not be useful [114]. Hence, sharing usage information with families who have similar life patterns could provide parents with insights and strategies for effective mediation. These communities can offer guidance on regulating tech use, handling unfamiliar situations, and employing appropriate mediation strategies.

> *"Our participants also wanted to see the usage and limiting statistics of other families, hoping to determine how other families manage this issue. [...] In addition to sharing simple statistics, we can help those families to form online communities for information and emotional support as in ParentNet." - [114]*

5.2.2.5 Reward Systems and Social Motivators to Incentivize Tech Disengagement. Several papers in our sample recommend using external motivators to encourage children to regulate their tech use [37,56,105,110,114]. A common pattern is using tangible reward systems to incentivize offline activities while reducing device time. These incentives should align with children's preferences to effectively motivate them to practice disengagement [105]. For example, Hung et. al suggest an interactive micro-incentive system where adolescents earn points through completing small tasks to progress toward real-world rewards [105]. Similarly, Dumaru et. al propose awarding bonus screen time for completing parent-set chores [56]. Unlike other papers, they also discuss a punitive approach, where screen time is revoked if tasks are not completed, acting as a negative extrinsic motivator [56].

> *"[...] revoke or provide bonus screen time based on their compliance with the chores specified by the parents. [...] This would help to improve the aspect of instilling self-regulation by helping parents explicitly communicate about the expected behavior to the children, along with the possible outcomes." - [56]*

In addition to tangible rewards, Ko et al. propose a point-earning mechanism linked to screen time limits, where points have no material value but could promote intrinsic motivation by fostering a sense of accomplishment and personal growth [114].

> *"We used point systems in which the user can earn points proportional to the use-limiting duration. With such a point system, we expect that their intrinsic and social motivation can be increased—even though the points itself do not have any actual material value." - [114]*

Another type of external motivator emphasizes social aspects, such as involving children in use-limiting competitions with others [114], sharing accomplishments [110,114], and providing encouragement [56], which can promote a sense of accountability and achievement.

5.2.2.6 Diverse User & Situational Characteristics Require Customizability. Most papers stress the importance of considering individual characteristics of children and diverse family needs, highlighting several factors that influence children's technology usage and behavior regarding tech limits. These factors include age [56,72,96], gender, race and socioeconomic status [71,72], personality types, motivation levels, executive function [49], physical capability [114], and special needs [56]. For instance, in the context of smart speakers or toys, parents from higher socioeconomic backgrounds often preferred establishing non-use periods to reduce device attachment. In contrast, parents from lower socioeconomic backgrounds viewed these devices as useful aids for keeping children engaged independently, especially if the parents had to work longer hours [72].

Furthermore, when designing interventions targeting tech addiction, it is recommended to consider children's psychological state, addiction triggers, and social environment [105]. For example, when children are in an emotionally charged situation (e.g., during gaming), relying on

self-control may not be sufficient. In such cases, one suggestion was for systems to infer adolescents' emotional state through sensors and tailor interventions accordingly (e.g., offering gentle reminder vs parental involvement) [105].

Several papers recommend age-based design for parental control tools, as children's needs and self-regulation capabilities evolve over time [56,72,96,100,114,213]. Adapting the strictness of rules and the granularity of personal information disclosure based on children's age and their gradual development of self-regulation skills can help maintain sustained use [56,96,105,114].

The papers in our review describe how intervention designs should also consider the diverse characteristics of parents, including parenting styles, personal ideals, and tech competence [54,56,71,114,131]. Moreover, parents' mediation approach can be influenced by internal disagreements and societal judgements [54], and the family's overall goals regarding tech use [71]. For instance, families that value transparency— such as sharing concerns or fears around tech use, including children's feelings that parents may not fully understand their reasons for using technology—may adopt different strategies than those that prefer selective disclosure, where not all information is shared between parents and children. This underscores the need for value-sensitive design [71].

> *"[...] parent's assessment of child media appropriateness can emerge from a number of contextual factors [they] likely cannot delineate in abstraction. What the line is and when it will be crossed emerges in-situ: in the context of past, present, future; in the context of internalized ideals and personal desires; in the context of broader family dynamics and a child's immediate behavior, etc." - [131]*

Papers in our sample emphasize the need to adapt rules to various contexts and situational demands [32,54,56,71,72,100,105,131]. For instance, stricter restrictions might be necessary

during school periods, while rules could be relaxed during vacations [56]. Additionally, maintaining appropriate context-specific rule enforcement can be challenging for parents due to their busy lifestyles, underscoring the need for easily adjustable, dynamic settings [54].

> *"[...] parents' own principles do not necessarily fit the actual practices in the everyday life at home, whereas easily adjustable or dynamically changing settings, for example, depending on context can be helpful. Such settings could consider other factors than time at day, e.g. location." - [54]*

5.2.3. Relating the Identified Recommendations within our Early Adolescent-Centric Design Space

From the researcher-proposed recommendations extracted from our systematic review, we identified 14 design mechanisms for supporting early adolescents' technology disengagement (summarized in Table 6). We consolidated similar recommendations across different studies into overarching "design mechanisms" that fit into the four design dimensions within our early adolescent-centric design space outlined in section 4. Below, these mechanisms are summarized (see Table 6), along with an overview of how well they align with the user preferences identified within the design space from our elicitation study (see Figure 12).

Recommendations from 13 out of 15 included papers relate to various ways to provide children with agency [32,37,49,54,56,71,72,100,105,110,114,169,213]. These recommendations align with both early adolescents' and their parents' preferences for solutions with at least a moderate amount of agency, as identified in our elicitation study. While two papers do not explicitly address how to facilitate agency, one notes that children's need for autonomy may evolve with age [96], and the other focuses more on parenting strategies for managing technology use

[131]. We identified six design mechanisms with the potential to support ***early adolescents' agency*** that researchers recommend incorporating into intervention design. As listed in Table 6, these mechanisms include collaborative rule-setting, autonomous goal setting, self-monitoring and reflection, granular privacy controls, contextualized assistive tools, and family-wide initiatives. These approaches offer a range of different ways to empower early adolescents to self-regulate their tech use, while also considering their evolving need for autonomy and privacy.

The design mechanisms that facilitate ***supportive parental engagement*** include communication between parents and children, involvement in children's tech disengagement, and parenting support. These recommendations emphasize the importance of active supportive parental engagement, which is consistent with parents' preferences identified in our elicitation study. However, early adolescents' preferences varied—some preferred limited parental engagement, seeking more autonomy in managing their tech use, while others welcomed a certain level of support. The range of design recommendations described here might address these differing preferences. For example, while mechanisms of parental involvement might not be desirable to those early adolescents who value independence, they might at least appreciate the open communication about rules and expectations.

The design mechanisms for ***mentorship*** support include parent-based mentorship, community-based mentorship, and adaptive system support. According to our elicitation study findings, parents strongly preferred parental mentorship while early adolescents' preferences varied among different levels of peer support combined with parental guidance. Although the majority of identified researchers' recommendations focus on parent-based mentorship, the mechanisms for community-based and adaptive system support offer more diverse ways to guide children's tech disengagement, complementing parental guidance.

Table 6: Researcher-suggested design mechanisms aligned with corresponding design dimensions

Dimension	Design Mechanism	Definition
Children's Agency	Collaborative Rule-Setting [37,71,100,105,110,114,169]	involve children in negotiations and establishing common rules for all family members
	Autonomous Goal Setting [37,49,110,114]	allow children to set their own goals and tasks and provide them with choices
	Self-Monitoring and Reflection [32,49,110,114,169]	enable children to track their own usage and progress, reflect on their tech-related behaviors
	Granular Privacy Controls [56,96,105,114]	respect privacy needs by considering age and comfort levels
	Contextualized Assistive Tools [72,105]	adapt to children's needs and emotions
	Family-Wide Initiatives [72,114]	allow children to engage in tech disengagement practices with their family through collaborative monitoring and use-limiting
Supportive Parental Engagement	Communication [32,56,71,72,110,114,169]	share expectations and reasoning behind rules through messaging, reminders, and guided discussions
	Involvement [37,110,114,131,169]	promote collaboration, competitions, and shared goals, and address children's emotions by responding to their requests
	Parenting Support [32,56,71,131]	incorporate reminders and parental reflection tools for understanding family goals and deviations, nudge parents to engage in discussions, track rule-breaking factors
Mentorship	Parent-Based Mentorship [32,37,56,71,72,96,110,114,131,169,213]	incorporate parental monitoring, parent-set rules, and mechanisms for Supportive Parental Engagement discussed above
	Community-Based Mentorship [71,72,105]	provide support from family, peers, and experts, via reminders, competitions, and social learning
	Adaptive System Support [54,72,105]	offer adaptive support from digital interventions by tracking emotions, comfort, and context, and tracking family non-use behaviors to trigger nudges
Motivation	Extrinsic Motivators [56,105,114]	include parental encouragement, bonus screen time for parent-set rule compliance, competitions with scoreboards, rankings, and micro-incentives
	Intrinsic Motivators [32,37,49,56,71,72,96,100,105,110,114,169]	include agency-promoting mechanisms, features supporting open communication, collective goals, collaboration, and gamification with non-material point-based systems

Researchers recommend various design elements fostering children's ***motivation*** in tech disengagement, incorporating both intrinsic and extrinsic motivators, aligning with early adolescents' and parents' preferences identified in our elicitation study. While the papers in our sample offer distinct mechanisms for promoting external rewards, we noticed limited discussion of the direct incorporation of intrinsic motivators. For instance, few design mechanisms enable children to choose inherently enjoyable offline activities, which can align interventions more

closely with children's personal interests and motivations, rather than requiring them to complete tasks that they might not enjoy. Although not explicitly discussed, most papers do suggest mechanisms that can foster intrinsic motivation (e.g., features promoting agency and collaboration).

5.3. Discussion

Findings from our systematic literature review provide insights into the current research addressing children's tech overuse via digital interventions aimed at promoting tech disengagement, along with highlighting key researcher recommendations for designing such interventions. For example, researchers emphasized the importance of involving children in rule-setting and self-monitoring, respecting their privacy, promoting family collaboration and communication, and utilizing reward systems and social motivators to incentivize tech disengagement practices. Additionally, researchers recommended incorporating tools to support parents in managing children's tech use and suggested ways to design for users' diverse needs and situational demands. From our review, we also curated 14 design mechanisms that have the potential to promote tech disengagement among early adolescents that future digital interventions targeting this age group should consider incorporating.

Despite employing search queries that identified over 1300 abstracts, our systematic review identified only 15 relevant articles, with just 6 focusing on prototype design for tech disengagement, only 4 of which included user evaluation. A similar lack of user-centered research was observed in prior reviews, for example, a systematic literature review on parental control tools for children's online safety found only 7 studies involving end users in the design or evaluation process [106]. This indicates a relatively open research space, with opportunities for future work

to explore more user-centered approaches in developing tech disengagement interventions for early adolescents.

Our systematic review indicates only limited research specifically targeting early adolescents (11-14 years). Most papers focused on a broader age range, making it difficult to fully pinpoint guidelines specifically tailored to this age group. Since each developmental stage has unique requirements, different ages likely require different forms of support for regulatory activities like managing tech use. For example, while appropriate for early adolescents, the autonomy granting design mechanisms presented in Table 6 might not benefit younger children, as they may not yet be matured enough to make informed decisions. More age-specific research efforts are needed to ensure that digital interventions cater to the unique needs of different age groups.

5.3.1. Social Factors Shaping Design Recommendations

Through our review, we observed several social factors influencing the use and perception of interventions, shaping the design recommendations. These include parent-child trust and conflict, emotional dynamics, and cultural norms. For instance, while intrusive monitoring can raise parental awareness, it may compromise trust and autonomy, especially for older children, leading to parent-child disagreements. Designers should promote mutual trust while respecting privacy though abstracted personal information disclosure, joint reflective activities, and consent-based privacy agreements. Emotional factors also shape recommendations; for example, imposing restrictions without proper reasoning can undermine autonomy and cause resentment, while unclear communication about rules can create misunderstandings. To support emotional wellbeing, interventions should encourage shared decision-making, open communication, and sharing of

contextual factors impacting rule compliance. Additionally, cultural norms often impact parenting and mediation strategies, as families from different backgrounds may have diverse views on appropriate tech use, autonomy granting, and reward mechanisms.

The design recommendations across varied user needs and social factors suggest that HCI researchers should consider their relationships and applicability. For instance, autonomy-granting mechanisms and intrinsic motivators can complement each other, while integrating parental and community-based mentorship may depend on family preferences. Further research is needed to explore how to effectively present multiple features without overwhelming users and understand real-world trade-offs.

5.3.2. Limitations and Generalizability

While our systematic literature review initially identified 1386 papers from two relevant databases (ACM and IEEE), only 15 papers met our inclusion criteria in the final sample. One possible explanation could be the design of our search query, which may have unintentionally narrowed the results or led to an overrepresentation of less relevant papers. For example, we included some intervention-related terms in our search query (e.g., intervene, regulate, reduce), which might overlook papers that do not use these terms but describe similar concepts using different language, like “prevention” or “balanced tech usage”. Conversely, some of these terms, such as “regulate”, could have introduced noise by retrieving papers that discuss regulation in other contexts (e.g., emotion regulation). To improve the signal-to-noise ratio, future studies might refine the query by experimenting with more precise or alternative search terms.

Our systematic review considered two databases (ACM and IEEE) within a timespan of 10 years. While this approach was informed by similar reviews [199,200], it may have restricted the

size of our final sample. Expanding the search to include databases from fields like psychology, education, and child development, along with additional platforms like Taylor & Francis, Elsevier, DBLP, and Google Scholar, could provide different perspectives.

5.4. Summary

Our systematic review provides a characterization of the current research on tech disengagement solutions addressing children's technology overuse. Findings from this review highlight researchers' design recommendations for digital interventions, such as collaborative rule-setting, self-monitoring, privacy maintenance, and addressing diverse user needs. Based on insights from our elicitation study, we assess the relevance of these recommendations for early adolescents. Additionally, our review reveals a lack of design-oriented research that specifically targets this demographic. The insights gained from our systematic review provide synthesized guidelines, which can support future research exploring design solutions for addressing early adolescents' technology overuse.

Chapter 6

A Systematic Analysis of Existing Parental Control Applications

To gain a more comprehensive understanding of existing solutions for early adolescents' tech disengagement, we conducted a systematic app analysis of the available parental control apps targeting tech overuse. Although hundreds of parental control applications are marketed to a broad spectrum of ages, it is unclear if their features meet the specific needs of early adolescents. Therefore, our app analysis aimed to uncover the current design focus of these parental control solutions and assess how they support early adolescents' tech disengagement, drawing on preferences identified in our elicitation study (Section 4.3). Specifically, our app analysis addressed the following research questions:

1) In the context of our early adolescent-centric design space for tech disengagement interventions, how well do existing parental control apps align with the preferences of early adolescents and parents? Where do potential misalignments exist?

2) Does the design focus of these parental control apps align with the researcher-proposed design recommendations identified in our systematic literature review (section 5.2)?

This chapter describes our approach to collecting parental control applications, analyzing their features, and evaluating their alignment with target users' preferences identified in our elicitation study from Chapter 4. It provides a characterization of the functionalities of existing apps, highlights areas where these apps fail to meet user needs, and discusses design implications.

6.1. Approach

Informed by methods utilized in previous literature [3,80,198,205,206], we systematically analyzed existing parental control apps to assess their implemented design strategies and focus (section 6.2.1). Our approach drew on the findings from our elicitation study described in Chapter 4, which highlighted areas of preferred solutions for both early adolescents and their parents across different design dimensions including agency, parental engagement, mentorship approaches, and motivation types. We used our design space as an analysis tool to further evaluate the alignment between the current app focus and the needs of our target users (section 4.4), identifying gaps where existing solutions might not fully address these needs (subsection 6.2.2). Additionally, by comparing these apps with the design recommendations from our systematic literature review (section 5.2), we uncovered further gaps and opportunities, and discussed implications for future design efforts (subsection 6.3.2).

6.1.1. App Collection

We searched the Google Play Store and Apple App Store during May and June 2024 for apps that offer strategies to limit early adolescents' tech overuse. We used the following search keywords: 'Limit Screen Time', 'Family Screen Time App', 'Screen Time Control (kids/adolescents/teens)', 'Screen Control Kid', 'Child Screen Timer', 'Parental Control'. For the Apple App Store, we used an open-source app-store scraper [146], previously utilized in a similar study analyzing apps [127], to extract search results. We could not use the Google Play Store app-store scraper [147] to retrieve more than 30 results, likely due to policies introduced in March 2024 restricting machine-generated traffic [84]. Therefore, I manually collected the Android apps from the Google Play Store search results for each set of keywords. From the generated app lists from both stores, a second researcher and I manually screened app titles, descriptions, and screenshots on each product page to verify that they met the inclusion criteria stated below.

App Inclusion Criteria – (App Selection Phase)

- The app description and screenshots include features related to limiting tech overuse (e.g., planning device time, limiting screen time, monitoring usage time).
- The app targets children/early adolescents/teens (e.g., the description/title/screenshots mention children/teens/kids). Apps targeting babies, toddlers, or only parents are excluded.
- The app has an English-language user interface.
- The app has at least 10k+ downloads (Google Play Store) or at least 5 ratings (Apple App Store).

After applying the inclusion criteria and removing duplicates, we collected a total of 88 apps (56 Android and 32 Apple).

6.1.2. App Evaluation

To evaluate the collected apps, we began by installing them on devices. Many apps in our sample required a companion app to support both a parent and a child profile/mode. Typically, this setup involved installing one app on a "parent device" and another on a "child device". When evaluating Google Play Store apps, we used two Android tablets (Galaxy Tab S9 FE; storage: 128 GB, android version: 14). For the App Store apps, we used an iPhone (iPhone 15 pro; storage: 128 GB, version:17.5.1) as the parent's device and an iPad (iPad Pro 3rd Gen; storage: 256 GB, version:17.2) as the child's device. After installing the 88 collected apps, we removed 25 Android apps and 16 Apple apps from our sample during the app evaluation phase, based on the exclusion criteria listed below. Consequently, the final app list contained 47 apps (31 Android and 16 Apple). See Table 7 for the lists of apps from Google Play Store and Apple App Store.

App Exclusion Criteria – (App Evaluation Phase)

- The app cannot be used without paying for a subscription or does not offer a free trial. If the app allows a free trial with some premium features disabled, we included it, documenting the features that could not be tested.
- The app does not function (e.g., crashes, inability to pair with the companion app), requires additional components (e.g., Xbox, router, SIM cards), requires unsafe configurations, or is incompatible with our evaluation devices.
- The app evaluation revealed no features related to tech disengagement.

Table 7: List of Google Play Store and Apple App Store apps included in the app analysis

Google Play Store Apps		Apple App Store Apps
1Question Screen Time Control	Kids Place Parental Control	Circle Parental Controls APP
Adora - Parental Control, Adora Kids	kids360: Parental Control	FamiGo: Parental Control App
Airdroid - Parental Controls	KidsNanny Parental Control App	FamiSafe - Location Tracker, FamiSafe Kids - Blocksite
Boomerang Parental Control	MobileFence - Parental Control	Kaspersky Safe Kids with GPS
CALMEAN Control Center	Parental Control - FamilyTime	Net Nanny Parental Control App
ESET Parental Control	Parental Control - Kids Mode	Norton Family Parental Control, Norton Family Companion App
Family Space	Parental Control - Scrnlink	Ohana Parental Screen Control
FamiOn: GPS Location Tracker, Kidsy	Parental Control by Kidslox	Parental Control App - Mobicip
Find my kids: Parental Control, Pingo by Findmykids	Parental Control SecureKids	Parental Control App - Monitor
FlashGet Kids: parental control	Safe Lagoon Parental Control	Parental Controls – SuzyApp
Google Family Link, Family Link parental controls	Safes - Parental Control	Qustodio Parental Control App
iWawa - Parental Control	Taki - your screen time friend	Safe Family: Screen Time App
Kid Security: family locator, Tigrow! by Kid Security	Teen Time - Parental Control	Screen Time - Parental Control
Kido Protect Parental Control	TimeoutIQ. Smart Education	Screen Time Control
Kids App Lock: Parental Lock	Trumsy	Screen Time Parental Control
Kids Mode - Kids Lock App		XLocker - Control Screen Time

Along with another researcher, I evaluated our final sample of 47 apps using a "Walkthrough Method", following Wang et al.'s Approach [198]. Unlike the traditional "Cognitive Walkthrough," which targets usability issues [123], our walkthrough focused on identifying features related to tech disengagement. Both the second researcher and I explored all apps together as potential new users, playing a specific role (i.e., a parent or an early adolescent user), while trying out all available features. We then shared our observations and independently listed and described all features of each app. If the app allowed users to select an age-based restriction mode, we chose the age group that aligns with our target audience of 11-14 years. In cases where multiple

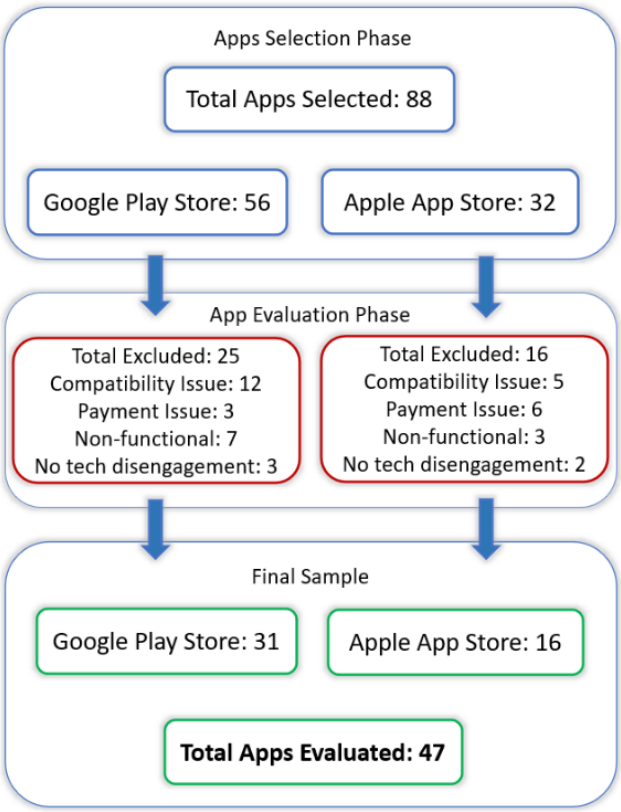

Figure 15: App Analysis Workflow.

supervision modes were available (e.g., monitor only, monitor and show warnings, monitor and manage), we chose those with the most parental restrictions, as these modes typically provided the most comprehensive access to the range of features offered by the apps.

6.1.2.1 Identifying Distinct Features and Generating a Codebook. From the descriptions of all features explored in the collected apps, I independently used a bottom-up approach to identify and categorize features related to limiting children's tech overuse, distinguishing between parent and child features. I initially coded the distinct parent and child features based on the descriptions documented during the app evaluation, grouping similar features under higher-level codes (e.g., "MESSAGING" in Figure 16). These coded features were documented in a codebook along with descriptions of the codes (more examples from the codebook are included in Appendix C.2, see Figure 16 for a snippet). Then I clustered the codes into different feature categories. A second

Feature Category: Communication & Negotiation				
Children's Feature Sub-Categories	Feature ID	Final Codes	Initial Coding of Individual Features	Individual Features Identified
Requesting for Rule Changes/ Extensions	EF6	REQ-CUST-MSG	REQ-CUST-MSG	Send custom message for the request
	EF7	REQ-OFFLINE-NEGOTIATE	REQ-OFFLINE-NEGOTIATE	Prompts children to ask in-person if the request is denied/limit exceeded
	EF8	MODE-CHANGE-REQ	MODE-CHANGE-REQ	Request for changing the mode of restriction/changing a rule
	EF9	CONTENT-ACCESS-REQ	CONTENT-ACCESS-REQ	Request for accessing a blocked app/site
Messaging	EF10	MESSAGING	IN-APP-CHAT	Send and receive messages
			IN-APP-FAMILY-CHAT	Group messenger with family if multiple devices are connected
			IN-APP-CHAT-PROMPTS	there are stickers, and prompts as well to facilitate communication
			AUDIO-MSG	can record audio msg and send to the parent
	EF11	MESSAGING-RCV-ONLY	IN-APP-CHAT-ONLY-RCV	Cannot send messages, only receive messages from parents

Figure 16: A snippet from our codebook that includes sub-categories of children's features under the feature category "Communication/Support".

researcher, who also participated in the app evaluation, crosschecked the codebook against their own observations to ensure completeness. The codebook was collaboratively refined by both the second researcher and I, and a summary of the feature categories and key findings is provided in section 6.2.1.

6.1.2.2 Mapping the Apps to the Design Dimensions. Using the independently documented app feature descriptions from the app evaluations (subsection 6.1.2.1), the second researcher and I collaborated to identify and code all features for each app based on the predefined codebook discussed above. Then we mapped the apps onto the four key design dimensions for early adolescents' tech disengagement formulated during our design space exploration (see section 4.1). Using the app feature descriptions and the definitions of the coded features from our codebook, both the second researcher and I independently rated each of the 47 apps on these dimensions within a range of low, low-medium, medium, medium-high, and high, according to the guidelines presented in Table 8. We subsequently cross-checked their mappings, resolving any disagreements through discussion. Despite using a 5-point scale, many apps are not precisely located at these discrete points but rather fall within a range around these points (e.g., between mid and mid-high). We placed each app at the closest point for clarity, discretizing the dimensions for our app mapping, following the approach taken in the elicitation study (see section 4.3.3). Our goal with this mapping

Table 8: Guidelines for mapping features to design dimensions.

Dimension Ranges	Guidelines for Mapping
Level of Children's Agency	
low	absolutely no say for children - parents decide everything (e.g., set rules/block apps)
low-mid	children can negotiate but parents have the final say (e.g., request extra time and track own usage/select tasks from the parent-created list)
mid	both have equal say regarding the disengagement process (e.g., decide rules together and both can track)
mid-high	some features where the children have the final say, parents can negotiate (e.g., stop supervision)
high	children decide everything (e.g., setting their own limits and tracking usage)
Level of Supportive Parental Engagement	
low	no option for parents to communicate/address children's emotions via the app
low-mid	some features to address children's requests/emotions (e.g., respond to requests/administer rewards)
mid	good level of communication from parents (e.g., in-app chatting, sharing reasonings)
mid-high	some features for parents to practice co-disengagement (e.g., competitions, joint tasks)
high	co-practicing disengagement with the child (e.g., same rules for both)
Type of Motivation	
only intrinsic	many features that promote decision-making, self-monitoring, planning inherently enjoyable offline tasks
more focus on intrinsic than extrinsic	most features are intrinsic (e.g., self-monitoring and choosing tasks, planning), along with some external rewards/motivation/pressure
combination	a combination that equally balances both types of motivation (e.g., choosing your own tasks with rewards)
more focus on extrinsic than intrinsic	a few features are intrinsic, mostly external rewards/motivation/pressure
extrinsic	only external rewards/motivation/encouragement/competition/external pressure
Type of Mentorship	
only parental	no peer support or guidance (e.g., only parental restrictions and guidance)
parental with some peer-based mentorship	mostly parental guidance with some support from peers/peer-like character (e.g., messaging/reminders)
Combination of peer-based & parental	peer-based mentorship from a virtual character with peer-like characteristics, along with equal level of parental guidance and supervision
peer-based with some parental mentorship	mostly peer guidance with some parental support (e.g., messaging/reminders)
peers only	no parental support or guidance (e.g., peer-set restrictions and guidance)

exercise is to identify the current focus areas within the design space, rather than to pinpoint the relative positioning of each app. This broader level of granularity also facilitated a more productive

conflict resolution and discussions compared to a more granular approach. Findings from this analysis can be found in subsection 6.2.2.

6.2. Findings

The following sections present the key outcomes from our app analysis, highlighting the types of features identified and how these apps align with our early adolescent-centric design space.

6.2.1. Categories of Feature Identified

From our app analysis, we identified 6 categories of features, which are listed in Table 9, along with the key features identified within each category. In total, we identified 64 features - 34 child features and 30 parental features. Some features appeared in both groups (e.g., both parent and child can monitor daily device usage). Below, each of the 6 categories of features identified from this app analysis is discussed.

Content Restriction: To limit overall technology use, parents often restrict children's access to digital devices, online media, or certain applications (e.g., games) [16], a strategy that was also prominent in our app analysis. The most common content-restriction feature, found in 40/47 apps, enables parents to control their children's access to all or specific apps. Restrictions are typically enforced by blacklisting or hiding apps, where most parental control apps simply block access without showing any notice to the child, demonstrating a lack of transparency and awareness of the parent-set restrictions for the child. Additionally, 29/47 apps allow parents to block their children's devices at any time, making the device inactive, except for parent-set whitelisted apps. Although these blocking features can limit children's tech use, they emphasize enforcing parental control over promoting children's self-regulation.

Table 9: Summarizing key findings for parental and child features across different feature categories

Feature Categories	Parental Features	Child Features
Content Restriction	40/47 apps allow parents to block all or specific apps 29/47 apps allow parent-triggered device blocking	40/47 apps restrict from accessing blacklisted apps 10/47 apps display default notices or blocked screens when trying to access restricted devices/content
Time Restriction	28/47 apps set a time limit for overall device use 21/47 apps set a limit for specific apps 20/47 apps allow limit adjustments	In 39/47 apps, time limits are applied without input from children 19/47 apps allow children to request extra time
Planning Screentime	27/47 apps allow scheduling of device time 23/47 apps allow scheduling of downtime Can set offline tasks for downtime in 8/47 apps	3/47 apps allow children to select their own tasks
Reinforcements	Decide the ratio of earned points/screentime awarded for learning or task completion in 13/47 apps Review evidence of task completion before awarding points or screen time in 5/47 apps Engage in competition with children in 1/47 apps	Earn points/rewards for completing tasks in 5/47 apps Earn screen time in 8/47 apps for offline tasks or learning activities Submit evidence of task completion in 5/47 apps Engage in competition with parents or peers in 1/47 apps
Monitoring Usage and Progress	39/47 apps track device or app usage (e.g., daily, weekly, monthly, custom dates) Can stop monitoring in 6/47 apps	13/47 apps allow children to monitor their own usage 6/47 apps allow progress tracking for learning or tasks 11/47 apps display timers for children 4/47 apps provide warnings before time outs 9/47 apps make rules visible to children 3/47 apps allow children to stop parental monitoring
Communication & Negotiation	5/47 apps allow custom responses to children's requests 6/47 apps include in-app messaging for parent-child communication 3/47 apps support one-way messaging from parents Can set reminders for children in 4/47 apps	19/47 apps allow children to request changes to rules 5/47 apps let children send custom messages 3/47 apps encourage offline negotiation with parents 6/47 apps support in-app chatting, with a few allowing voice messages and stickers

Time Restriction: Limiting time is the second most common feature found in 39 out of the 47 apps analyzed. Time limits are typically applied on overall device use or on specific apps. When the time limit is exceeded, the parental control app will block all or specific apps or lock the device. Parents can set different limits for individual days or apply the same limit every day, with possible exceptions on weekends. While 20/47 apps offer flexibility in adjusting limits, they do so without involving children in the initial decision-making process.

***Planning Screentime*:** Of the 47 apps surveyed, 34 included scheduling features that allow parents to plan children's device time (27/47) or downtime (23/47). Planning device time involves specifying periods for device use and selecting apps for each period (e.g., apps for study or entertainment). Scheduling downtime involves creating offline routines (e.g., bedtime, homework) and setting offline tasks (e.g., chores, challenges), during which the device is paused with all apps blocked. Typically, offline tasks are selected by parents, with only 3/47 apps allowing children to choose their own tasks. These scheduling features focus on helping parents manage and structure their children's tech use, like the features discussed above, rather than involving children in setting their own schedules.

Reinforcements: We found that the use of positive reinforcement strategies in these apps is generally limited. 13/47 apps incorporate gamification techniques by offering points, real rewards, or screen time for spending screen-free time and completing offline tasks or learning activities. Among these, 5/47 apps require children to submit evidence of task completion for parental review before rewarding, reinforcing parental control rather than encouraging children to take ownership of their behavior. Only one app involves children in competition with parents or peers to encourage other activities. Overall, the limited use of positive reinforcements relies mainly

on external rewards, without fostering intrinsic motivation, which is important for developing self-regulation skills [165].

Monitoring Usage and Progress: Most parental control apps (39/47) enable parents to track their children's overall device usage or individual app usage, over different periods of time. However, only 13/47 allow children to monitor their own screen or app usage. Additionally, while all these apps employ many parent-set restrictions, only 9/47 make these rules visible to children. This indicates a gap in transparency and self-monitoring opportunities for children, which could affect their ability to practice tech disengagement independently and understand the parent-set boundaries enforced by the apps.

Communication & Negotiation: Among the 47 apps, 19 allow children to request rule changes, such as extending time limits, accessing restricted content, or changing the mode of restriction, which parents can approve or deny. Additionally, 3/47 apps encourage offline negotiation by asking children to discuss their opinions about the rules with their parents, and only "Boomerang Parental Control" prompts parents to seek more information from their children before accepting or rejecting a request. Although limited, these apps allow children to let their voices be heard and adjust rules accordingly through negotiation. In terms of communication, 6/47 apps have in-app messaging features that allow both parents and children to communicate. However, 3/47 apps support only one-way messaging from parents where children cannot reply. Overall, this highlights a general lack of interactive and supportive two-way communication features, which could limit effective parent-child dialogue and negotiation.

6.2.2. Mapping Apps onto Design Dimensions

To highlight areas of focus and identify whether current parental control apps address the needs and expectations of our target users, we map these apps onto our early adolescent-centric design space defined in Chapter 4, following the method in subsection 6.1.2.2. Our findings are presented below by illustrating the distribution of 47 apps across four design dimensions (see Figure 17) and providing examples from our analysis. Each graph is overlaid with the ovals from Figure 12, representing the preferences of parents (red) and early adolescents (blue) as identified in our elicitation study (see section 4.4). These ovals highlight the ranges of user preferences, offering a visual comparison against the app mappings.

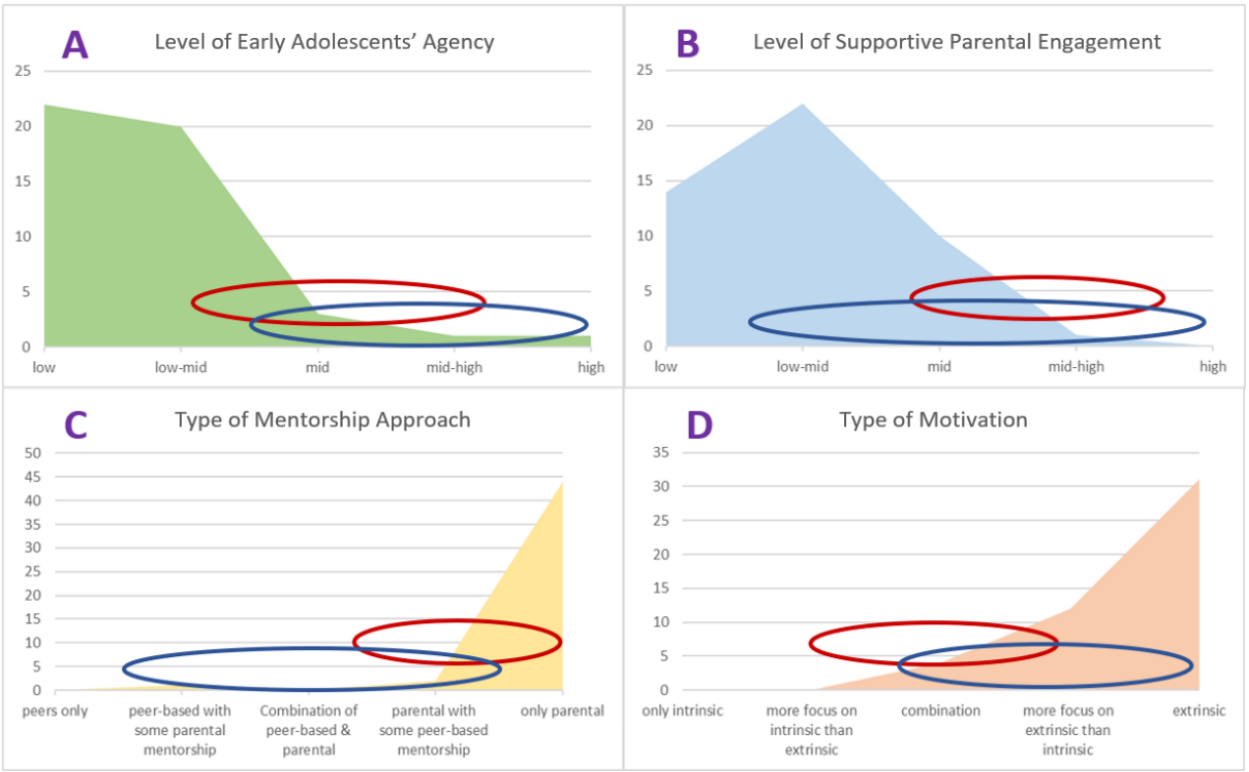

Figure 17: The area graph shows (A) agency levels, (B) supportive parental engagement levels, (C) mentorship types, and (D) motivation types for 47 parental control apps on a 5-point scale. The X- and Y-axes in each graph represent the dimension ranges (defined in Table 8) and number of apps, respectively. Blue and red ovals indicate early adolescents' and parents' preferences across the dimensions, respectively, as identified in section 4.4.

6.2.2.1. ***Level of early adolescents' agency*.** According to our design space study discussed in Chapter 4, early adolescents expressed a preference for mid to high levels of agency in practicing tech disengagement. Parents' preferences were also in the mid-range, leaning toward the higher levels. However, we found that most parental control apps in our sample fall in the low (22/47) and low-mid (20/47) ranges (see Figure 17A). For instance, "Kids App Lock: Parental Lock" provides low agency which restricts app access and enforces device blocking without involving children in rule-setting, usage tracking, or negotiation. An example of an app with a low-mid agency is "CALMEAN Control Center". Although it does not involve children in initial rule-setting and parents have the final say, it enables them to negotiate time limit-related rules by sending requests to parents. Here, children can also monitor their app usage, view rules, and track remaining device time.

Only 3/47 apps had a medium level of agency. For example, "Find my kids: Parental Control" and "FamiOn: GPS Location Tracker" empower children to disable parental supervision and negotiate with parents. The "Kid Security: family locator" companion app also enables them to stop parental monitoring, choose offline tasks, and track their progress. We found just one app in the mid-high range and one in the high range of agency. "Google Family Link" was mapped to the mid-high range as it empowers children to disable all parent-set restrictions and negotiate rule changes by sending requests. If they choose to disable parental rules, this app warns them that it will restrict device access for 24 hours, after which they can use it without restrictions. While offering time to reconsider their decision before acting impulsively, it also serves as a disincentive by temporarily removing access. The only app with a high-level agency was "Trumsy", which does not enforce parental restrictions. In this app, the children can choose their offline tasks and challenges, co-practice tech disengagement with their parents, and track their progress.

6.2.2.2. ***Level of supportive parental engagement.*** Our design space study showed that parents preferred mid to high levels of supportive engagement, while early adolescents had varied preferences. Our mapping placed most apps in the low (14/47) to low-mid (22/47) ranges (see Figure 17B). Apps with low parental engagement do not incorporate any features for parent-child communication or address children's emotions (e.g., Family Space). Apps in the low-mid range include some features addressing children's feelings, such as letting parents respond to children's rule-change requests, setting reminders, and administering rewards to foster positive emotions toward tech disengagement (e.g., "kids360: Parental Control").

According to our rating, 10/47 apps had a medium level of supportive parental engagement, like "Boomerang Parental Control", which includes in-app chatting supporting communication between parents and children. Along with responding to children's negotiation requests, it also allows parents to share their reasoning behind restrictions while inviting children to justify their rule-change requests. We rated only one app, "Trumsy" as having a mid-high level of parental engagement. It allows parents to co-practice tech disengagement as a form of competition and motivates children by administering rewards. We did not find any apps with high parental engagement in that the apps actively involve parents in tech disengagement with their children on a regular basis.

6.2.2.3. ***Type of mentorship.*** Most of the apps in our sample (44/47) employ parental mentorship (see Figure 17C), reflecting parents' preferences identified in the elicitation study. Only two apps included some elements of peer or peer-like support alongside parental mentorship. For example, "Trumsy" allows children to compete with peers by completing challenges, while "Safe Lagoon" integrates an AI Bot that reminds children about rules through chat interactions. We found only one app, "Taki - your screen time friend", that employs a balanced combination of a peer-

based approach and parental mentorship. It uses a friendly virtual character to foster children's self-regulation which interacts with children as a peer through dialogues and gestures and provides distractions to smoothly end screen time before the time limit is reached. While parents do not actively mentor children through this app, they are responsible for setting time limits and tracking usage. We did not find any app relying solely on peer-based guidance. Although our design space study did not indicate a strong inclination for a purely peer-based approach, many early adolescents did express a desire to include peer support to some extent alongside parental guidance.

6.2.2.4. ***Type of motivation*.** According to our design space study, both parents and early adolescents preferred a combination of intrinsic and extrinsic motivation, with early adolescents showing a greater inclination toward extrinsic motivation, particularly positive reinforcements for tech disengagement. Our findings reveal that 31/47 apps rely solely on extrinsic motivation with only 12 incorporating elements of intrinsic motivation (see Figure 17D). Moreover, most apps in our sample (30/47) utilize only restrictive measures, such as device blocking, rather than encouraging voluntary engagement through positive reinforcement. These restrictive features can act as external pressure to comply with rules, as non-compliance can result in negative outcomes (e.g., no device access). Only 13/47 apps include positive extrinsic motivation alongside rule enforcement, typically offering rewards for following parent-set instructions, such as completing offline tasks. For instance, "Screen Time Parental Control" rewards children with additional screen time for completing parent-selected offline activities. An example app that includes some intrinsic motivation with external rewards and pressure is "FamiOn: GPS Location Tracker". This app motivates offline activities with reward points, which can be redeemed for real rewards (e.g., toys) from child-created wish lists. It also fosters some intrinsic motivation by allowing children to select tasks from a parent-set list and offering social support through messaging features.

Only four apps in our sample demonstrated a balanced combination of intrinsic and extrinsic motivation. For example, “Kid Security: family locator” incorporates both rules and rewards as extrinsic motivators while fostering intrinsic motivation through self-monitoring and enabling children to choose inherently enjoyable offline tasks. Although “Google Family Link” primarily relies on external pressure through parental restrictions, it also supports intrinsic motivation by allowing children some control over their tech regulation. For instance, the app empowers them to disable parental restrictions and self-monitor their usage. Our sample did not include an app that prioritizes intrinsic motivation alone due to the prevalent use of parent-enforced rules that act as external pressure.

6.3. Discussion

Findings from our app analysis reveal the current design focus of digital interventions, identifying six primary categories of features, including time and content restrictions, planning screentime, reinforcements, and communication. However, we observed that most of these apps have features that are parent-focused, aligning with prior findings on apps promoting online safety [77,206]. Our analysis confirms that these design issues extend beyond safety-focused interventions, applying also to tech disengagement apps. This generalization to apps with a different objective highlights the need for designing digital interventions that address the requirements of both early adolescents and their parents.

6.3.1. Connecting Researchers’ Recommendations to App Design: Implications for Design

This subsection links the design recommendations from our systematic literature review (section 5.2) with the app design focus identified through our app analysis. Both analyses revealed a

noticeable gap between the design elements researchers advocate and those commonly implemented in existing apps. For example, most of the included papers in our review highlight the importance of granting children a sense of agency through mechanisms like collaborative rule-setting, autonomous goal-setting, and self-monitoring. However, most parental control apps focus primarily on restricting children's access to technology without involving them in decision-making processes. This suggests a lack of apps that encourage children to develop self-regulation skills through greater autonomy, reflecting a need for app developers to adopt more empowering features in their designs.

Our systematic review found that researchers emphasize the importance of fostering communication and collaboration between parents and children in managing tech disengagement. Despite these recommendations, our app analysis identified only a few parental control apps that integrate features for parent-child communication and support, which is critical for negotiating device usage rules and ensuring fairness in their enforcement. This gap highlights an opportunity for app developers to design features that promote open discussions and co-practice of digital boundaries between parents and early adolescents.

Researchers' recommendations on mentorship, especially parent-based mentorship, are reflected in most apps, with nearly all utilizing some form of parental guidance. However, our findings from the systematic review also highlight the potential benefits of broader mentorship approaches, such as community-based or peer-based systems, which were largely absent from the apps reviewed. Since some early adolescents prefer a combination of peer and parental support as observed in our elicitation study, there is an opportunity to design more dynamic mentorship systems integrating options for children to seek guidance from a wider range of sources, which could better align with their developmental needs.

Our review identified a range of recommendations for providing positive extrinsic motivation in tech disengagement interventions, with a focus on strategies such as rewards and reinforcements. Although most of the reviewed papers did not explicitly discuss intrinsic motivation, they emphasized the importance of promoting agency and collaboration, which fosters intrinsic motivation. Despite these recommendations, most parental control apps in our sample rely heavily on negative extrinsic motivation, particularly through restrictive measures such as device blocking or time limits. While some apps do incorporate positive reinforcement, only a few foster intrinsic motivation by offering children control over choosing enjoyable offline activities or self-monitoring. Both our co-design and elicitation study findings suggest that simply pressuring early adolescents to follow rules may not effectively motivate them to practice tech disengagement [37,38]. Therefore, parental control apps should consider incorporating more positive reinforcements and features that foster intrinsic motivation, enabling children to find personal meaning and satisfaction in reducing screen time while promoting self-regulation.

Researchers also suggest incorporating customizable features that adapt to users' diverse characteristics, such as age, gender, personality, and level of tech addiction. We found only 10 apps that allowed parents to change their modes of supervision, providing the flexibility to select a more appropriate mediation strategy for their early adolescents. Furthermore, as discussed in 6.2.2.1, only a few apps allow children to change their level of control by turning off parental supervision. Although some apps offer adjustable time limits and screen-time planning based on specific contexts (e.g., school hours, vacation), most do not involve children in these decisions, undermining their autonomy. These findings emphasize the importance of developing digital interventions that offer customizability for both parents and children, empowering them to tailor

features to their individual needs and situations to foster a more personalized and sustainable approach to tech disengagement.

Our systematic review in Chapter 5 revealed that prior research promotes autonomy granting and motivational mechanisms alongside supportive parental engagement and guidance. However, most existing apps emphasize restrictive parental control, and few studies explore functional prototypes that instantiate these recommendations or assess their practical impact. HCI researchers and practitioners can address these gaps by examining real-world application of these recommendations and developing parent-child collaborative technologies that balance autonomy and control, while mitigating trust issues and conflict. To determine the sustainability of the design mechanisms and their impact on tech usage patterns, more longitudinal studies are required, as most papers in our sample involve only short-term evaluations (e.g., 2-3 weeks).

6.3.2. Limitations and Generalizability

In our app analysis, our search terms may have shifted more towards the control-oriented apps, as most apps specifically designed to help children limit screen time are marketed in this category. While we included broader terms such as “limit screen time” or “family screen time app” to capture variation, general time management or productivity apps were primarily targeted at adults rather than children. To maintain relevance for early adolescents, we focused on apps that explicitly referenced children, teens, or early adolescents, excluding those aimed at adults. Consequently, our analysis did not cover general-purpose everyday apps, such as social media or gaming apps, which might include features supporting tech disengagement. Future work could examine these apps beyond parental control tools and explore how general-purpose tools could be adapted for early adolescents.

We also excluded apps that required paid subscriptions without offering any free trials, consistent with a prior study analyzing parental control apps for online safety [207]. This decision may have left out some widely used apps from our final sample, however, given that there were only 9 such apps in our initial sample, it is unlikely that including these apps would drastically shift our overall findings.

When mapping the apps onto our early adolescent-centric design space, we used a 5-point scale to rate and position the apps on various design dimensions. While this broad classification facilitated a comparative overview and helped app evaluators to identify key focus areas, not all apps fit neatly into these discrete points. This lack of precision could result in some loss of detail, particularly with complex features. For example, an app may offer varying degrees of agency, but the extent and quality of this agency could vary across contexts, which may not be fully captured in the scale. Future research could explore more nuanced mapping techniques to better capture these complexities.

6.4. Summary

Our app analysis highlights the key design areas of existing apps and identifies critical gaps in how well they address the expressed needs of early adolescents and their parents. By positioning these apps within our early adolescent-centric design space, we reveal significant alignments and misalignments with user preferences described in Chapter 4. Notably, most apps fail to meet the preferences of both parents and early adolescents, indicating a lack of user-centred interventions. Furthermore, connecting the app analysis findings to the design recommendations from our systematic review described in Chapter 5 reveals mixed alignment. While some apps partially support these recommendations, most focus on restrictive approaches instead of fostering self-

regulation, lack features for active parental engagement, and rely heavily on external motivation through rules and restrictions. These findings point to potential areas for future design, based on the recommendations from HCI researchers and the gaps between the current app focus and target user preferences.

Chapter 7

Reflections on Engaging Early Adolescents in Tech Disengagement Research: Challenges, Insights, and Long-Term Considerations

This chapter delves into some of the key aspects of the studies conducted throughout this thesis. It begins with the challenges faced in recruiting early adolescent participants and suggests other potential approaches for reaching this group more effectively. Next, insights gathered from conducting studies with early adolescents, both grouped with peers and paired with parents, are discussed. Additionally, the experience of engaging early adolescents in online co-design of tech disengagement solutions are analyzed, including the adaptation of methods for the online setting, participant involvement in online design activities, use of virtual tools, and the challenges and

advantages we experienced in the process. Finally, our approach of exploring a broad range of design strategies is contrasted with the alternative of focusing on a single deployable solution through a longitudinal study, highlighting the trade-offs between breadth and depth in designing and evaluating tech disengagement interventions.

7.1. Challenges in Recruiting Early Adolescents in Studies Regarding Tech Disengagement

One of the challenges we encountered while conducting the user studies was recruiting early adolescent participants. Despite employing diverse recruitment methods, including online advertising, physical posters, snowball sampling, and word of mouth, we were able to recruit only 34 early adolescents across two user studies. Challenges in recruiting and involving early adolescents are also well-documented in HCI literature [63,64]. At this developmental phase, early adolescents often struggle with motivation in general, which can make participation in research studies particularly unappealing [64]. Moreover, since this age group spends more time online and gaming compared to others [103], the idea of contributing to studies regarding tech disengagement may conflict with their attachment to technology.

Innovative and alternative recruitment strategies could help attract more early adolescent participants. For instance, organizing summer camps that combine tech disengagement activities with opportunities for socializing and other fun and age-appropriate events could make participation more appealing. However, designing such activities would require significant time and effort to ensure participation from those who are not interested in tech disengagement in the first place. Collaborating with schools and working with authorities to organize sessions could be

another potential approach to reach more participants. However, this strategy has the additional overhead of obtaining approval from school boards and careful consideration to ensure that such studies do not add to the already heavy workload of teachers. Another approach could be to collaborate with children's sports teams, as these often have downtimes between games or practices, providing opportunities to engage participants in research during these breaks.

7.2. Early Adolescent-Only vs. Parent-Child Sessions: Reflections from Our Study Designs

We observed notable differences in participant engagement between our two studies. In the co-design study (Chapter 3), 21 early adolescents worked in groups of three over three sessions. All seven groups actively participated in the activities, offering valuable insights into tech disengagement. In contrast, the elicitation study (Chapter 3) involved 13 early adolescents paired with their parents, and we observed a few instances where the adolescent participants were not as engaged. For instance, a few were noticeably less involved than their parents, using their devices (e.g., smartphones or tablets) during sessions, while their parents expressed concerns about excessive device usage.

This difference in engagement across the two studies could be attributed to several factors. For instance, power imbalances within their families could discourage some early adolescents from fully participating with their parents present. Additionally, some parents seemed more motivated to participate in the elicitation study than their children, whereas early adolescents in the co-design study appeared to be mostly self-motivated. While the parent-child joint sessions fostered meaningful discussions about family tech use and provided insights into their shared perspectives,

the trade-off of this approach was that we were unable to elicit the early adolescents' opinions without the influence of parental presence.

Our experience also highlights the value of group-based activities for engaging early adolescents. Although designing effective group activities has its own challenges (e.g., balancing participation, incorporating engaging ice-breaking and team-building activities, time management), the peer interactions in our co-design study seemed to foster a more relaxed environment than the parent-child joint sessions in the elicitation study. Our co-design study participants appeared more comfortable and engaged when collaborating with peers, compared to some participants when paired with their parent in our elicitation study. This suggests that group settings with peers might be more motivating for this age group than individual sessions with parents.

7.3. Online Co-Design with Early Adolescents: Challenges and Opportunities

Co-design, a form of participatory design where participants collaborate with researchers, has traditionally been conducted in co-located settings. Due to COVID-19 restrictions, as of 2020, it has become more common for researchers to conduct co-design studies online [44,60,122]. Since our first study (Chapter 3) was conducted during the height of the pandemic, we involved early adolescents in online co-design methods, illustrating the use of a range of virtual tools to enable active participation. Below, the benefits and challenges encountered while conducting online co-design are discussed.

As mentioned earlier in section 7.1, early adolescents can be a difficult demographic to recruit, and conducting online studies expanded our potential pool. We were able to include diverse perspectives by including international participants, which would not be possible with only local

recruitment. The online setting also made scheduling the individual study sessions more flexible, since caregivers did not have to commute to our lab to let their children attend the study.

Our study involved international participants from seven different countries, demonstrating the potential for online co-design to bring global perspectives into the design process. However, when submitting our work for peer review, some reviewers expressed concerns that involving international participants in a focused investigation might introduce too much diversity to contextualize the findings with a small sample size. This raises a broader question in co-design: Is it more effective to incorporate diverse perspectives in a single study or conduct multiple smaller studies tailored to specific populations? In the case of our online co-design study, the differences in participants' perspectives owing to geography were subtle enough that we were not able to detect them with our study methods. While it is possible that with our domain of investigation, variability in family dynamics in our participant pool dominated the cultural and geographical factors, the question remains on how to balance the inclusion of diverse perspectives with the depth of analysis required to understand the specific needs of a population.

Conducting the studies online introduced some challenges, which included internet connection issues, participants being distracted by siblings, and technical difficulties setting up the study. Moreover, based on my previous experience of conducting co-design with children [36], I felt that building a rapport with our participants would have been easier in person. The overhead of managing multiple tools simultaneously to smoothly run a session and the Zoom fatigue of running multiple sessions in a day were also challenging. Additionally, using virtual tools to support typical physical co-design activities required responding to scrutiny from our institutional ethics board over secure storage policies, an issue that we did not face with physical prototyping. Since online co-design is now more common than in pre-pandemic times, more research is needed

to investigate how we can design an integrated set of virtual tools aimed to support a wide range of child-centric co-design activities while addressing privacy concerns regarding participant data.

Contributing to the study in an online setting did not seem that challenging for our early adolescent participants. They were comfortable interacting with virtual tools and engaged in co-design activities while providing high-quality contributions to the design process. However, tangible and interactive experiences with prototyping could have allowed participants to focus on the co-design activities, without being bothered by the additional technicalities of the virtual tools (e.g., Google Jamboard). Future research should explore ways to facilitate online co-design where early adolescent participants can have a similar experience to physical co-design activities to enable them to contribute even more to the design process.

7.4. Breadth vs. Depth Approach in Designing Digital Interventions

This thesis presents a range of strategies for investigating the design of digital interventions, where we adopted a breadth-over-depth approach rather than focusing on creating a single solution. We explored a wide array of potential ideas, incorporating perspectives from both early adolescents and parents, gathered through our co-design (Chapter 3) and elicitation studies (Chapter 4). This process led to the creation of an early adolescent-centric design space, which we used to characterize existing research through a systematic literature review (Chapter 5) and examine current parental control applications through an app analysis (Chapter 6). Together, the findings from these studies can be further utilized to guide the development of diverse new solutions. While an alternative approach could involve thoroughly investigating the effectiveness of certain tech disengagement strategies for early adolescents through implemented and tested solutions, there are several challenges to consider.

Despite the availability of numerous parental control apps, tech overuse remains a concern among early adolescents as most apps fail to effectively address this issue. Our app analysis of 47 parental control apps revealed that many focus on restrictive approaches instead of fostering self-regulation and fail to align with our target users' needs or support the researchers' recommendations from our systematic review. Focusing on developing a single intervention without an in-depth exploration of the design space, users' needs, and existing solutions could have just added another tool to the already existing solutions, with the risk that the chosen approach for the intervention might ultimately fail, leading to wasted resources and time. Instead, our approach considers a broader space of ideas, exploring multiple strategies that offer different points of view, rather than focusing on just one. This can guide future designers by presenting a range of potential interventions to explore. However, the trade-off is that this approach does not investigate the deployment and actual use of these solutions.

A more focused approach might involve developing and evaluating a complete prototype for one intervention, potentially with a few variants of the same approach to test different elements. However, given time and resource constraints during a PhD, it would not be practical to develop and deploy contrasting and mature apps for multiple strategies. By contrast, our elicitation studies explored three contrasting design ideas and solicited user feedback on different design aspects, offering insights into parent-child perspectives within the design space. These findings also highlighted that a single approach may not work for all families, as family structures and needs vary widely. This underscores the importance of considering multiple strategies that can be adapted according to diverse family needs.

To evaluate the effectiveness of a single approach, a longitudinal study would also be necessary to assess behavior change over time, but this has its own set of challenges: How do we

ensure participants are using the intervention effectively without regular reminders or persuasion, given that we want to promote self-motivated tech disengagement? How do we evaluate the long-term impact without weekly check-ins or enforced usage of the interventions? Additionally, the intervention has to be reliable and sophisticated enough for deployment and independent use by the participants. While our broad approach provides a foundation for designing early adolescent-centric digital interventions, highlighting varying needs and parent-child perspectives, a more focused, long-term research might be necessary to understand how to implement and evaluate these interventions effectively in diverse family contexts.

7.5. Summary

This chapter reflects on the studies conducted in this thesis, highlighting key observations and challenges. It discusses the difficulties encountered while recruiting early adolescent participants for studies regarding technology disengagement and also reflects on the insights gained from conducting such studies with only early adolescents compared to paired with parents. Additionally, this chapter shares experiences and lessons learned from engaging early adolescents in online co-design for developing tech disengagement solutions, addressing both the challenges and the opportunities in these contexts. Finally, it discusses the adoption of a breadth-over-depth approach to exploring digital interventions in this thesis.

Chapter 8

Conclusion

Children's excessive use of technology remains a significant challenge for many parents, especially with early adolescents, given their growing independence and resistance toward parent-set device restrictions. While numerous parental control solutions exist, many rely on restrictive measures rather than empowering early adolescents to self-regulate their digital habits. Given the unique developmental stage of this demographic, there is a pressing need for interventions that align with their needs and expectations rather than solely enforcing rules and restrictions. This thesis addressed this need by exploring how to design digital interventions aiming to support early adolescents in limiting their tech overuse.

To better understand early adolescents' conceptualization of the problem of tech overuse and their perceived solutions, we directly engaged them in the co-design of digital interventions. Building upon the findings from our co-design study, we defined and explored an early adolescents-centric design space. Through an elicitation study, we incorporated insights from both early adolescents and their parents to pinpoint the alignment and differences between both groups' viewpoints within this design space. Using this design space as a framework, we then explored existing digital solutions through a systematic review and app analysis to identify any divergences from parent-child preferences within our proposed design space and highlight potential gaps that require more attention. Through this research, we contribute a comprehensive understanding of an early adolescents-oriented design space for digital solutions and provide grounded recommendations for designing interventions that foster healthy tech usage among early adolescents, based on the perspectives of our primary user groups. This chapter summarizes our key contributions, followed by a discussion of the limitations of this thesis and promising future research avenues.

8.1. Thesis Contributions

This thesis makes empirical, methodological, theoretical, artifact, and survey contributions to the fields of child-computer interaction (CCI) and digital intervention research as described below.

8.1.1. Contributions to CCI Research on Early Adolescent Tech Overuse

Our co-design study in Chapter 3 contributes new empirical insights into early adolescents' conceptualization of tech overuse and their vision for appropriate digital interventions to promote disengagement—a topic underexplored in prior literature. Our findings also contribute key design

considerations from the perspectives of early adolescents, such as balancing their autonomy with parental involvement, incorporating positive reinforcement, and including relatable messaging. These findings shed light on the specific needs and preferences of early adolescents regarding tackling tech overuse.

In Chapter 4, by involving both parents and early adolescent participants in an elicitation study, we contribute empirical insights into their perspectives on tech overuse and mediation strategies, along with highlighting areas of alignment and differences. For instance, both groups favored granting early adolescents' agency, while also recognizing the necessity for parental control for those with low self-motivation to reduce tech use. However, opinions differed regarding mentorship approaches; most parents gravitated toward a parent-based approach, while early adolescents' preferences varied.

This thesis also offers methodological contributions [209] for engaging early adolescents in HCI research through co-design. The study methods used in Chapter 3 can be particularly useful to the CCI research community, especially for researchers seeking to involve this demographic in research studies. Our adaptation of co-design techniques (e.g., collaborative story creation, brainstorming, sketching) effectively encouraged active participation, despite the challenge of motivating this age group in research [64]. These methods fostered collaboration and generated high-quality contributions to intervention design for tech disengagement—an area that can be challenging given early adolescents' increased technology use [103].

Together, these two studies provide important design considerations grounded in the insights of our target users, offering valuable direction for HCI researchers aiming to design effective and sustainable solutions addressing tech overuse.

8.1.2. Contributions to the Domain of Digital Intervention Design Research

Our investigation into the domain of digital interventions primarily contributes an early adolescent-centric design space for addressing tech overuse. Chapter 4 details our approach to formulating this design space using a "Research through Design" method, outlining four key design dimensions: early adolescents' agency, supportive parental engagement, motivation type, and mentorship approaches. This design space can be utilized as a framework by designers to systematically explore intervention strategies tailored to specific design challenges, representing a theoretical contribution according to Wobbrock and Kientz [209]. To illustrate its application, we also contribute three contrastive design concepts implemented as video prototypes. These prototypes demonstrated how different combinations of these dimensions can inform alternative solutions, serving as artifact contributions [209] to the field.

Beyond these theoretical and artifact contributions from Chapter 4, our systematic literature review (Chapter 5) and app analysis (Chapter 6) contribute a structured synthesis of existing research and applications, exposing key trends and gaps in digital interventions for early adolescents, as found in survey contributions [209]. By characterizing prior relevant literature, the review identified 14 key design mechanisms that align with existing data on our target users' preferences, while the app analysis revealed a misalignment between existing interventions and parent-child needs, highlighting a gap in user-centered design. Although our analyses are based on a curated sample rather than an exhaustive survey, our findings provide a structured understanding of the current landscape of tech disengagement solutions along with identifying what makes digital interventions effective and acceptable for early adolescents. By combining a systematic review of academic literature with an analysis of a sample of available parental control applications, this

thesis identifies underexplored areas within the design space of early adolescent-centric interventions. These insights can be leveraged by HCI researchers and practitioners in developing more effective and user-centered solutions.

8.2. Thesis Limitations

In this section, we acknowledge key limitations of this thesis, including sampling bias in participant demographics, potential limits of the proposed design space, and constraints in evaluating the effectiveness of our design strategies.

8.2.1. Sampling Bias in Participant Demographics

While this thesis addresses tech overuse, which inherently involves participants with frequent tech usage, conducting the user studies online may have introduced some sampling bias. In our online elicitation study, participants' background information revealed that most participants came from relatively high socio-economic backgrounds. While we did not specifically record socio-economic data in the co-design study, the recruitment strategy was similar to the elicitation study, and this study was also conducted online. This suggests that our sample may have underrepresented participants from lower socio-economic backgrounds, especially those in underdeveloped regions with limited or shared internet and device access. These participants might have a different perception of tech overuse, appropriate intervention, and parental mediation strategies from those captured in our studies. Hence, further investigation is required to assess the generalizability of our findings to broader socio-economic groups.

8.2.2. Potential Limitations of Our Proposed Design Space

While using our initial early adolescent-centric design space as a tool for analyzing existing solutions (Chapter 5 & 6), we identified some nuances that our existing design dimensions might not fully articulate. For instance, while the design dimension "mentorship approaches" currently covers a spectrum between parental and peer-based mentorship (see section 4.1.1), researchers also recommend community-based mentoring from experts and other families with similar lifestyles. Future research should further refine this design space by incorporating additional dimensions that explore these types of complex aspects of tech disengagement. Investigating the multidimensional relationships within an expanded design space could lead to more innovative, user-centered solutions that address the unique needs of target demographics.

8.2.3. Limitation in Evaluating the Effectiveness of Our Design Strategies

As discussed in section 7.4, in this thesis, we opted for a breadth-over-depth approach by exploring a broad range of design solutions rather than focusing on implementing and evaluating a single intervention. While this approach provided us with a comprehensive understanding of potential strategies, it does not assess the long-term effectiveness of any specific intervention strategy in promoting positive behavior change regarding early adolescents' tech use.

Behavior change is a long-term process that requires investigation over several months or years. A longitudinal study with a deployable prototype could reveal which design factors encourage early adolescents to gradually disengage from technology overuse. Such studies could also explore whether users' sentiments shift across the design dimensions after real-world implementation and usage of the design insights from this thesis. For instance, while some of our

study participants advocated for peer-based mentorship, peer pressure or negative feedback could have harmful consequences. Similarly, although many participants wanted to empower early adolescents with greater agency, practical experience may reveal challenges in their self-regulation capabilities. Therefore, future work should examine the generalizability of our findings by evaluating the long-term effectiveness of digital interventions and assessing behavior change in early adolescents' tech use through a longitudinal study.

8.3. Future Research Directions

In this section, we highlight promising directions for future research, including interventions for early adolescents with technology addiction, promoting purposeful tech use, applying our findings to other domains, integrating end-user development to address diverse needs, and a long-term vision for developing interventions that are responsive to early adolescents' needs and support their digital well-being.

8.3.1. Exploring Digital Interventions for Early Adolescents with Technology Addiction

While this thesis focuses on disengagement from technology overuse, it does not specifically target early adolescents struggling with digital addiction. Our proposed design space (Chapter 4) includes aspects that may foster self-regulation abilities for managing tech use, which could be beneficial for those experiencing tech dependency. However, these elements might not be suitable for early adolescents with addiction, who are often unable to regulate their behavior [111] and may require more targeted and intensive interventions to guide their tech usage behavior. Future work should explore the extent to which our findings might be applicable to this group.

Exclusively recruiting participants with tech addiction could be challenging as being labeled as "tech-addicted" could be stigmatizing. Participants might feel judged, leading to biased responses and reluctance to participate. Further research is needed to identify the design needs of this group, who are in a stronger need of effective interventions to battle against addiction. For instance, designing assistive technologies that involve parents, educational institutes, and expert therapists together in the disengagement process might be beneficial for dealing with tech addiction [9].

8.3.2. Promoting Purposeful Tech Use

This thesis focuses on exploring the design space of digital interventions aimed at supporting early adolescents' self-regulation of tech use. A complementary approach to fostering healthy tech habits is promoting purposeful technology use, by encouraging children to have positive and specific intentions to mindfully engage with technology [99,107]. This aspect, however, was not a focus of this thesis, and as a result, our systematic review did not include this literature. Therefore, future systematic reviews could include this literature to offer a broader perspective.

While we did not specifically focus on fostering mindfulness related to purposeful use of technology [99,107], our design concepts do include some elements that could potentially be applicable to the context of intentional tech use. These include features like self-monitoring and reflection, which are known to enhance mindfulness [23]. Further exploration could investigate the suitability of our identified design dimensions in outlining a design space for interventions that promote intentional and purposeful tech usage, with "agency" being a potential dimension applicable to this domain.

8.3.3. Applicability of Our Findings to Other Domains

While this thesis is primarily centred on technology disengagement, there are other domains where our findings might be applicable. For example, research on interventions for online safety has found that most solutions are parent-focused and often disregard children's needs and expectations [80]. Future studies could explore whether our proposed early adolescent-centric design space (Chapter 4) can be a starting point to design more child-oriented online safety solutions catering to their needs.

Our adaptation of co-design methods (Chapter 3) can potentially be utilized to engage early adolescents in studies on complex or less intrinsically motivating research topics. For instance, participants may be reluctant about discussing sensitive issues such as addiction, mental health, bullying, etc. Future studies can investigate whether the co-design techniques can encourage active participation in these challenging domains as well.

8.3.4. Addressing Diverse Needs by Integrating End-User Development into Digital Interventions

Our findings underscored the importance of addressing early adolescents' varied individual characteristics and the diverse needs of families, indicating that a one-fits-all solution may not be suitable (Chapter 4). Instead, enabling users to modify and adapt the tools according to their individual differences and evolving needs could prove beneficial. This aligns with research in End-User Development (EUD), which empowers non-technical users to modify systems through a set of activities to better fit their requirements. These modifications can include customizing existing functionality, integrating external features, and adding new user-created features [212]. Since

anticipating every user need might not be possible during initial development, EUD allows users to own their problems and adapt systems as non-professional developers according to their evolving needs [45].

Our formative design activities empowered early adolescents to contribute responsible design ideas that speak to their requirements and expectations (Chapter 3 & 4). This involvement, however, is crucial not only at the *design time* but also at the *use time* to accommodate their evolving needs [62]. This is especially important for this demographic, as they undergo significant developmental changes in thinking patterns, self-concept, and motivation during the transition to adolescence [202]. Furthermore, parents may have varied needs in different situational contexts that may not be apparent during the initial design phases. To address these diverse needs, providing a variety of features and hybrid options combining different strategies could be beneficial. Adjustable settings that cater to early adolescents' needs and parental comfort levels could enhance the intervention's effectiveness. On the other hand, providing numerous setting options might be overwhelming, especially for non-tech-savvy users. Therefore, exploring an appropriate tailoring approach that empowers end users to adapt the intervention without overwhelming them with complexity [39], might be an important future research direction, necessary to ensure effective and consistent use of the intervention.

One potential solution is a persona-based customization approach, where early adolescents and parents can collaboratively tailor interventions using predefined but flexible user personas. Personas are realistic representations with fictitious details of real-world users, commonly used in user-interface design [201,215]. This approach could help facilitate EUD activities to support the continuous adaptation of interventions to meet evolving user needs. Future work should explore how presenting users with a range of relatable and diverse personas for both end-user groups might

enhance the adaptability and effectiveness of tech disengagement interventions, potentially through a long-term study with an implemented prototype.

8.3.5. Long Term Vision

This thesis has demonstrated the value of engaging early adolescents in the design of interventions while also highlighting gaps in existing research and the availability of interventions that meet their needs. Ultimately, our work contributes to the development of digital solutions that promote self-regulation of technology overuse, tailored to the unique needs of this demographic. We hope that future research will continue to incorporate the voices of early adolescents, leading to effective and appropriate interventions that better support their digital well-being.

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Appendices

Appendix A: Co-Design Study Additional Material

A.1 Research Ethics Board Approval

University of Manitoba | Research Ethics and Compliance

Human Ethics - Fort Garry
208-194 Dafoe Road
Winnipeg, MB R3T 2N2
T: 204 474 8872
humanethics@umanitoba.ca

PROTOCOL APPROVAL

Effective: February 23, 2022 Expiry: February 22, 2023

Principal Investigator: Andrea Bunt
Protocol Number: HE2022-0008
Protocol Title: *Designing a tech-based mediation strategy to help children disengage from overuse of technology*

Andrea L Szwajcer, Chair, REB2

Research Ethics Board 2 has reviewed and approved the above research. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*- TCPS 2 (2018).

This approval is subject to the following conditions:

i. Approval is granted for the research and purposes described in the protocol only.

ii. Any changes to the protocol or research materials must be approved by the HEO before implementation.

iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.

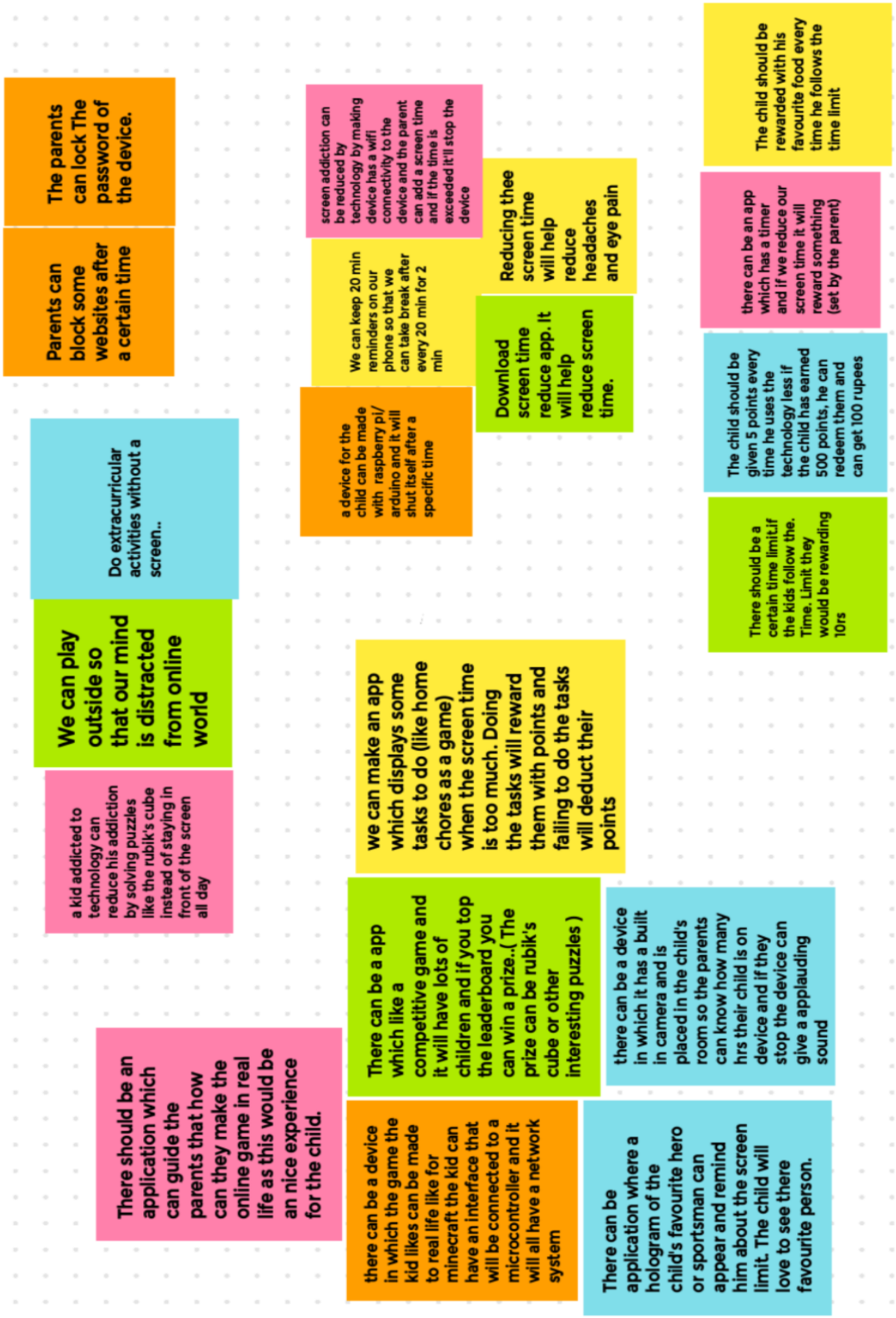
iv. This approval is valid for one year only. A Renewal Request must be submitted and approved prior to the above expiry date.

v. A Protocol Closure must be submitted to the HEO when the research is complete or if the research is terminated.

vi. The University of Manitoba may request to audit your research documentation to confirm compliance with this approved protocol, and with the UM *Ethics of Research Involving Humans*Ethics of Research Involving Humans policies and procedures.

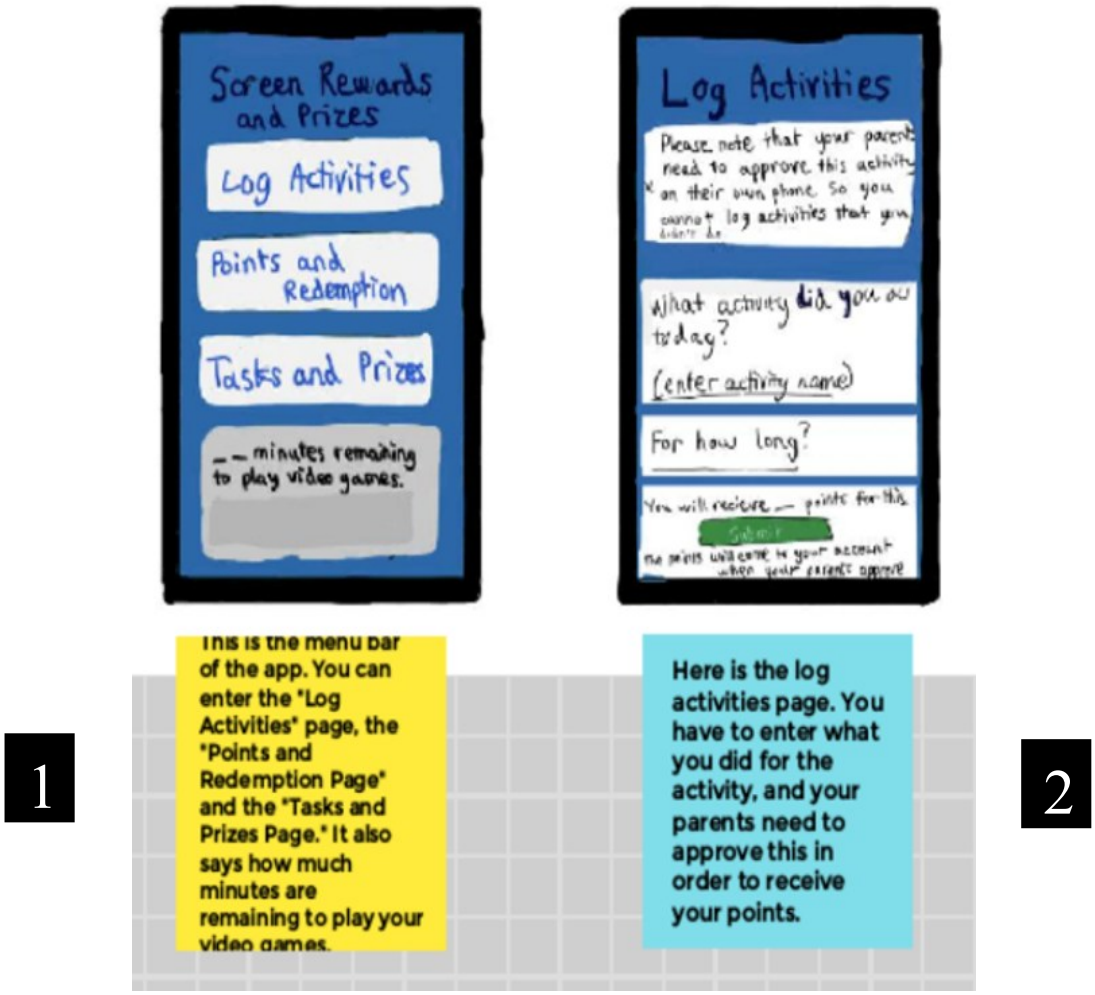
A.2 Enlarged Screenshot of Figure 3

Ideas Generated by Group 2 during the Brainstorming Session



A.3 Enlarged Screenshot of Figure 4

Following are screenshots of the final design sketch by Group 5 (G5). This is an app that will reward the children with screen time if they complete the tasks chosen by their parents. Children can suggest tasks that they are interested in doing. Parents will evaluate the performance before approving the rewards. There is a leaderboard that inspires friendly competition among friends and family members.



3

There will be a limit on how many points you can get so you cant play excessively for a long time.

By default, the weekdays you can have a cap of 90 points at max. On the weekends, you can have a cap of 120 points at max. Your parents can always change the sketch at any time.

Parents will give you tasks to do. They can choose the task and choose the reward of points from each task. The task will be mostly based off of your recommendations and your favourite hobbies.

4

5

The child can choose his hobbies and the challenges will be based off his favourite topics and hobbies. The child can also make recommendations of what they like to do.

They will know that they have to do it, so there's really no point into not making recommendations, or else it will be even more boring.

6

You can connect your accounts to your family and friends to see how many tasks they've done. This can be an inspiration and a friendly competition, making you more active.

A.4 Pre-Study Survey

1. Which devices do you use at home?

- [ ] Desktop
- [ ] Laptop
- [ ] Tablet
- [ ] Smartphone
- [ ] Gaming Console
- [ ] Television
- [ ] Other

2. Which devices do you own?

- [ ] Desktop
- [ ] Laptop
- [ ] Tablet
- [ ] Smartphone
- [ ] Gaming Console
- [ ] Television
- [ ] Other

3. How much time do you spend with your devices daily?

4. Do your parents have any rules for your device usage?

- ◯ Yes
- ◯ No

5. Do you follow these rules?

- ◯ Yes
- ◯ No
- ◯ Sometimes

A.5 Semi-Structured Interview Questions

Preliminary Focus Group Interview Questions (Semi-structured)

- What rules do your parents have for your device usage?
- Do you and your parents have different thoughts about the rules?
    - What do you think about the rules?
- Do you follow these rules?
    - How often do you break them?
    - What happens when you break the rules?
    - Why do you think you find it hard to follow the rules?
- If you were in charge, would you create any rules for your device use?
    - What would these rules be?
- Would you like to find a solution that can help you follow the rules more easily?

Post-study Focus Group Interview Questions (Semi-structured)

- Can you describe your sketch?
- How do you think this is going to help children to follow the rules?
- Is there anything in this solution that you think may not be helpful enough?
- Would you like to use this solution for yourself? Do you think it will help you follow the rules easily?
- What do you think your parents will feel about this solution?

Appendix B: Elicitation Study Additional Material

B.1 Research Ethics Board Approval

Human Ethics - Fort Garry
208-194 Dafoe Road
Winnipeg, MB R3T 2N2
T: 204 474 8872
humanethics@umanitoba.ca

AMENDMENT APPROVAL

July 4, 2023

Principal Investigator:	Andrea Bunt
Protocol Number:	HE2022-0008
Protocol Title:	*Designing a tech-based mediation strategy to help children disengage from overuse of technology*

Human Ethics Office as designated by , REB2

Research Ethics Board 2 has reviewed and approved your Amendment Request submitted on July 4, 2023 to the above-noted protocol. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*- TCPS 2 (2022).

This approval is subject to the following conditions:

i. Approval is granted for this amendment only.

ii. Any further changes to the protocol require subsequent amendment approvals from the HEO before implementation.

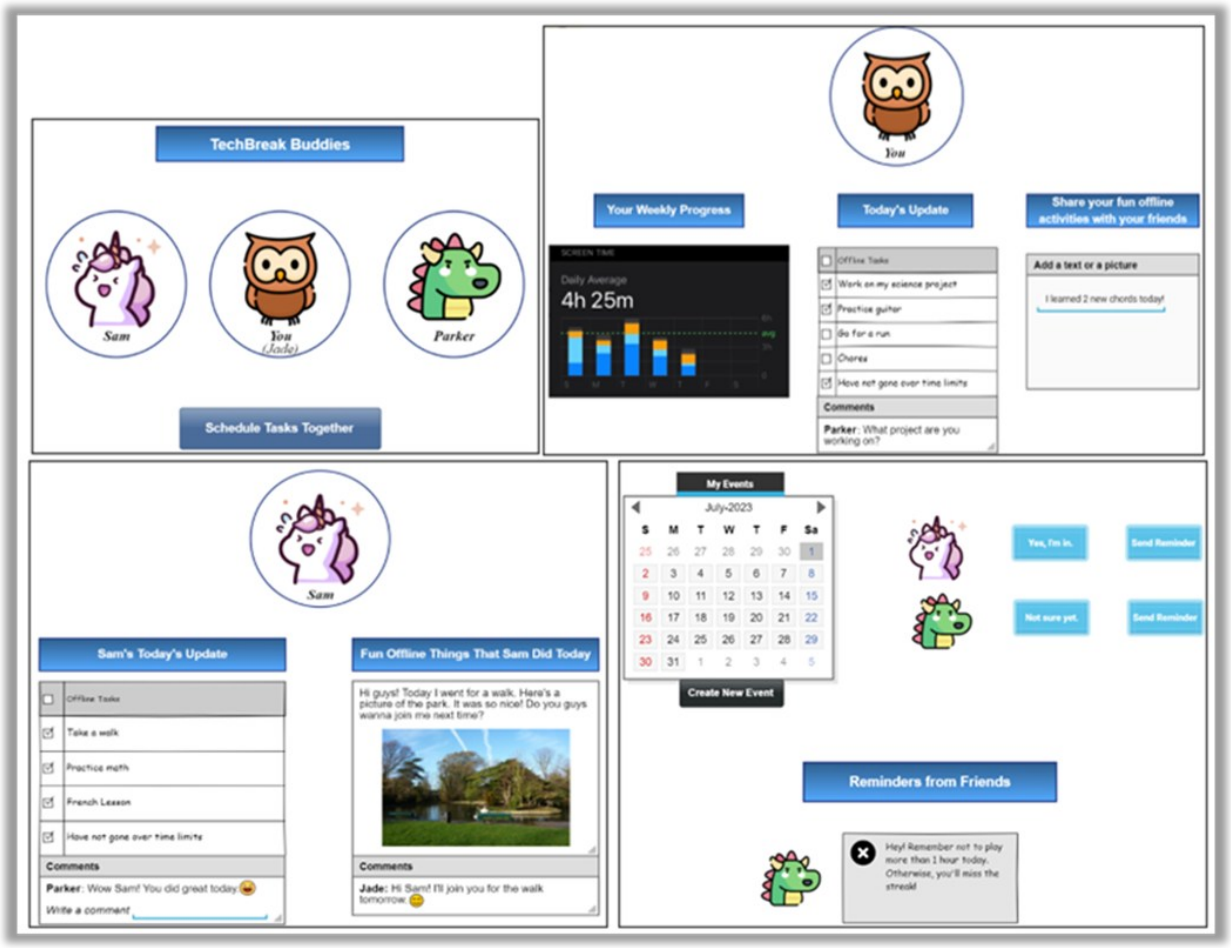
iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.

iv. Amendment Approvals do not change the protocol expiry date. Please refer to the original Protocol Approval or subsequent Renewal Approvals for the protocol expiry date.

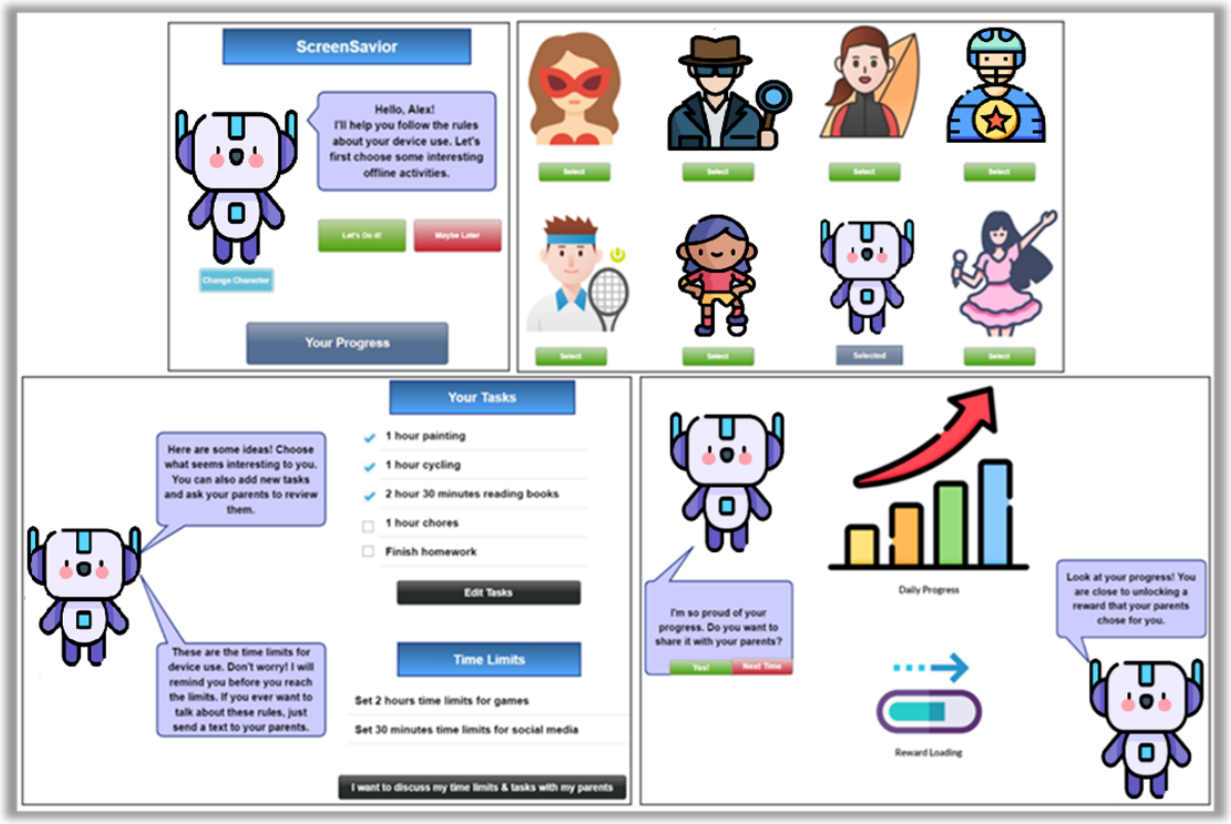
B.2 Prototype Screenshots Including All Features

B.2.1 Parent-Child Unplug

B.2.2 TechBreak Buddies



B.2.3 ScreenSavior



B.3 Background and Tech Usage Surveys

B.3.1 Background Survey for Parent Participants

1. What is your relationship with the child participant?

- ◯ Mother/Stepmother
- ◯ Father/Stepfather
- ◯ Non-binary / Gender-nonconforming parent
- ◯ Other

2. Are you a single parent?

- ◯ Yes
- ◯ No

3. What is your nationality?

4. Which gender do you identify as?

- ◯ Woman
- ◯ Man
- ◯ Non-binary
- ◯ Prefer not to say
- ◯ Other

5. Which of the following best describes you? (Select all that apply)

- ☐ Black (e.g., African, Afro-Caribbean, African-Canadian descent)
- ☐ East Asian (e.g., Chinese, Korean, Japanese, Taiwanese descent)
- ☐ Latino (e.g., Latin American, Hispanic descent)
- ☐ Middle Eastern (Arab, Persian, West Asian descent, e.g. Afghan, Egyptian, Iranian, etc.)
- ☐ South Asian (e.g., East Indian, Pakistani, Sri Lankan, Indo-Caribbean)
- ☐ Southeast Asian (e.g., Vietnamese, Cambodian, Laotian, Thai, Filipino)

6. What is your marital status?

- ◯ Married
- ◯ Living common-law
- ◯ Separated
- ◯ Widowed
- ◯ Divorced
- ◯ Single

7. What is your highest educational attainment?

- ◯ Primary
- ◯ Middle school
- ◯ High school
- ◯ Bachelor
- ◯ Master
- ◯ PhD

8. What is your employment status?

- ◯ Full-time
- ◯ Part-time
- ◯ Stay-at-home
- ◯ Not working
- ◯ Student
- ◯ Retired

9. What is the range of your household Income?

- ◯ Less than $30k
- ◯ $30 - $49k
- ◯ $50 - $75k
- ◯ More than $75k

10. What is your child's age?

- ◯ 11
- ◯ 12
- ◯ 13
- ◯ 14

B.3.2 Tech Usage Survey for Parent Participants

1. Which devices does your family own?

- [ ] Television
- [ ] Computer
- [ ] Tablet
- [ ] Video game console
- [ ] Smartphone with internet access
- [ ] VR devices (such as Samsung Gear VR and Oculus)
- [ ] Wearable devices (such as smartwatches and fitness trackers)
- [ ] Personal assistants (such as Alexa and Google Home)
- [ ] Other

2. Which devices does your child own?

- [ ] Television
- [ ] Computer
- [ ] Tablet
- [ ] Video game console
- [ ] Smartphone with internet access
- [ ] VR devices (such as Samsung Gear VR and Oculus)
- [ ] Wearable devices (such as smartwatches and fitness trackers)
- [ ] Personal assistants (such as Alexa and Google Home)
- [ ] Other

3. Which devices does your child have access to in the bedroom?

- [ ] Television
- [ ] Computer
- [ ] Tablet
- [ ] Video game console
- [ ] Smartphone with internet access
- [ ] VR devices (such as Samsung Gear VR and Oculus)
- [ ] Wearable devices (such as smartwatches and fitness trackers)
- [ ] Personal assistants (such as Alexa and Google Home)
- [ ] Other

4. At which age did your child own a smartphone?

- ◯ Less than 11 years
- ◯ 11-12 years
- ◯ 13-14 years
- ◯ Does not own a smartphone

5. Household rules for using digital devices:

- [ ] My house has no rules or boundaries for device use.
- [ ] My house has rules about time limits for different device usage.
- [ ] My house has rules about "screen-free zones" (rooms or places in the house, such as a bedroom) where no one is allowed to use screens, including televisions, computers, and smartphones.
- [ ] My house has rules about screen-free times (times when no one is allowed to use media, such as dinnertime) when no one is allowed to use screens, including televisions, computers, and smartphones.
- [ ] My house has rules about viewing screens around bedtime.
- [ ] Other

6. Do you have internet content rules for your child?

- ◯ Strict internet content rules
- ◯ Not strict internet content rules

7. How often does your child break the household rules for device usage?

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Seasonal
- ◯ Yearly
- ◯ Never
- ◯ We don't have such rules

8. How often do you have conflict with your child regarding their technology use?

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Seasonal
- ◯ Yearly
- ◯ Never

B.3.3 Tech Usage Survey for Early Adolescent Participants

1. Which devices does your family own?

- [ ] Television
- [ ] Computer
- [ ] Tablet
- [ ] Video game console
- [ ] Smartphone with internet access
- [ ] VR devices (such as Samsung Gear VR and Oculus)
- [ ] Wearable devices (such as smartwatches and fitness trackers)
- [ ] Personal assistants (such as Alexa and Google Home)
- [ ] Other

2. Which devices do you own?

- [ ] Television
- [ ] Computer
- [ ] Tablet
- [ ] Video game console
- [ ] Smartphone with internet access
- [ ] VR devices (such as Samsung Gear VR and Oculus)
- [ ] Wearable devices (such as smartwatches and fitness trackers)
- [ ] Personal assistants (such as Alexa and Google Home)
- [ ] Other

3. Which devices do you have access to in the bedroom?

- [ ] Television
- [ ] Computer
- [ ] Tablet
- [ ] Video game console
- [ ] Smartphone with internet access
- [ ] VR devices (such as Samsung Gear VR and Oculus)
- [ ] Wearable devices (such as smartwatches and fitness trackers)
- [ ] Personal assistants (such as Alexa and Google Home)
- [ ] Other

4. At which age did you own a smartphone?

- ◯ Less than 11 years
- ◯ 11-12 years
- ◯ 13-14 years
- ◯ Does not own a smartphone

5. Household rules for using digital devices:

- [ ] My house has no rules or boundaries for device use.
- [ ] My house has rules about time limits for different device usage.
- [ ] My house has rules about "screen-free zones" (rooms or places in the house, such as a bedroom) where no one is allowed to use screens, including televisions, computers, and smartphones.
- [ ] My house has rules about screen-free times (times when no one is allowed to use media, such as dinnertime) when no one is allowed to use screens, including televisions, computers, and smartphones.
- [ ] My house has rules about viewing screens around bedtime.
- [ ] Other

6. Does your parents have internet content rules for you?

- ◯ Strict internet content rules
- ◯ Not strict internet content rules

7. How often do you break the household rules for device usage?

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Seasonal
- ◯ Yearly
- ◯ Never
- ◯ We don't have such rules

8. How often do you have conflict with your parents regarding your technology use?

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Seasonal
- ◯ Yearly
- ◯ Never

B.4 Focus Group Interview Questions (Semi-structured)

- **After demonstrating each prototype:**

1. Can you tell me about a time where you think this prototype could be useful?
2. Can you tell me about a time where you think this prototype would not work?
3. What did you like most about the prototype? Why?
4. What did you not like about the prototype? Why? How would you like to change it?
5. More questions specific to the prototype, e.g.,
    a. Do you think your friends would be able to help you limit your device use? Why? (to child) [peer-oriented prototype]
    b. What do you think about being able to see each other's tech usage? [parent-oriented prototype]
    c. How would you feel about being reminded to stop based on rules that you both agreed upon?

- **After demonstrating all the prototypes:**

1. Can you tell me more about your preferences? Why did you like this prototype more than the other two? Why did you like this one the least?
2. Would you use any of these prototypes? Why / Why not?
3. Why do you think they (child/parent) preferred this one the most?

Appendix C: App Analysis Additional Material

C.1 Codebook

Feature Sub-Categories	Parent Feature ID	Final Codes	Initial Coding of Individual Parents' Features	Individual Parents' Features Identified
				Device Limits
	PF1	DEVICE-LIMIT	DEVICE-LIMIT-TIMER	Set device limit as a timer for each time device is being used. Mostly when there's 1 device that parents let kids use with settings.
			DEVICE-LIMIT-DAILY	Set a daily device limit
Time Limits			DEVICE-LIMIT-WEEKLY	Set a daily device limit for each day of the week
	PF2	CHANGE-DEVICE-LIMIT	DEVICE-LIMIT-EXCEP	Set different limits for weekends/weekdays/vacation
			DEVICE-LIMIT-EXTENS	Can add bonus time
			DEVICE-LIMIT-REDUCE	Can reduce device time (e.g., decrese available time by 5 mins/1 hr)
	PF3	DEVICE-BLOCK/UNBLOCK	DEVICE-BLOCK/UNBLOCK	Can pause/block/unblock anytime
	PF4	DEVICE-NO-LIMIT-MODE	DEVICE-NO-LIMIT-MODE	parent can apply unlimited device use/freetime for a certain period, when there's no rule. Kid has their own choices to do
				App Limits
	PF5	APP-LIMIT	APP-LIMIT-CATEGORY	Set limits for learning apps vs other apps
			APP-LIMIT-INDIV	Set limits for specific apps
				Plan Offline Time/Tasks
	PF6	SET-OFFLINE/LEARNING-TASKS	SET-TASKS-OFFLINE	Choose and schedule offline tasks/chores/classes/learning apps/challenges from recommended lists or custom/ weekly tasks, no fixed time
			SET-TIME-REWARD-TASK	Set time for learning/offline tasks to earn rewards (duration not schedule)
		SCHEDULE-DOWNTIME	SCHEDULE-SESSION-NO-INTERNET	Set schedule with no internet
Planning	PF7		SCHEDULE-OFFLINE-SESSIONS	Routines for offline tasks (bedtime/homework), scheduling offline period. Schedule downtime (e.g., all apps blocked or nothing/lock down/paused device)
				Plan Device Time
		SCHEDULE-DEVICETIME	SCHEDULE-SESSION-APPS	Set schedule (selecting allowed/blocked apps for studying/focus time/screentime) per day/week
	PF8		SCHEDULE-SESSION-APP-INTV	Set schedule with apps allowed and intervals in between
Communication/Support				**Requesting Time Extension**
		REQ-APPR/DENY	DEVICE-LIMIT-EXTENS-APPR/DENY	approve or deny request for bonus time (by themselves/if asked via app/in-person)
			RESPONSE-EXTENS-REQ-DFLT	Accept/reject request
	PF9		APP-LIMIT-EXTENSS-APPR/DENY	Can add bonus time for an app (if asked via app/in-person)
			CONTENT-ACCESS-APPR/DENY	Allow limited time access to a blocked app/site
	PF10	RESPONSE-MSG-CUST	RESPONSE-MSG-CUST	Accept/reject with a custom message
				Messaging
	PF11	MESSAGING	IN-APP-CHAT	Send and receive messages
			IN-APP-CHAT-PROMPTS	there are stickers, and prompts as well to facilitate communication
	PF12	REASON-BLOCK/RULE	INSTANT-DEVICE-BLOCK-MSG / RULE-DETAILS	Apply quick block on the device/ device shutoff with a text stating the reason/assigning a task
				Parent-Set Reminders
	PF13	SET-REMINDERS	SET-REMINDERS	Create reminders for events for both the child & parent or just the child. both can get notifications
			RING-ALARMS-REMINDERS	Parents can send a loud alarm/ring the device to kids' phones even in silent mode
	PF14	ASK-REASON-REQ		App encourages parents to ask kid for more info about their request, e.g., app access, what app, why

Feature Sub-Categories	Children Feature ID	Final Codes	Initial Coding of Individual Children's Features	Individual Children's Features Identified
				Device Limits
			APP-LIMIT-EXTENS-REQ	Can request for extra time for an app (once/if request denied not until 30 mins)
Time Limits	EF1	CHANGE-LIMIT-REQUEST	DEVICE-LIMIT-EXTENS-REQ	Can request for extra time (once/ if request denied not until 30 mins)
			REQ-DFLT-MSG	Send a default message for the request
	EF2	LIMIT-SELF-REGULATE-MENTOR	LIMIT-SELF-REGULATE-MENTOR	virtual mentor encourages to self-regulate before limit (the character asks for a leaf before 25 secs & shows they are tired. if the child gives the leaf, its happy annd asleep. if they want to spend more time it wakes up and cries.
				Plan Offline Time/Tasks
Planning	EF3	SET-TASKS-OWN	SET-TASKS-OWN	Choose offline tasks/chores/classes/challenges from a default recommended list
	EF4	SET-TASKS-PARENTS	SET-TASKS-PARENTS	Choose offline tasks/chores/classes/challenges from parent-selected weekly tasks
	EF5	SET-TASK-REQ	SET-TASK-REQ	can request parents for setting more tasks to earn more time/reward
Communication/Support				
				Requesting Time Extension
	EF6	REQ-CUST-MSG	REQ-CUST-MSG	Send custom message for the request
	EF7	REQ-OFFLINE-NEGOTIATE	REQ-OFFLINE-NEGOTIATE	Prompts the kids to ask in-person if the request is denied/limit exceeded & no in-app support
	EF8	MODE-CHANGE-REQ	MODE-CHANGE-REQ	Request for chaning the mode of restriction/changing a rule
	EF9	CONTENT-ACCESS-REQ	CONTENT-ACCESS-REQ	Request for accessing a blocked app/site (once if request denied can't ask again)
				Messaging
			IN-APP-CHAT	Send and receive messages
	EF10	MESSAGING	IN-APP-FAMILY-CHAT	Group messenger with family if multiple devices are connected
			AUDIO-MSG	can record audio msg and send to the parent
			IN-APP-CHAT-PROMPTS	there are stickers, and prompts as well to facilitate communication
	EF11	MESSAGING-RCV-ONLY	IN-APP-CHAT-ONLY-RCV	Cannot send messages, only receive messages from parents
	EF12	AI-SUPPORT	AI-SUPPORT	an AI bot is there. if kid clicks on limits/schedule it shows the rules in the chat
	EF13	COMPLAIN-DEVELOPER	COMPLAIN-DEVELOPER	Kids can share their complaints about the app to the develpers

				Reward
Reward/Reinforcement	PF15	SET-TASK/LEARNING-REWARD-SCREEN	SET-LEARNING-REWARD	Decide learn vs earn ratio for earning screentime by learning something
			SET-TASK-REWARD-SCREEN	Assign tasks with reward as screen time / access to apps
	PF16	SET-TASK-REWARD-PTS	SET-TASK-REWARD-PTS	Assign tasks and set points for tasks
	PF17	SET-TASKS-BLOCKED		Assign tasks and block device access unless tasks are completed
	PF18	SET-GOALS-REAL-REWARDS	SET-GOALS-REAL-REWARDS	Specify rewards and how many stars needed to earn the reward
	PF19	APPROVE-TASK-REWARD	APPROVE-TASK-REWARD	Approve the task, by entering pin on the kid's device to award reward
	PF20	APPROVE-TASK-ENCOURAGE	APPROVE-TASK-ENCOURAGE	when approving a task parents can send encouraging texts. (e.g., but not when task rejected)
	PF21	REWARD-SCREEN-NO-GOAL	REWARD-SCREEN-NO-GOAL	parents can choose reward only mode so that the kid can't use screen if parents don't send rewrads but the app doesn't allow setting goal or tracking progress. So it's basically upto the parent when they wanna reward
	PF22	DISCARD-EARNED-TIME	DISCARD-EARNED-TIME	parents can discard earned time and block the device
				Competition
	PF23	COMPETITION-PARENT	COMPETITION-PARENT	competition with parents on tasks
Content Restriction		RESTRICT-APP-ACCESS	BLOCK-APPS-CATEGORY	Block certain app categories (always unaccessible)
			BLOCK-APPS-IND	Block certain apps - greyed out, won't open
			HIDE-APPS	Hide apps - not found on the device
	PF24		WHITELIST-APPS	Whitelist apps for all time access
			ENCOURAGED-APPS	Apps that can be used during a scheduled session, not count down the time (e.g., educational apps
			RESTRICTION-NEW-APPS	Automatically apply limits to newly installed apps
			NO-NEW-APP-INSTALLED	Set restriction that no new app can be installed
			NO-APP-UNINSTALLED	Set restriction that no new app can be removed/uninstalled
	PF25	RESTRICT-WEB-ACCESS	BLOCK-BROWSER/INTERNET	Block browsers/wifi/internet
			BLOCK-WEBSITES/CATEGORIES	Block certain websites, categories, search keywords, videos, adult content, social media sites etc./safe browsing
	PF26	INSTANT-DEVICE/APP-BLOCK	INSTANT-APP-BLOCK	Apply quick block on specific apps
			INSTANT-APP-BLOCK-RMV-REWARI	Pause all app access by discarding earned screentime
			INSTANT-DEVICE-BLOCK	Apply quick block on the device/ device shutoff/block all apps
			SET-DEVICE-BLOCK-DURATION	Apply quick block on the device/ device shutoff for a day/week
	PF27	RESTRICTED-PARENTAL-APP	RESTRICTION-PARENTAL-APP	Restrict from uninstalling/disabling the parental control app / changing setting (using pin)
			HIDE-PARENTAL-APP	Parental control app cannot be accessed by the kid (installed without their knowledge/hidden)

	EF14	EARN-SCREEN-LEARN/TASKS	EARN-APP-ACCESS-LEARN	Learn to earn limited access to the permitted entertainment/blocked apps (parents choose the learning /task apps)
			EARN-SCREEN-LEARN/TASKS	Has to earn screentime by answering questions/learning on tasks/educational apps (parent-chosen)
			STORE-EARNED-SCREEN	Unused screentime gets stored in a time bank, which can later be used if parents decide to schedule a
Reward/Reinforcement				
	EF15	EARN-PTS-OFFLINE-TASKS	EARN-PTS-OFFLINE-TASKS	Earn points for time spent on offline activities
	EF16	EARN-REAL-REWARDS	EARN-REAL-REWARDS	If kids earn points, they can get rewards that kids dreamt of/money/tv time
	EF17	SUBMIT-TASK-EVID	SUBMIT-TASK-EVID	child has to send a notification/photo about task completion to parents for approval
	EF18	REAL-REWARD-WISHLIST	REAL-REWARD-WISHLIST	Add what reward they want in a wishlist (e.g., kids can create dreams adding pictures of what they want)
	EF19	RCV-CERTIFICATES	RCV-CERTIFICATES	Receive certificates for paricipating in competitions
				Competition
	EF20	COMPETITION-PARENT	COMPETITION-PARENT	competition with parents on tasks/challenges
	EF21	COMPETITION-PEER	COMPETITION-PEER	leaderboards for competition (dance/class) with peers
				Motivating Character
	EF22	VIRTUAL-MENTOR-MOTIVATION	VIRTUAL-MENTOR-QUOTE	Animated relatable character that shows motivational quotes
			VIRTUAL-MENTOR-INTERAC	the character communicats with gestures and dialogues with a child-like voice to motivate behavior change (learn to stop watching if limit is up, fix posture)
	EF23	MOTIVATIONAL-QUOTE		Motivational reminder to earn points by doing tasks
Content Restriction	EF24	STOP-SUPERVISION-BLOCKED	STOP-SUPERVISION-BLOCKED	stop supervision, but it'll remove access from the device for 24 hours
	EF25	STOP-SUPERVISION-NEGOTIATE	STOP-SUPERVISION-NEGOTIATE	kids can turn on/off parents' monitoring features. If it's turned off, parents can't turn it on. Prompts to motivate parents to talk to the kid and reach an agreement.
	EF26	STOP-MONITORING	STOP-MONITORING	can stop parent's feature of monitoring app usage

				Overall Screen Usage Monitoring
Goal Advancement			SCREEN-USAGE-CUST-RANGE	See daily screen usage within a custom range
			SCREEN-USAGE-DAILY	See daily screen usage
			SCREEN-USAGE-HOURLY	See hourly screen usage
	PF28	TRACK-SCREEN-USAGE	SCREEN-USAGE-WEEKLY	See weekly screen usage
			SCREEN-USAGE-BI-WEEKLY	See bi-weekly screen usage
			SCREEN-USAGE-MONTHLY	See monthly screen usage/average monthly usage
			SCREEN-USAGE-COMPARE-KIDS	Compare kids' screen usage with kids of similar age range (feature didn't work)
				App/Internet Usage Monitoring
			APP-LOG	Individual app usage is recorded (daily/weekly/bi-weekly/monthly)
			CURRENT-ACTIVE-APP	Can see which app is active
	PF29	TRACK-APP-USAGE	MOST-USED-APPS	List the most used apps
			NEW-INSTALLED-APPS	List the newly installed apps
			LAST-USED-APP	Show the last-used apps
			APP-LAUNCHES/DEVICE-UNLOCKS	Can see apps launched, and number of unlocks
			SOCIAL-MEDIA-RECORDED	Social media use on apps are recorded (record calls, text, contacts, images, emails)
			BROWSING-RECORDED	Web & search history, social media uage, monitor & manage youtube are recorded
			BLOCKED-CONTENT-ATTEMPT	Can see if kids attempted to open blocked settings/sites/apps
			TRACK-SELF-REGULATION	can track self-regulation by viewing how many times kid failed to practice self-regulation, e.g., taki
				Monitor Progress
			TRACK-POSTURE	track whether kid followed proper posture and maintained proper distance while looking at the screen
			TRACK-SELF-REGULATION	can track self-regulation by viewing how many times kid failed to practice self-regulation, e.g., taki
			COMPARE-PROGRESS	can compare kids average usage time with entire average children of that age
	PF30	PROGRESS-TRACKING	TRACK-PROGRESS	See progress on learning/earned screentime/reward/task completion
			VIEW-ACCOMPLISHMENTS	Can view their certificates, completed tasks/lessons, and leaderboard

				Overall Screen Usage Monitoring
Goal Advancement			SCREEN-USAGE-DAILY	See daily screen usage
			SCREEN-USAGE-WEEKLY	See weekly screen usage
	EF27	TRACK-SCREEN-USAGE	SCREEN-USAGE-BI-WEEKLY	See bi-weekly screen usage
			SCREEN-USAGE-MONTHLY	See monthly screen usage/average monthly usage
				App/Internet Usage Monitoring
			APP-LOG	individual app usage is recorded (daily/weekly/bi-weekly/monthly)
	EF28	TRACK-APP-USAGE	MOST-USED-APPS	List the most used apps
				Rule Awareness
	EF29	VIEW-RULES	VIEW-RULES	Can always view/check the defined/updated houserules, see the blocked apps, limits
	EF30	PAENTAL-APP-INFO	PAENTAL-APP-INFO	App lets teens know what parents can monitor and what is not being supervised (e.g., app usage but not messages)
	EF31	DISPLAY-TIMER	DISPLAY-TIMER	Shows the timer/remaining time to the kids, updaes every minute
	EF32	DISPLAY-TIMER-MENTOR	DISPLAY-TIMER-MENTOR	A virtual character reminds of the timer/remaining time to the kids
				Monitor Progress
	EF33		TRACK-PROGRESS	See progress on learning/earned screentime/reward/task completion
		PROGRESS-TRACKING	VIEW-ACCOMPLISHMENTS	Can view their certificates, completed tasks/lessons, and leaderboard
			TRACK-COMPETITION	Compare progress on challenges with peers/parents on a leaderboard
			TRACK-PHYSICAL-ACTIVITY	Children can see how much they walked, and the points they earned for each week
	EF34	WARNING-TIMEOUT	WARNING-TIMEOUT	5 mins warning before timeout
			NOTICE-APP-NO-ACCESS	parents can block, allow or set limits for apps. if time run out apps are greyed out. if trying to open it shows you can use it for -- mins tomorrow
				Ease of Access
			VIEW-RULES	Can always view/check the updated & defined houserules, see the blocked apps, limits
			DISPLAY-TIMER	Shows the timer/remaining time to the kids, updaes every minute
			NO-TIMER-DISPLAYED	No way to track how much time is left/used
			NO-VIEW-RULES	Can always view/check the updated & defined houserules, see the blocked apps, limits