



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

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Abstract

Children's excessive technology use remains a significant challenge for parents, especially with early adolescents, given their growing independence and resistance towards parent-set device restrictions. Despite numerous parental control tools, there is limited research on tailored solutions for this age group. This paper advances this design problem by introducing and studying a child-centric design space for digital interventions targeting early adolescents' technology overuse. Synthesizing literature on mediation strategies, early adolescents' perspectives, and self-regulation, we first identify four pertinent design dimensions (early adolescents' agency, supportive parental engagement, mentorship style, and motivation). Using these dimensions, we then create three contrastive design concepts as video prototypes. Utilizing the prototypes in an online study with 13 early adolescents (ages 11-14) and their parents, we provide insights into how both groups conceptualize effective digital interventions. Our findings highlight areas of consensus (e.g., granting early adolescents' agency) as well as considerable variability (e.g., differing preferred mentorship approaches).

CCS Concepts

• **Human-centered computing**; • **Human computer interaction (HCI)**; **HCI design and evaluation methods**; **User studies**;

Keywords

Overuse of Technology, Technology Disengagement, Early Adolescents, Parents

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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" [111]. While the internet and technology can offer significant benefits, like facilitating education and socialization, overuse has been linked to technology addiction, cognitive delays, and other health complications such as eating and sleeping disorders [41, 86, 106, 122].

Given the detrimental effects of technology overuse, parents often turn to digital interventions to mediate their children's device use and promote a balance between beneficial and excessive use [22, 83]. However, most existing interventions are overly restrictive and parent-focused [2, 47, 117], disregarding children's emotions and agency, which contributes to resistance to parental rules [4, 44, 80] and leads to parent-child conflicts [12, 21, 26, 64]. These challenges underscore the need for interventions that consider children's voices regarding their tech disengagement to encourage compliance [55, 58]. This is particularly crucial for early adolescents, who are starting to develop their sense of autonomy and independence [28, 36]. Apart from a recent co-design study with early adolescents, which summarized design factors they deemed important and showcased their design ideas [23], designing digital interventions targeted to their needs has received little attention in the research literature. Consequently, despite the concerning rise in technology overuse among this age group [60], how to design interventions to help early adolescents moderate their tech use remains a largely unsolved problem.

In this paper, we define a design space based on insights from previous research, to investigate the design of digital interventions aimed at addressing excessive tech use among early adolescents. Our exploration of this initial design space involves identifying diverse design solutions and assessing them by incorporating insights from both early adolescents and their parents. Recognizing the familial context in which digital interventions are typically deployed, it is important to understand how early adolescents' design preferences align with those of their parents. Our investigation addresses two key 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?

To answer the above research questions, we drew inspiration from the Research through Design approach, which utilizes design artifacts to elicit individual attitudes and perceptions [125]. As our first step, we outlined an initial design space based on existing literature on mediation strategies (e.g., co-use [61], active mediation [97]), early adolescent-perceived important design factors (e.g., positive reinforcement, agency) [23], and self-regulation strategies (e.g., self-planning [14], journaling [72]). Our initial design space identifies four key dimensions: early adolescents’ agency, supportive parental engagement, motivation type, and mentorship approaches. Next, we developed three contrastive design concepts as video prototypes, each focusing on different points along the dimensions. We then conducted an elicitation study with 26 participants, 13 pairs of an early adolescent and a parent, where we probed 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. For example, both groups favored granting early adolescents’ agency, while also recognizing the necessity of parental control for those with low self-motivation to reduce tech use. However, opinions differed regarding mentorship approaches; most parents gravitated towards a parent-based approach, while early adolescents’ preferences varied.

Our contributions are: 1) We propose an initial design space that outlines four core design dimensions for designing digital interventions addressing early adolescents’ tech overuse. 2) We illustrate the application of the design space through three contrasting design concepts. 3) We present study findings showing preferences and areas of convergence within the design space.

2 RELATED WORK

2.1 Mediating Early Adolescents’ Tech Overuse

Due to the negative effects of technology overuse, parents attempt to intervene in their children’s tech use through various strategies, including active mediation, restrictive mediation, monitoring, co-monitoring, and co-use [10, 19, 61, 74, 82, 87, 102]. However, there are conflicting findings on the effectiveness of these strategies, particularly for early adolescents [61]. For instance, while some research suggests that a restrictive approach to reducing tech use might not suit this age group due to their increasing need for autonomy [65], others have 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 on adolescents’ smartphone overuse [61], whereas others have suggested combining active and restrictive mediation [105]. These conflicting findings underscore the challenges of designing for this age group and the need for further research.

While parents attempt to mediate excessive tech use with various strategies, children often find ways to escape the parental rules [98]. This problem intensifies with age, as parents find it more difficult to maintain rules and boundaries [96]. To reduce parental stress, parents often turn to parental control apps to regulate their children’s tech use [11]. These digital interventions have the potential to protect children from tech overuse and reassure parents by sharing the burden of managing the overconsumption issue [11]. For example, apps like Google Family Link [126] and Net Nanny

[127] allow parental monitoring and control features for children’s digital media use. However, studies of digital interventions have found that many tools disregard teens’ perspectives and emphasize parental needs for device control [20, 44, 117]. These tools are often considered invasive, as they force compliance and undermine teens’ strong desire for autonomy [20], leading to rule-breaking tendencies, parent-child conflicts, and even discontinuation of the interventions [98]. These findings stress the importance of considering both early adolescents’ and parents’ perspectives. To address their diverse viewpoints and work towards mutually acceptable solutions, we explore different design approaches within a design space of digital interventions, while seeking feedback from both groups.

2.2 Important Design Factors and Values for Designing Digital Interventions

To design effective digital interventions, researchers have explored various design factors and values that might be important to children and parents. Employing a “Value Sensitive Design Approach (VSD)” [39, 40], studies have uncovered parental values for risk management of young children’s media use [84, 85], core values causing tension between teens and parents [25], strategies for parental control and teen self-regulation [117], and values for designing parental control apps for adolescents’ online safety [6]. Among these values are safety, trust, privacy, teen autonomy, parent-teen communication, parental involvement and support, morality, and fun [6, 25, 46, 84, 85]. The studies listed above, however, have primarily focused on children’s online safety, which often prioritizes protective measures like content filtering or monitoring online activities. Our emphasis lies in designing solutions that support children in managing and limiting their own device time, with the aim of fostering a balanced digital lifestyle. Even if online safety is ensured, it may not necessarily prevent the risk of overusing technology, implying that the identified values for online safety might not directly transfer to the distinct issue of children’s excessive tech use. Thus, we use insights from this body of research to inform our initial design space, exploring the specific applicability of these findings to the context of tech disengagement. Furthermore, the aforementioned research focuses on both young children and teens, whereas we concentrate on early adolescents. This demographic presents unique design challenges due to their growing sense of autonomy, increased tech usage, and a potential for more frequent parent-child conflicts compared to other age groups [33, 60].

Prior research on child-centric digital interventions targeting tech overuse has recommended empowering children to regulate their device usage while considering parental rules [65] and engaging them in negotiations with parents to some degree regarding these rules [44, 64]. Researchers have also emphasized the importance of including children’s opinions into device rules [71] and suggested practicing joint mediation within families [65, 69]. Letting their voices be heard and incorporating elements that they find beneficial could motivate more compliance than simply enforcing device rules [44]. To elicit opinions directly from early adolescents, Chowdhury and Bunt involved them in co-designing digital interventions [23]. Analysis of interviews and idea sketches revealed that early adolescents value emotional support, positive

reinforcement, interesting technical components, and a balance between autonomy and parental involvement [23]. While these insights represent a vital first step towards designing for this age group, relying solely on their perspectives moving forward is insufficient. For example, the early adolescent participants likely did not have the depth of perspective needed to fully assess the potential impact of their design ideas and priorities. In addition, some of their proposed design ideas might not be welcomed by their parents. Our work, therefore, extends this line of research by integrating relevant literature on early adolescents' self-regulation and behavior change, investigating diverse combinations and variations of different design factors, translating the combinations into tangible designs, and incorporating perspectives from both early adolescents and their parents.

Leveraging insights from the abovementioned studies and using design factors directly rooted in early adolescents' perspectives as a foundation, in this paper, we identify important design dimensions and outline an initial design space for digital interventions tailored to this demographic. Our findings further contribute to this literature by investigating trade-offs in potential solutions within this design space, aimed at mitigating early adolescents' tech overuse.

2.3 Promoting Early Adolescents' Self-Regulation to Encourage Disengagement from Tech Overuse

To promote early adolescents' healthy tech use, it is essential that the mediation strategies focus on developing their self-regulation abilities, rather than forcing them to comply [20]. Self-regulation, defined as the ability to initiate control over our thoughts, emotions, and actions to achieve a certain goal [123], involves three phases consisting of self-observation, self-judgement, and self-reaction [7]. This suggests that digital interventions should focus on empowering early adolescents to monitor their own usage, evaluate their progress, and support them in correcting their behavior accordingly. Several strategies have been proposed to facilitate children's self-regulation regarding managing technology use, including self-planning, feedback and reinforcements, journaling, self-directed speech, and repeated reminders [4, 14, 29, 53, 72, 75, 97, 101, 117]. Additionally, persuasive technologies that integrate data visualization and motivational elements (e.g., gamification) are known to promote behavior change by supporting self-management and regulation [31, 73, 116]. Since tech disengagement might be a form of behavior change for many early adolescents, adapting elements from these technologies could be useful in designing effective digital interventions. Furthermore, a range of external factors can impact early adolescents' development of self-regulation, including parental involvement, peer influence, autonomy support, and parent-child relationships [14, 32, 77, 89, 90, 99, 120]. Hence, by considering these external factors, and incorporating diverse self-regulation strategies discussed above, we generate contrasting design concepts to identify areas of differing opinions and mutual agreement regarding digital interventions among early adolescents and parents. Our goal with this approach is to uncover insights into solutions that have the potential to cater to the requirements of both groups.

3 DEFINING AND EXPLORING A DESIGN SPACE FOR DIGITAL INTERVENTIONS TARGETING EARLY ADOLESCENTS

In defining and exploring an initial design space for digital interventions addressing early adolescents' tech disengagement, we were inspired by the Research through Design (RtD) approach, which integrates design methodologies, techniques, and procedures to create and assess artifacts as potential solutions [124]. These artifacts or prototypes are used as probes to elicit insights from end users to assess the feasibility of the solutions [5], aiming to create new knowledge on how to solve a complex problem [54, 124, 125]. RtD is particularly useful when multiple stakeholders hold conflicting perspectives, making it challenging to accurately model their needs [124, 125]. Our approach is informed and motivated by prior work that employed RtD in investigating design solutions for children [5, 9, 30, 37, 38, 54, 109, 112, 113, 119].

3.1 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 [6, 44, 45, 61, 62, 69, 87, 97, 105, 108, 118], early adolescent-perceived important design factors [23], and their self-regulation abilities [32, 36, 43, 77, 89, 90, 99, 117, 120]. From this literature, 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.

3.1.1 Level of Early Adolescents' Agency: Low Agency — High Agency. Early adolescents have expressed a need for increased agency while practicing tech disengagement [23], likely due to their growing sense of autonomy [28]. Encouraging self-awareness and allowing them to take charge of their disengagement practices might motivate them to adhere to the mediation strategies [97]. 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.

3.1.2 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 [117, 121]. Not being considerate of early adolescents' emotions while monitoring or enforcing tech usage rules can lead to frustration and mistrust towards parents [117, 121].

While early adolescents prefer more independence, they also desire a supportive relationship with their parents and some level of parental involvement [23, 94]. Conversely, parental overinvolvement can create attachment issues, social problems, and anxiety [27]. 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.

3.1.3 Type of Mentorship: Peer-based Mentorship — Parental Mentorship. While parental mentorship is a common approach to guide children’s tech disengagement [52, 76, 108], peer-based mentorship might also have advantages given that peers have a significant influence during early adolescence [81]. Since early adolescents often rely on their peers, promoting supportive accountability among peers has the potential to motivate the use of behavioral interventions [59]. In a prior study, early adolescents suggested that a mentor with peer-like, relatable characteristics could help manage tech overuse [23]. Based on these insights, this dimension explores the spectrum between peer-based and parental mentorship.

3.1.4 Type of Motivation: Intrinsic Motivation — Extrinsic Motivation. Two well-recognized forms of motivation, intrinsic and extrinsic, play important roles in promoting behavior change [56]. 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) [56, 93]. Incorporating both intrinsic motivation (e.g., engaging in interesting offline activities) and extrinsic motivation (e.g., rewards) was perceived useful to early adolescents in limiting tech overuse [23]. 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.

3.2 Generating Design Concepts

Utilizing our design dimensions and drawing on prior research employing “Research through Design” in design space exploration [3, 48, 51, 110], 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, prior work indicates that early adolescents want at least some autonomy in their tech disengagement practice [23]. 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 [93]. 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 [128]. Video demonstrations and screenshots of all the features of these prototypes are included in the supplementary materials. While translating our design concepts into tangible prototypes, we borrowed elements from early adolescent-generated design solutions [23], persuasive technologies [31, 73, 116], and various self-regulation strategies proposed in prior literature [4, 14, 29, 53, 72, 75, 97, 101, 117]. We describe the design concepts below. At the end of this section, we also provide a visual representation of our estimated placements of these concepts on the dimensions to highlight the diverse areas they explore within the design space (Figure 4).

3.2.1 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 [65, 69]. In the Parent-Child Unplug prototype (Figure 1), 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 1A, Figure 1B), 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 usage [65], and negotiate rule-setting with parents [44, 64]. 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 1C). These features serve as forms of reinforcement, which, according to early adolescents, can motivate their disengagement practice [23]. There is a ‘My Journal’ feature (included in the Supplementary Materials), which serves as a reflective self-evaluation tool [72], allowing early adolescents to express their feelings regarding the device rules and their tech disengagement

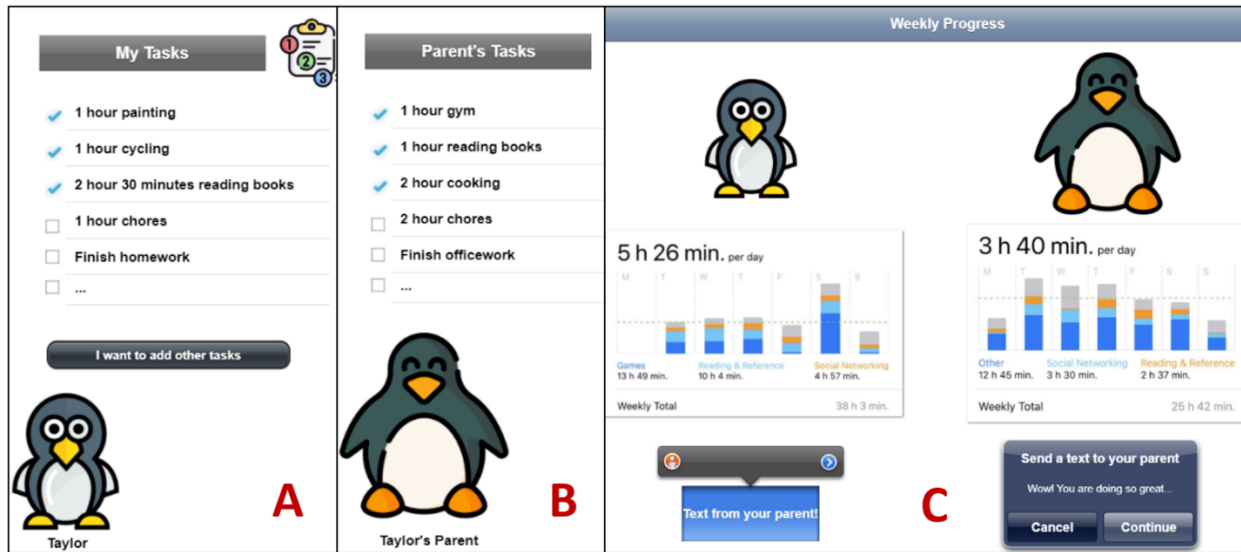


Figure 1: Screenshots from Parent-Child Unplug; (A) The early adolescent will have a list of tasks that they can edit according to their interests. (B) The parent will have their own list of tasks. (C) Both can view each others' progress and message each other to remind and encourage.

experiences. They can share these notes with their parents, with the aim of facilitating open communication [6, 46].

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 [107].

3.2.2 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 [103]. 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 2A), aiming to support self-monitoring and digital autonomy [67, 114]. Through features like viewing each other's task lists, sharing pictures or texts related to offline tasks, leaving comments (Figure 2B), and sending reminders about tasks to each other (Figure 2C), 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 [8]. Additionally,

the peers can schedule joint activities (Figure 2C) to promote peer collaboration. To foster a positive atmosphere and avoid negative emotions of competition [109], 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 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 [36]. On the other hand, sharing activities with peers promotes a sense of accomplishment in that their effort is recognized, which implies extrinsic motivation [36]. Leaving comments and encouragement from peers can foster a sense of social support, which contributes to both intrinsic and extrinsic motivation [77].

3.2.3 ScreenSavior (SS). The third design concept integrates a motivational companion as a mentor (Figure 3). Due to their growing sense of independence, early adolescents often resist parental rules [35]. Guidance from an influential figure with relatable or early adolescent-like characteristics might encourage adherence to tech disengagement interventions [23]. This prototype allows early adolescents to choose their preferred character from a range of different options (Figure 3C). This character will help them create a list of offline tasks by suggesting different ideas, facilitating self-planning for tech usage [14, 57]. The character will also provide a list of time limits (pre-approved by parents) and remind the user to follow those rules (Figure 3A). The character will periodically check in

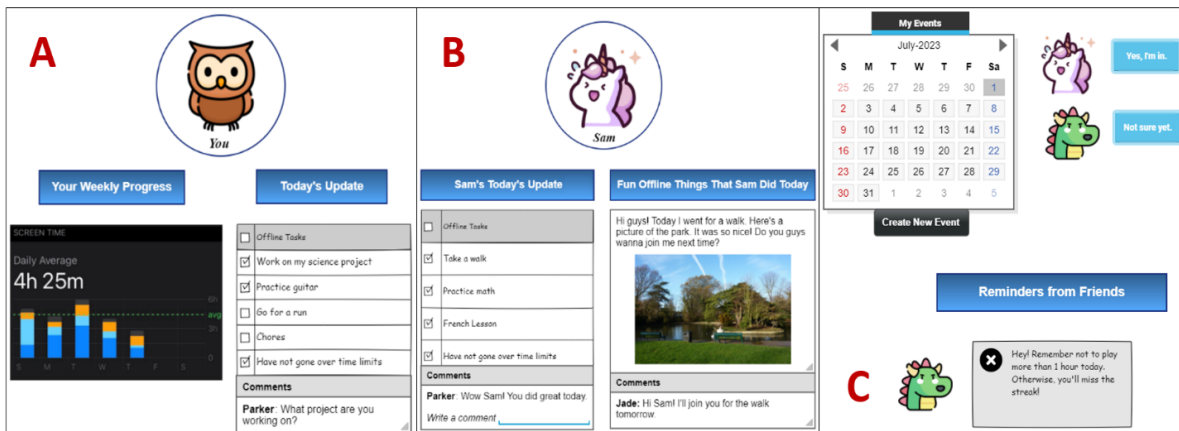


Figure 2: Screenshots from TechBreak Buddies; (A) The early adolescent will have their own profile where they can track their own progress. Their task update will be shared with their peers. (B) The early adolescent can view their peer’s profile, see their updates, and leave messages. (C) They can create events for joint activities and remind each other about the rules.

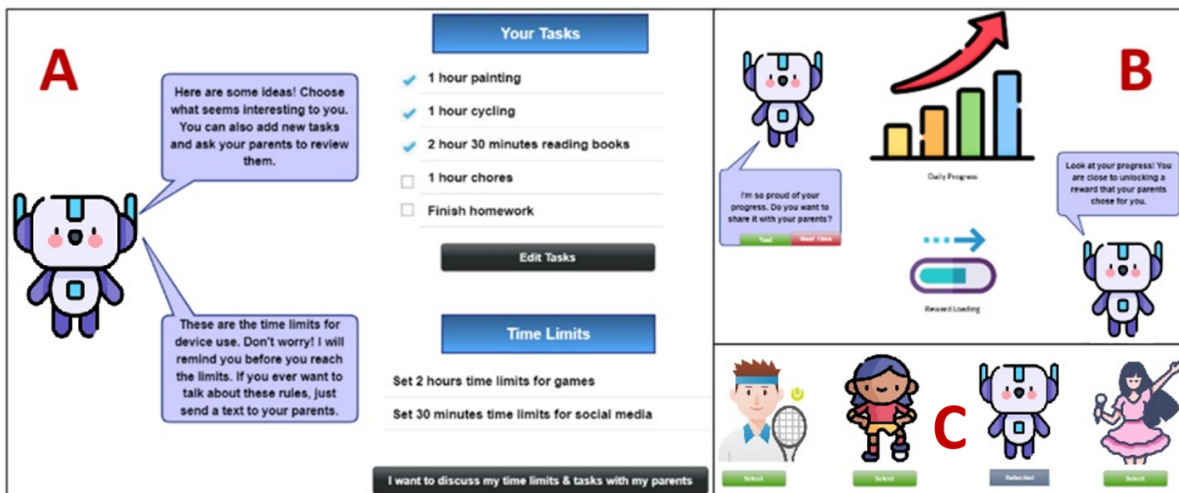


Figure 3: Screenshots from ScreenSavior; (A) A virtual character will remind the early adolescent about their rules. (B) The character will share their tech disengagement progress and updates about rewards, and encourage them to follow the rules. (C) The early adolescent can customize the character according to their liking.

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 [6, 46]. The character informs the early adolescent of their progress and provides words of encouragement to motivate their adherence to the rules (Figure 3B). 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 [31, 73, 91, 100, 116].

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

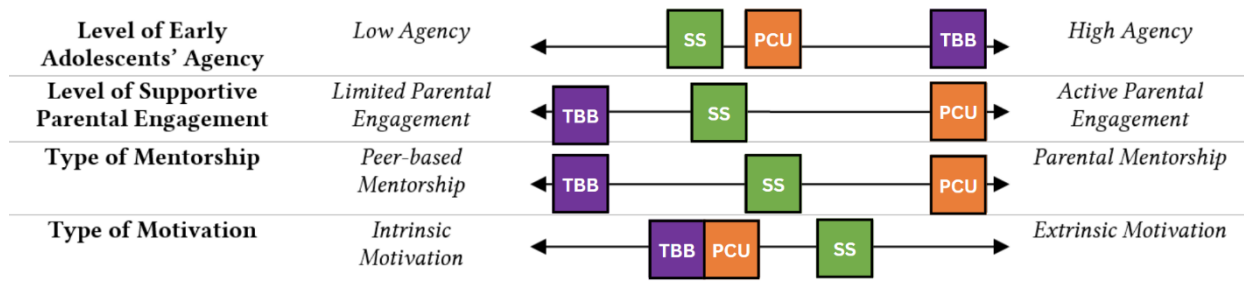


Figure 4: Visual representation of our estimated placements of the design concepts on the continuum of the design dimensions.

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

4 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 towards 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 [3, 16, 48, 110]. 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 [48].

4.1 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. Our sample size was informed by other studies exploring design spaces with children [54, 109, 112, 113], 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 [95], with more than 6 hours daily considered excessive [18], our eligibility criteria for early adolescent participants required experience using digital media for more than two hours daily. "Digital media" in our recruitment material was intentionally not defined to make its interpretation flexible. 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 [50] 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. The study was approved by our institutional research ethics board. All study materials are included in the supplementary materials.

4.2 Study Tasks & Procedure

After obtaining consent and assent from both the parent and the early adolescent, but before attending the study session, we asked the parent participant to complete a pre-study background survey (Figure 5 summarizes our study design). The survey (adapted from [49, 79]) 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. One researcher administered all study sessions, which were approximately 60-90 minutes long. Sessions were recorded for the purpose of data analysis.

We started the session by introducing our research problem. Then we 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 [78]). We then demonstrated the video prototypes discussed in the previous section. To gather detailed feedback regarding the design concepts, after each demonstration, the researcher conducted a short semi-structured interview with each participant, always beginning with the early adolescent participant. We inquired about what elements they liked or disliked in the prototype, and whether they had any suggestions for improvement. To gain additional contextual insight, we 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. We counter-balanced the order of the prototype demonstrations to mitigate order effects.

After demonstrating all three prototypes, we asked both participants to rank the prototypes according to their preferences, recording their opinions individually on separate sheets of paper. We ended the study session with a joint discussion to gain more insights into participants' overall rankings and thoughts on the design solutions.

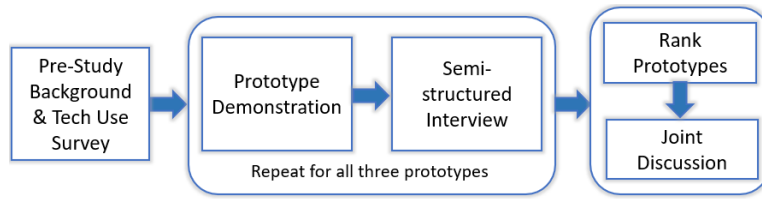


Figure 5: Study Design

5 DATA COLLECTION & ANALYSIS

Our primary source of data is the recordings of the study sessions which captured participants’ reactions towards our video demonstrations, their responses during the semi-structured interviews and joint discussions, and their rankings of the design concepts. We transcribed the sessions and applied Reflexive Thematic Analysis [13] to the transcribed data. The researcher who conducted the study sessions, 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, this researcher 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 [17]. Later, through several rounds of iterations, two researchers worked together to fine-tune these themes, while always cross-referencing with the original data to maintain its authenticity. The researchers discussed their 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 [48]. 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. We 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. Here we discretized the dimensions rather than considering them as continuums for the purpose of analysis, 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 ranges of responses and highlight areas of consensus (see Figure 6).

5.1 Reflexivity Statement

Since our analysis heavily relies on qualitative and subjective research methods, we acknowledge how our background and experiences might influence our interpretation of the data. The authors of this paper are HCI researchers in Canada. One researcher, originating from a developing country, brings a unique cultural and socio-economic perspective, while the other researcher comes from a developed country, adding a contrasting perspective. One of the

researchers is a parent of two children, including an early adolescent (at the time of data analysis). Both researchers have prior experiences conducting studies with early adolescents. Given that tech overuse can often lead to family conflicts, both researchers approached the subject with mindfulness and sensitivity. Our research methods and analysis were through the lens of limiting tech use to mitigate impacts of overuse. An alternative lens would be purposeful technology use [57, 63].

6 FINDINGS

We begin our findings by summarizing the survey data to provide context about participants’ technology usage patterns and household rules. Then, we discuss themes regarding participants’ attitudes toward different aspects of our design concepts. Next, we share our findings from the targeted analysis regarding participants’ preferences for specific areas within the design dimensions.

6.1 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. We asked the same set of questions 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.

6.2 Parents' and Early Adolescents' Reactions towards Different Aspects of the Design Concepts

In this section, we present findings from our thematic analysis. To support our findings, we provide sample participant quotes labeled as data coming from an early adolescent participant (e.g., E1) or their parent participant (e.g., P1). While presenting our findings, we refrain from specifying participant counts to avoid drawing presumptions about their agreement or disagreement on a theme [24]. For instance, a participant not voicing an opinion on a particular theme, does not mean they disagreed with it [24].

6.2.1 Most early adolescents favored increased agency, but those with low self-regulation skills may require parental control. Consistent with existing literature, early adolescents demonstrated a strong desire for increased autonomy when it comes to managing technology use [23, 44, 117]. 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 [88]. 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."

6.2.2 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 towards 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 [32].

6.2.3 Preferred 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 towards 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 [81]. 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 [70]. 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 towards 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."

6.2.4 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 [56]. 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 towards 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."

6.2.5 *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...”

6.2.6 *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 [66].

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.”

Given participants’ desire for adaptability along with personalization and customization, it is worth exploring whether “flexibility” should be considered as another potential design dimension for early adolescents’ digital interventions.

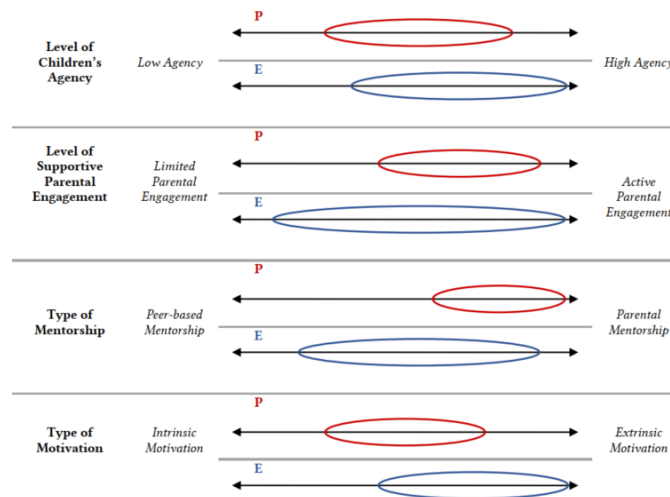


Figure 6: A visual representation of the estimated variability in participants’ preferences for each design dimension. The width of the ellipses highlights where the majority of responses are situated (excluding outliers), illustrating the divergence in views; ‘P’ and ‘E’ denote the preferences of parents and early adolescents, respectively.

6.3 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. In this section, we dive further into participant preferences by presenting findings from our targeted analysis (discussed in section 5), 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 6 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 towards 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 towards extrinsic motivation.

6.4 Participants’ Overall 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 7). 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 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, “Screen Savior” 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

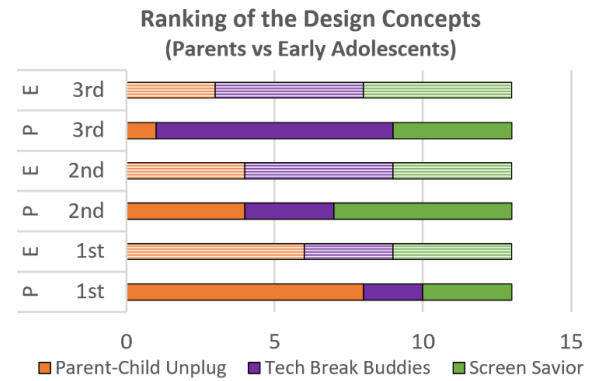


Figure 7: Parents’ and Early Adolescents’ rankings of the design concepts.

do not favor high levels of early adolescents’ agency. While “Tech-Break 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.

7 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 towards 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 [115]. Recognizing these diverse needs, both 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 towards 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. Future research should therefore consider adding a "level of flexibility" dimension to the design space to guide the investigation of different approaches to personalization.

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. Such studies could also explore whether users' sentiments shift across the design dimensions after real-world implementation and usage of our design insights. For example, while some 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. However, a challenge with longitudinal 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 [68]. 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 [68].

While motivating early adolescents for research participation can be challenging [34], prior work has shown that formative design activities can empower them to contribute responsible design ideas [23]. Our 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 towards 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.

We focused on exploring the design space centered around digital interventions to support early adolescents' self-regulation of tech use. While we did not specifically focus on fostering mindfulness related to purposeful use of technology [57, 63], our design concepts include 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 [15]. 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.

7.1 Limitations

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. 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 [42, 92]. 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 [104]. 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 [3, 48, 51, 110], 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.

8 CONCLUSION

In this paper, we presented and studied an initial design space for digital interventions aiming to address early adolescents' technology overuse. Our design space outlines four important design dimensions that could impact early adolescents' disengagement from excessive use of technology. Our proposed design concepts demonstrate different aspects of the dimensions, and our study findings offer direct insights from early adolescents and their parents about their perceptions and preferences for these dimensions. Our design space and study insights can serve as an important resource for HCI researchers and practitioners interested in pursuing new digital interventions that are grounded in the needs and perspectives of early adolescents.

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