Co-Designing with Early Adolescents: Understanding Perceptions of and Design Considerations for Tech-Based Mediation Strategies that Promote Technology Disengagement

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ABSTRACT

Children's excessive use of technology is a growing concern, and despite taking various measures, parents often find it difficult to limit their children's device use. Limiting tech usage can be especially challenging with early adolescents as they start to develop a sense of autonomy. While numerous tech-based mediation solutions exist, in this paper, we aim to learn from early adolescents directly by having them contribute to co-design activities. Through a multi-session, group-based, online co-design study with 21 early adolescents (ages 11-14), we explore their perceptions towards tech overuse and what types of solutions they propose to help with disengagement. Findings from these co-design sessions contribute insights into how the participants conceptualized the problem of tech overuse, how they envisioned appropriate mediation strategies, and important design considerations. We also reflect on our study methods, which encouraged active participation from our participants and facilitated valuable contributions during the online co-design sessions.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); HCI design and evaluation methods; User studies; Interaction design; Interaction design process and methods; Participatory design.

KEYWORDS

Technology Disengagement, Early Adolescents, Co-Design, Tech-Based Mediation Strategies

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1 INTRODUCTION

With the abundance of technology present in our surroundings, children's excessive use of digital devices has become a concerning issue. Alongside watching television, children are spending large amounts of time with different sophisticated devices (e.g., smartphones, tablets, computers, gaming consoles), where they have access to a plethora of media applications as sources of entertainment. For example, a 2021 study found that almost all children in the UK accessed online media [65]. In the United States, children's (ages 8-18) screen usage has increased by 17% since the beginning of the COVID-19 pandemic [71].

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 detrimental effects, including negative impacts on social and cognitive development, sleep, and health [32, 64, 84]. If not monitored and controlled, children's urge to use digital devices and online media excessively can turn into an addiction [78, 90], which can lead to daily-life disturbances [12], aggressive behavior [1], and symptoms of withdrawal [40]. It is therefore not surprising that children's increasing use of technology has become an alarming issue for many parents and that they often attempt to play the role of gatekeeper [15, 63].

A large body of research has looked at parents' involvement and attitudes towards children's media usage [3, 5, 23, 44, 68], and parents' different mediation strategies [12, 56, 60, 63, 67, 79, 80]. Studies have also explored how children use technology within the home [40] and their attitudes towards parental mediation [1, 34, 59]. Despite applying various measures, parents often fail to control their children's tech usage [1, 59] and mediation strategies can create conflicts between children and parents [4, 14, 20, 48, 55]. While this is a complex, multifaceted problem, one potential issue is that children might not have had sufficient voice in developing these mediation strategies. Motivated by prior research suggesting that considering children's opinions while developing rules can encourage adherence [31, 35, 41, 43], in this paper, we explore involving children in the design process of tech-based interventions as a way for them to express their opinions and contribute ideas about potential design solutions.

Given the benefits of co-designing as a method to elicit children's perspectives on technologies that they will ultimately be using [2, 9, 13, 21, 25, 38, 57], we involve children in co-design to gain knowledge regarding what design aspects and attributes of tech-based mediation strategies resonate with them. We focus our investigation on early adolescents (ages 11-14), an age group where

tech overuse is an increasing concern [45]. This age group also presents interesting design challenges given their developing sense of autonomy [22, 30] and the increased potential for parent-child conflicts [28]. Through our co-design study, we explore the following research questions: 1) How can we involve early adolescents in online co-design for child-centric tech-based mediation strategies? 2) What kinds of design solutions do they create and what factors do they consider while designing? How do these factors align with existing adult-designed solutions?

To address our research questions, we conducted a multi-session group-based online study with 21 early adolescents. By involving participants in focus-group interviews, collaborative story creation, brainstorming, and sketching, we investigated their attitudes towards designing tech-based mediation strategies for their own tech disengagement. Findings from our study reveal insights into how early adolescents conceptualize the issue of technology overuse and what design solutions they perceive to be useful. Our participant-generated solutions encompass a variety of ideas ranging from encouraging other activities, to educating about the issue of tech overuse, to using time awareness tools. Our findings also contribute insight into key design considerations from the perspectives of early adolescents, including the importance of balancing their autonomy with parental involvement, incorporating positive reinforcement, and including messaging that is relatable. Additionally, we share reflections on how the study method and co-design approach encouraged active collaboration and high-quality contributions from our participants. Our findings can be leveraged by HCI researchers to ground future explorations of the design space of tech-based interventions that promote healthy tech use by early adolescents.

2 RELATED WORK

In this section, we first discuss prior research on parental mediation strategies, children's and parents' attitudes regarding technical mediation, and review research on existing tech-based interventions. We then briefly overview literature on child-centric co-design techniques, which informed and motivated our study method.

2.1 Moderating Children's Tech Use through Parental Mediation and Tech-Based Interventions

To protect children from the risks of using online media and the negative impact of overusing technology, parents apply different kinds of mediation strategies, including restricting access, co-using the media, supervision, and monitoring [62]. While the restrictive approach can be effective for young children [44], children who are transitioning to adolescence can find it too controlling in light of their growing sense of autonomy [49, 80]. Hence, parents often combine different mediation strategies based on their own perceptions of tech use or their children's needs [3, 80].

To monitor, supervise or control their children's technology usage, many parents apply different technologies to help [44, 75, 87], a strategy referred to as technical mediation [3]. While some parents see merit in using tech-based mediation to facilitate children's healthy device use [44], others find these interventions unsuccessful [75], and children often feel that the tools overlook their needs [87]. For example, in one study, parents of young children (ages 1-5) reported that a tech-based mediation tool helped their children transition from engaging with technology to disengaging [44]. However, other work with teens found that they easily navigate around parental-control tools [75] and that existing tools mostly consider parents as the primary stakeholders [87]. Consistent with these findings, Gosh et al.'s analysis of reviews posted by children (8-19-years-old) for parental-control mobile safety apps revealed that the child reviewers felt that the apps invaded their privacy, were overly restrictive, and had negative effects on their relationships with their parents [34]. These mixed findings suggest that further research is needed to understand children's perspectives. If tech-based mediation strategies are not targeted to children's needs, for example, by ignoring their autonomy, children might feel forced to use the interventions as opposed to developing self-regulation strategies [34, 87]. Since children do not always see the rules as being personally beneficial [34], enabling them to voice their opinion while making the rules regarding technology use can help them to adhere to the rules [41, 43]. Leveraging these findings, we involve early adolescents in co-design so that they can express their ideas and opinions about tech disengagement and propose their own tech-based mediation strategies to promote healthy and controlled use of technology.

In addition to studying current perceptions and practices surrounding tech-based mediation, prior work has also proposed several design recommendations. Common recommendations include that tech-based mediation strategies should incorporate self-monitoring, risk-coping, impulse control techniques, and features that children find favorable [34, 75, 87]. Prior work has also recommended allowing children to manage their own device use, set self-directed boundaries while keeping parental rules in mind [49], and negotiate with their parents about the rules to some extent [34, 48]. In terms of whether children have the ability to resist their temptation to use technology, prior work has suggested that children's ability to delay gratification can be enhanced with the support of self-directed speech and reinforcement [1, 24, 58]. The recommendations described above are based on data collected using different methods (e.g., content analysis and surveys/interviews about current practices). We complement this body of research by contributing insights into what kind of ideas and solutions early adolescents generate through a co-design research approach.

Prior work has also contributed new systems designed to help children limit their own device use. There are systems that attempt to foster self-control [39, 42], for example, by letting children plan their own entertainment with the guidance of their parents [42], and by using augmented reality to practice self-regulation [39]. Researchers have proposed systems that involve children and parents in various joint activities [49, 50], for example, limiting device use as a family activity [49], and practicing self-regulation together [50]. Researchers have used augmented reality and also designed physical screen peripheral device interfaces to make children's screen withdrawal easier and seamless [79, 89]. Despite the prevalence of tech-based interventions to regulate children's media use as discussed in this subsection, we are not aware of prior work examining children's perspectives of tech-based mediation strategies through co-design activities. In doing so, we aim to provide children (in our case early adolescents), important stakeholders in this design problem, with a clear voice in the design process.

2.2 Co-Designing with Children

Co-design is a powerful approach to enable children to voice their opinions and direct researchers towards child-centric design choices [70]. Co-designing with children enables researchers to better understand and identify age-specific requirements. In light of these benefits, researchers have involved early adolescents and teens in co-design in a range of different domains including the co-design of personal informatics tools [70], mobile online safety applications [19], digital badge systems [69, 83], interactive technologies to enhance museum experience [9–11], tools to support parent-teen communication [86], and games to raise privacy awareness [52]. 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. Our work investigates how to apply these techniques in the context of a new application domain: involving early adolescents in co-design for tech-based interventions to facilitate tech disengagement.

Our co-design approach mostly borrows elements from the 'Collaborative Design Thinking (CoDeT) framework [57]. CoDeT supports co-design in groups with a high child-to-adult ratio, where the target age range is 9-10-year-olds [57]. 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 [57]. 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 study design even though our co-design sessions had a much lower child-to-adult ratio (3 children with 1 adult researcher; see section 3.1 for details). Thus, our study illustrates an application and adaptation of the principles of the CoDeT framework to an online setting with a low child-to-adult ratio and with early adolescents.

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 [16, 18, 26, 54]. 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 [26]. On the other hand, transitioning to online presents new challenges, such as maintaining online engagement, logistics support, and managing technical difficulties. In light of 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 [54]. For example, the authors discuss the importance of improvisation to balance the expected and unexpected factors during synchronous online co-design sessions [54]. Researchers have also explored how different co-design groups approached online co-design, documenting unforeseen challenges and comparing different design tools and logistics decisions [26]. We used these findings to inform our adaptations of the CoDeT framework to our online co-design setting.

3 CO-DESIGN STUDY METHOD

We conducted online co-design sessions with early adolescents to investigate how they approach the issue of tech 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 tech-based solutions they believe could help with disengagement. Our approach was inspired by the 'Collaborative Design Thinking' framework, which 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 [57]. 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. In this section, we share the details of our study method.

3.1 Participants

We recruited 21 participants (7 girls, 14 boys) who were 11-14 years old (mean age: 12.5, SD: 1.06). 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). 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 [36] and word of mouth. Our recruitment approach resulted in participants from seven different countries (Canada: 9, Bangladesh: 3, France: 3, India: 3, Dubai: 1, Netherlands: 1, Philippines: 1) to participate in our study. 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. This study was approved by our research ethics board.

Since the goal of co-design is to promote collaborative creativity [57], we opted to form groups rather than hold individual sessions. Collaboration tends to encourage creativity in children more than working individually [66], and the sense of accountability while working as a team can motivate contributions to design tasks [57]. 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, in one group all participants 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.

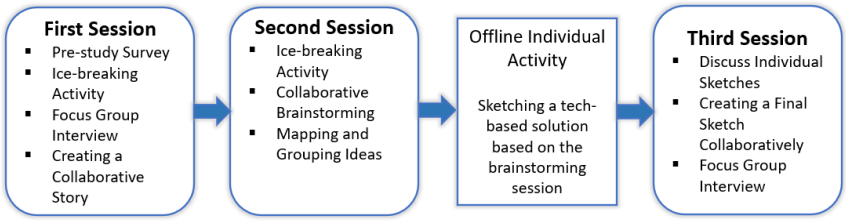

Figure 1: Study Method

3.2 Study Tasks, Procedure, and Data Collection

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 the problem with their peers, collectively brainstorm ideas, and produce a final design solution. One researcher conducted all the sessions. Each session lasted approximately 60-90 minutes and was recorded for data analysis purposes. Dividing the study into three sessions allowed participants to spend sufficient time on each of these activities and the opportunity to reflect on the problem of tech overuse individually in between the sessions. We describe each study session in detail below.

3.2.1 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, the researcher administered a short individual online survey to collect information on participants' current technology usage. Then participants introduced themselves and engaged in a team-building activity, where they came up with a name for their group. Then, the researcher 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 the researcher 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 [17] and we were cognizant of the fact that adolescents might distort the truth about an addiction to avoid stigmatization [37]. Therefore, we did not ask our participants to self-report childhood addictions or attempt to investigate addiction patterns.

After introducing the research problem, the researcher conducted a focus group interview where participants discussed their media usage patterns, their parents' restrictions, and their responses to those restrictions. Next, the researcher 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 through the characters of the story.

3.2.2 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, the researcher asked participants to collaboratively brainstorm different ideas and map similar ideas together using Google Jamboard. During this activity, the researcher reminded participants to focus on tech-based 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). The researcher 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 tech-based solution based on ideas from this brainstorming session. Prior research has demonstrated that incorporating both individual and group ideas can enhance the ideation process [51].

3.2.3 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. The researcher 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, the researcher 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 the researcher asked them to describe their sketch and explain why they think it might support children to disengage from excessive tech use, what aspects of their solution might not work and whether the solution would work for them.

4 DATA COLLECTION & ANALYSIS

Our primary data came from the recordings of the semi-structured focus group interviews and the participant-generated artifacts. We transcribed the study sessions and read through the transcripts and artifacts multiple times to familiarize ourselves with the data. Then we applied Reflexive Thematic Analysis [7], starting with multiple rounds of coding of the data, performed by the researcher who conducted the study sessions. In the next phase, the same researcher generated initial themes and subthemes by identifying patterns and then grouping the codes together. Then two researchers collaboratively refined and defined the themes while revisiting the data frequently to ensure that our themes are grounded in the raw data.

5 FINDINGS

We divide our study findings into three subsections. We first share findings from our survey and our initial focus group interviews, including participants' device usage patterns and their family experiences with technology. Then we discuss our findings regarding participant engagement in the co-design activities. Finally, we discuss important design factors that emerged from our thematic analysis. We support our findings with sample participant quotes and images of participant-generated artifacts. We label data 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, we do not present participant counts to avoid making assumptions about participants' agreement or disagreement regarding a theme [6]. 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 [6].

5.1 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.

5.2 Engagement in Co-Design Activities

Prior work has found that involving early adolescents in HCI research can be challenging [27, 28]. For example, early adolescents can be difficult to motivate, particularly when it comes to research participation [28]. Moreover, early adolescents spend more time online and on devices than other age groups [45]. 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. In this subsection, we discuss how our participants engaged in the study activities. When possible, we note particular aspects of the study method that appeared to facilitate design contributions and discussion.

5.2.1 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 addiction 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 towards parental rules regarding tech use. For example, in two stories, the main character felt upset and angry at their

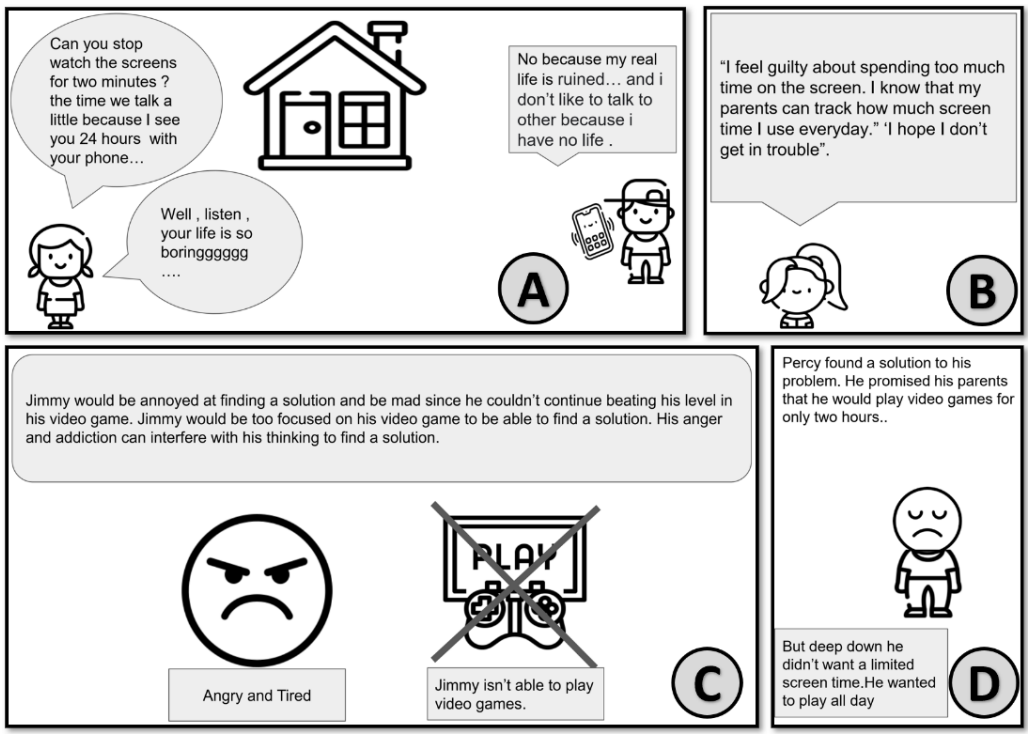

Figure 2: Excerpts from some of the collaborative stories created by our groups of participants. (A) G3 is describing a situation where a boy addicted to his phone is expressing his lack of interest in anything else when his friend asks him to have a conversation. (B) G7 describes how the main character 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.

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 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 [82] for whom the participants attempted to design different solutions in the next two sessions of the study.

5.2.2 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 tech-based 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).

Figure 3: Ideas Generated by Group 2 during the Brainstorming Session.

Table 1 shows a collection of ideas that illustrate the range that participants generated. Below we discuss key concepts that emerged from the ideas.

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 tech-based 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:

> *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 tech-based companion or mentor who could guide them towards 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 the track of time while using devices for entertainment, keeping track of their spent time and reporting that with an alarm, or a 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

Table 1: 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."

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 [screen time 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. – 1^{st} – 15 minutes, – 2^{nd} – 15 minutes, – 3^{rd} – 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.

5.2.3 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."

5.3 Participant-Perceived Important Design Factors

As discussed in section 5.2, 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 towards to facilitate their tech disengagement. In this subsection, we describe each of these design factors with examples from our sessions.

5.3.1 A Balance between Giving Children More Agency & Parental Involvement. During early adolescence, children develop a sense of autonomy [22], 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 has been known to encourage them to follow the rules [31, 35, 41, 43], allowing early adolescents some autonomy regarding 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."

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 [74].

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. 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 [29], 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 tech-based interventions:

P15-G5: "Well, I think, my original idea was to have a child being independent with the app, but I think if

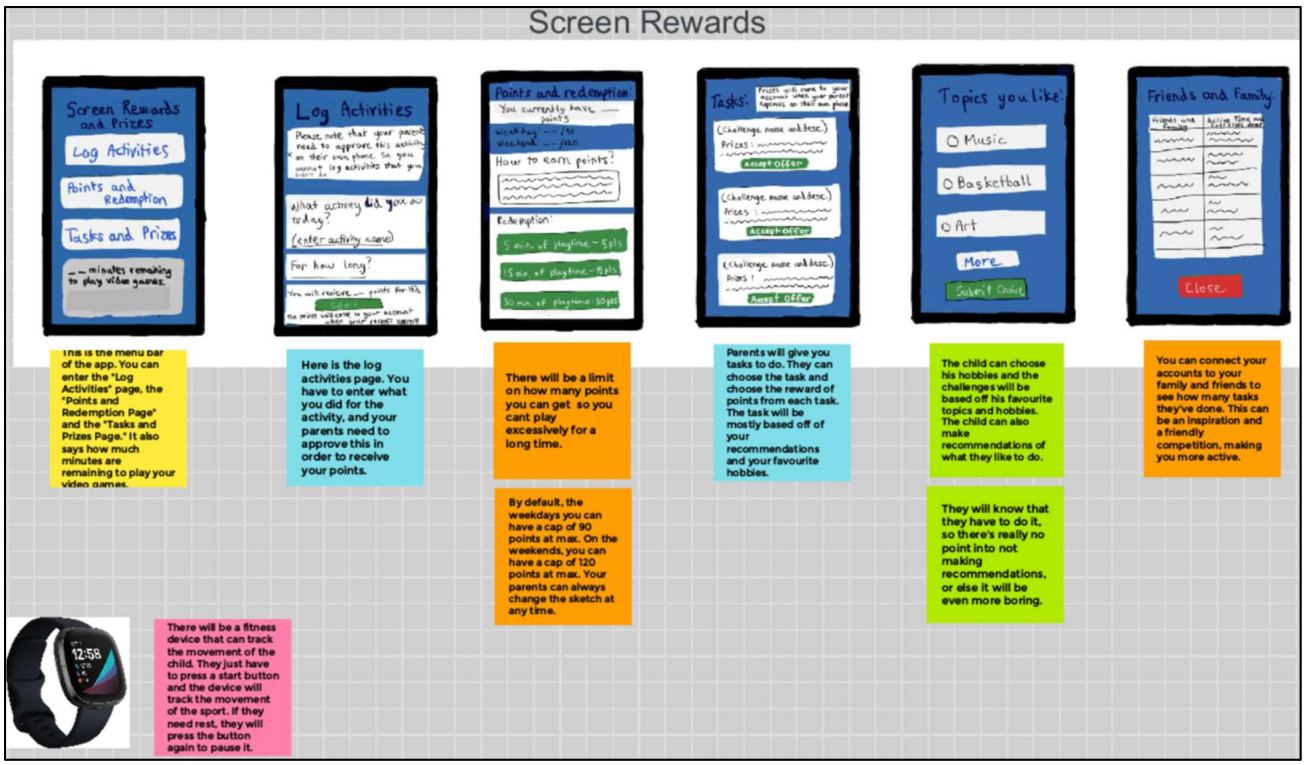

Figure 4: Final Design Sketch by Group 5 (G5); This is an app that will reward the children with screen time if they complete the tasks chosen by their parents. Children can suggest tasks that they are interested in doing. Parents will evaluate the performance before approving the rewards. There is a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

> *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."*

5.3.2 Considering Children's Emotions while Designing Mediation Strategies. While designing solutions, our participants expressed empathy towards 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 [89]. To make this transition easier, participations 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."*

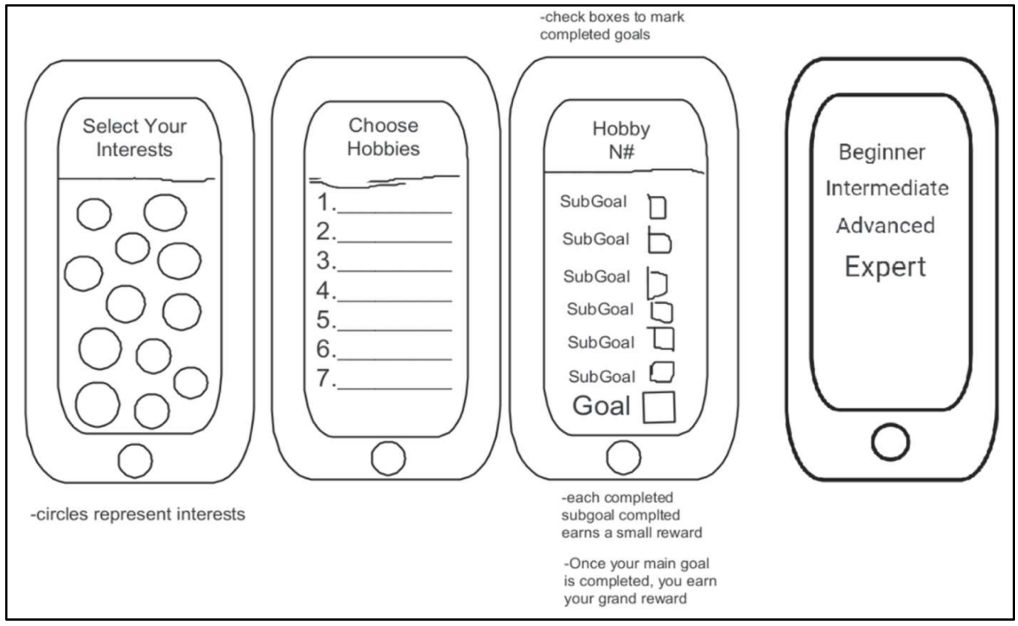

Figure 5: Final Design Sketch by Group 7 (G7); This is an app that enables children to find a new hobby. There are goals that they will accomplish collaboratively with their parents. Upon achieving a goal, they will be rewarded.

5.3.3 Positive Reinforcement to Motivate Participation. 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 [77] and reinforcement is a key component of a well-designed gamification experience [72]. A previous study with middle-school youth demonstrated the effectiveness of gamification for behavior change in case of preventing substance abuse and relationship violence [76]. 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 [77]. Our participants also talked about involving children in competitive games, where children could see each other's progress and the children 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!'"*

5.3.4 Relatedness and Novelty to Make Interventions Engaging. From the participant-generated design solutions, we observed that participants gravitated towards 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 that early adolescents often seek elements of trust and support from their peers [61]. 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 [29]. 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

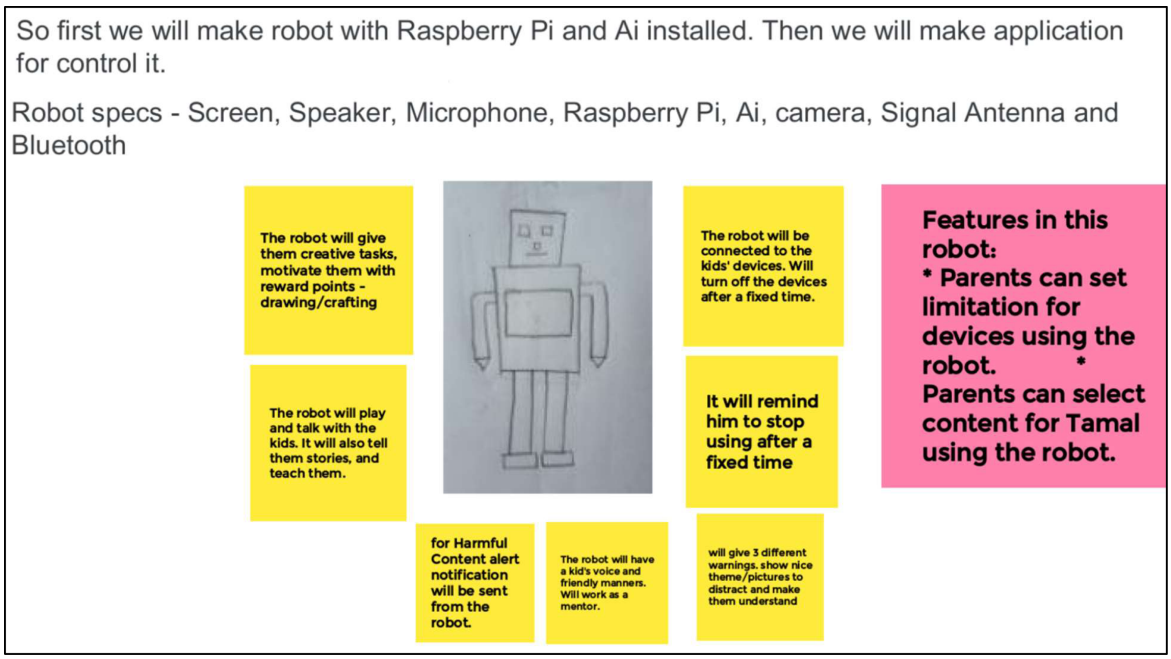

Figure 6: Final Design Sketch by Group 1 (G1); A companion robot to help children educate about the issue of tech overuse and support them in disengaging from technology.

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 tech-based 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 with time. These examples speak to the novelty-seeking tendency that is common in adolescence [81].

6 DISCUSSION

Our study findings provide insights into tech-based 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 2. We see support for many of these perspectives in the literature. For example, according to developmental psychology, children in early adolescence start to develop a sense of autonomy but still seek support from their parents [74]. Previous research states that teens feel that most of the existing interventions to control tech use overlook their needs and expectations [87], 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 [75]. 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 tech-based mediation solutions.

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 [30, 33], this shift also makes sense from a developmental standpoint.

Table 2: 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

One of our initial research questions was to what extent would design ideas from early adolescents match existing solutions? We did not observe any radically new ideas emerge – many elements of the participant-generated ideas can be found in the existing mediation strategies discussed in section 2.1. Thus, while their ideas do not necessarily spark entirely new research directions, our findings lend support that many of these elements do in fact resonate with early adolescents. Another goal of our work was to find 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 [31, 35, 41, 43]. Our findings are one step in this direction, but we see opportunities to push this even further. For example, how might early adolescents respond to tech mediation tools if they knew they were co-designed by children of their age? Or even further, what if early adolescents could design their own disengagement tools? How might the degree of child agency in design impact intervention effectiveness in terms of both tech usage and parental conflicts?

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 the 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 while considering design solutions in the following sessions. On the other hand, it is possible that asking participants to create multiple different personas might help to 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 participants 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 the researcher's 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.

7 LIMITATIONS

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 social status, income). Given that socioeconomic factors can impact parental mediation strategies in children's tech practices and parent-child relationships [73, 85], 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 [46]. 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 [53], 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.

8 FUTURE WORK

As discussed above, future work should investigate the generalizability of our findings to a larger sample of early adolescents as well as how different factors such as family backgrounds or socioeconomic status might impact how early adolescents design tech-based mediation strategies to control their tech overuse. Future studies should explore co-design with gender-uniform groups to investigate whether there is any impact of gender on participants' preferred solutions to control tech overuse. Finally, a co-design study involving both early adolescents and their parents could reveal interesting insights into parent-child relationships, family dynamics, and how different family experiences with technology influence design choices for technology disengagement.

When introducing our research problem, we did not specifically mention technology addiction. Interestingly, most of our participant groups (all except G3) mentioned addiction at some point. Although no participants self-identified as a tech-addict, many expressed their understanding of addiction and its consequences through their stories and design solutions, at least to some extent (see Figures 2A, 2C). However, since we did not ask them to define addiction, it is possible that they were equating technology overuse with addiction. Future studies could explore how early adolescents with technology addiction respond to the idea of finding solutions to control their tech use. Future work should also more carefully explore the suitability of proposed design solutions in supporting tech overuse vs. addiction. For example, many of our participants advocated for gamifying offline activities to encourage disengagement, however, gamification itself has components that are known to promote addiction [88]. On the other hand, prior work has investigated using gamification to battle addiction [8, 47].

Participants in our study realized that children in early adolescence are a very diverse population with different needs [28], and one solution is unlikely to work for all. For example, participants discussed how children with different levels of addiction would require more intensive parental involvement than those who sometimes struggle with technology dependency. Future work should therefore explore how different design elements might cater to different tech usage levels and personality types. Longitudinal studies are also needed to investigate how different early adolescents might apply these tech-based mediation strategies in their daily lives.

9 CONCLUSION

In this paper, we present insights into early adolescents' perceptions and opinions regarding the issue of tech overuse, how they envision tech-mediated solutions, and what factors they think might be helpful to support the disengagement from excessive use of technology. Findings from our study serve as justification and motivation for future design explorations that are grounded directly in the perspectives of early adolescents. Future research should continue to explore ways to involve this age group as design partners and to provide them with agency in the design of tech-based mediation tools.

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REFERENCES

[1] Chin-Siang Ang and Kam-Fong Lee. 2017. Ability to Resist Temptations of Technology Use: A Qualitative Analysis of Children's Views on Factors Associated with Delay of Gratification. *The Journal of genetic psychology 178.5*: 291-297.

[2] Erlend Bergen, Dag F. Solberg, Torjus H. Sæthre, and Monica Divitini. 2018. Supporting the Co-design of Games for Privacy Awareness. In *International Conference on Interactive Collaborative Learning*, 888–899. https://doi.org/10.1007/978-3-030-11932-4_82

[3] Cora Bergert, Antonia Köster, Hanna Krasnova, and Ofir Turel. 2020. Missing out on life: Parental perceptions of children's mobile technology use. *Proceedings of the 15th International Conference on Business Information Systems 2020 "Developments, Opportunities and Challenges of Digitization", WIRTSCHAFTSINFORMATIK*

2020. https://doi.org/10.30844/wi_2020_f1

[4] Lindsay Blackwell, Emma Gardiner, and Sarita Schoenebeck. 2016. Managing expectations: Technology tensions among parents and teens. *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW* 27: 1390–1401. https://doi.org/10.1145/2818048.2819928

[5] Lizzy Bleumers, Karen Mouws, Jonathan Huyghe, Maarten Van Mechelen, Ilse Mariën, and Bieke Zaman. 2015. Sensitivity to parental play beliefs and mediation in young children's hybrid play activities. *Proceedings of IDC 2015: The 14th International Conference on Interaction Design and Children*: 170–177. https://doi.org/10.1145/2771839.2771857

[6] V. Clarke and V. Braun. 2017. Quality in Reflexive TA Research. Retrieved from https://www.thematicanalysis.net/faqs/

[7] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 2: 77–101. https://doi.org/10.1191/1478088706qp063oa

[8] Deniz Cemiloglu, Mohamed Basel Almourad, John McAlaney, and Raian Ali. 2022. Combatting digital addiction: Current approaches and future directions. *Technology in Society* 68, November 2021: 101832. https://doi.org/10.1016/j.techsoc.2021.101832

[9] Vanessa Cesário, António Coelho, and Valentina Nisi. 2018. Co-designing Gaming Experiences for Museums with Teenagers. In *Interactivity, Game Creation, Design, Learning, and Innovation.*, 38–47. https://doi.org/10.1007/978-3-030-06134-0_5

[10] Vanessa Cesário, António Coelho, and Valentina Nisi. 2019. Word Association: Engagement of Teenagers in a Co-design Process. In *IFIP Conference on Human-Computer Interaction.*, 693–697. https://doi.org/10.1007/978-3-030-29390-1

[11] Vanessa Cesário, Sónia Matos, Marko Radeta, and Valentina Nisi. 2017. Designing interactive technologies for interpretive exhibitions: enabling teen participation through user-driven innovation. In *IFIP Conference on Human-Computer Interaction*, 232–241. https://doi.org/10.1007/978-3-319-67744-6_16

[12] Fong Ching Chang, Chiung Hui Chiu, Ping Hung Chen, Jeng Tung Chiang, Nae Fang Miao, Hung Yi Chuang, and Shumei Liu. 2019. Children's use of mobile devices, smartphone addiction and parental mediation in Taiwan. *Computers in Human Behavior* 93, April 2018: 25–32. https://doi.org/10.1016/j.chb.2018.11.048

[13] Bester Chimbo and J. H. Gelderblom. 2014. Comparing young children and teenagers as partners in co-design of an educational technology solution. In *Proceedings of the ISI e-Skills for Knowledge Production and Innovation Conference.*, 17–21.

[14] Eleanor Chin Derix, Tuck Wah Leong, and Julia Prior. 2021. It's the Same Conflict Every Time, on Repeat. In *Conference on Human Factors in Computing Systems. ACM*. https://doi.org/10.1145/3411763.3451714

[15] C. Chiong and C. Shuler. 2010. Learning: is there an app for that? Investigations of young children's usage and learning with mobile devices and apps. *New York: The Joan Ganz Cooney Center at Sesame Workshop.*: 13–20.

[16] Ananta Chowdhury and Andrea Bunt. 2022. Tutorials for Children by Children: Design and Evaluation of a Children's Tutorial Authoring Tool for Digital Art. In *Graphics Interface 2022*.

[17] Dimitri A Christakis. 2019. The challenges of defining and studying "digital addiction" in children. *Jama* 321, 23: 2277-2278.

[18] Aurora Constantin, Jessica Korte, Judith Good, Gavin Sim, Janet Read, Jerry Alan Fails, and Eva Eriksson. 2022. A Distributed Participatory Design Research Protocol for Co-designing with Children. *Proceedings of Interaction Design and Children, IDC 2022*: 510–516. https://doi.org/10.1145/3501712.3535286

[19] Arianna Davis, Neeraj Chatlani, Karla Badillo-Urquiola, and Pamela Wisniewski. 2021. Teenovate-Using Participatory Action Research to Create a Sustainable Teen Program Designing Adolescent Online Safety Solutions. *Available at SSRN 3882835*. https://doi.org/10.2139/ssrn.3882835

[20] Katie Davis, Anja Dinhopl, and Alexis Hiniker. 2019. "Everything's the Phone": Understanding the phone's supercharged role in parent-teen relationships. In *Proceedings of the 2019 CHI conference on human factors in computing systems.*, 1–14. https://doi.org/10.1145/3290605.3300457

[21] Allison Druin. 1999. Developing Cooperative New Technologies Inquiry: for Children with Children. *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*: 592–599. https://doi.org/10.1145/302979.303166

[22] David L. DuBois, Robert D. Felner, Stephen Brand, Ruby S.C. Phillips, and A. Michele Lease. 1996. Early adolescent self-esteem: A developmental-ecological framework and assessment strategy. *Journal of Research on Adolescence* 6, 4: 543–79.

[23] Melanie Duckert and Louise Barkhuus. 2021. To Use or Not to Use: Mediation and Limitation of Digital Screen Technologies within Nuclear Families. In *ACM International Conference on Interactive Media Experiences*, 73–83.

[24] Angela L. Duckworth, Tamar Szabó Gendler, and James J. Gross. 2014. Self-Control in School-Age Children. *Educational Psychologist* 49, 3: 199–217. https://doi.org/10.1080/00461520.2014.926225

[25] Jerry Alan Fails, Mona Leigh Guha, and Allison Druin. 2012. Methods and Techniques for Involving Children in the Design of New Technology for Children. *Foundations and Trends® in Human–Computer Interaction* 6, 2: 85–166. https://doi.org/10.1561/1100000018

[26] Jerry Alan Fails, Dhanush kumar Ratakonda, Nitzan Koren, Salma Elsayed-Ali, Elizabeth Bonsignore, and Jason Yip. 2022. Pushing boundaries of co-design by going online: Lessons learned and reflections from three perspectives. *International Journal of Child-Computer Interaction* 33: 100476. https://doi.org/10.1016/j.ijcci.2022.100476

[27] Daniel Fitton and Beth Bell. 2014. Working with teenagers within HCI research: Understanding teen-computer interaction. *Proceedings of the 28th International BCS Human Computer Interaction Conference: Sand, Sea and Sky - Holiday HCI, HCI 2014*: 201–206. https://doi.org/10.14236/ewic/hci2014.23

[28] Daniel Fitton, Janet C. Read, and Matthew Horton. 2013. The Challenge of Working with Teens as Participants in Interaction Design. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems.*, 205–210. https://doi.org/10.1145/2468356.2468394

[29] Manuela Fleming. 2005. Adolescent autonomy: Desire, achievement and disobeying parents between early and late adolescence. *Australian Journal of Educational and Developmental Psychology* 5: 1–16.

[30] Tatiana Fomina, Angelika Burmistrova-savenkova, and Varvara Morosanova. 2020. Self-Regulation and Psychological Well-Being in Early Adolescence: A Two-Wave Longitudinal Study. *Behavioral Sciences* 10, 3: 60.

[31] J.L. Freedman. 1965. Long-term behavioral effects of cognitive dissonance. *Experimental Social Psychology 1,2*: 145–155.

[32] Adam Galpin and Taylor Gemma. 2018. Changing behaviour: Children, adolescents and screen use. *The British Paychological Society*: 6.

[33] S. Gestsdóttir and R. M. Lerner. 2007. Intentional self-regulation and positive youth development in early adolescence: Findings from the 4-h study of positive youth development. *Developmental psychology* 43, 2: : 508.

[34] Arup Kumar Ghosh, Karla Badillo-Urquiola, Shion Guha, Joseph J. Laviola, and Pamela J. Wisniewski. 2018. Safety vs. surveillance: what children have to say about mobile apps for parental control. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–14. https://doi.org/10.1145/3173574.3173698

[35] J.F. Goodman. 2000. Moral education in early childhood. *Early Education and Development 11, 1*: 37–41.

[36] Leo A. Goodman. 1961. Snowball sampling. *The annals of mathematical statistics*: 148–170.

[37] Mark D. Griffiths. 2015. Problematic technology use during adolescence: Why don't teenagers seek treatment? *Education and Health* 33, 1: 6–9. https://doi.org/10.4309/jgi.2001.5.6

[38] M.L. Guha, Allison Druin, Gene Chipman, J.A. Fails, Sante Simms, and Allison Farber. 2004. Mixing ideas: a new technique for working with young children as design partners. *Proceedings of the 2004 conference on Interaction design and children: building a community*: 35–42. https://doi.org/10.1145/1017833.1017838

[39] Gahgene Gweon, Kung Jin Lee, Bugeun Kim, Jungwook Rhim, Jinyoung Kim, and Jueun Choi. 2018. MABLE: Mediating young children's smart media usage with augmented reality. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–9. https://doi.org/10.1145/3173574.3173587

[40] Lee Hadlington, Hannah White, and Sarah Curtis. 2019. "I cannot live without my [tablet]": Children's experiences of using tablet technology within the home. *Computers in Human Behavior* 94, June 2018: 19–24. https://doi.org/10.1016/j.chb.2018.12.043

[41] Yasmeen Hashish, Andrea Bunt, and James E. Young. 2014. Yasmeen Hashish, Andrea Bunt, and James E. Young. 2014. Involving children in content control: a collaborative and education-oriented content filtering approach. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14).*, 1797–1806. https://doi.org/10.1145/2556288.2557128

[42] Alexis Hiniker, Bongshin Lee, Kiley Sobel, and Eun Kyoung Choe. 2017. Plan & play: Supporting intentional media use in early childhood. *IDC 2017 - Proceedings of the 2017 ACM Conference on Interaction Design and Children*: 85–95. https://doi.org/10.1145/3078072.3079752

[43] Alexis Hiniker, Sarita Y. Schoenebeck, and Julie A Kientz. 2016. Not at the Dinner Table: Parents- and Children-s Perspectives on Family Technology Rules. *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing - CSCW '16*: 1374–1387. https://doi.org/10.1145/2818048.2819940

[44] Alexis Hiniker, Hyewon Suh, Sabina Cao, and Julie A. Kientz. 2016. Screen time tantrums: How families manage screen media experiences for toddlers and preschoolers. In *Proceedings of the 2016 CHI conference on human factors in computing systems*, 648–660. https://doi.org/10.1145/2858036.2858278

[45] Peter Holtz and Markus Appel. 2011. Internet use and video gaming predict problem behavior in early adolescence. *Journal of Adolescence* 34, 1: 49–58. https://doi.org/10.1016/j.adolescence.2010.02.004

[46] Jeroen Janssen, Gijsbert Erkens, Paul A. Kirschner, and Gellof Kanselaar. 2009. Influence of group member familiarity on online collaborative learning. *Computers in Human Behavior* 25, 1: 161–170. https://doi.org/10.1016/j.chb.2008.08.010

[47] Jingjie Jiang, Keith Phalp, and Raian Ali. 2015. Digital addiction: Gamification for precautionary and recovery requirements.

[48] Phoebe K. Chua and Melissa Mazmanian. 2021. What Are You Doing With Your Phone?; How Social Class Frames Parent-Teen Tensions around Teens' Smartphone Use. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–12. https://doi.org/10.1145/3411764.3445275

[49] Saba Kawas, Nicole S. Kuhn, Kyle Sorstokke, Emily Bascom, Alexis Hiniker, and Katie Davis. 2021. When Screen Time Isn't Screen Time: Tensions and Needs Between Tweens and Their Parents During Nature-Based Exploration. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems.*, 1–14. https://doi.org/10.1145/3411764.3445142

[50] Minsam Ko, Seungwoo Choi, Subin Yang, Joonwon Lee, and Uichin Lee. 2015. FamiLync: Facilitating participatory parental mediation of adolescents' smartphone Use. *UbiComp 2015 - Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*: 867–878. https://doi.org/10.1145/2750858.2804283

[51] Runa Korde and Paul B. Paulus. 2017. Alternating individual and group idea generation: Finding the elusive synergy. *Journal of Experimental Social Psychology* 70: 177–190. https://doi.org/10.1016/j.jesp.2016.11.002

[52] Priya Kumar, Jessica Vitak, Marshini Chetty, Tamara L Clegg, Jonathan Yang, Brenna Mcnally, and Elizabeth Bonsignore. 2018. Co-Designing Online Privacy-Related Games and Stories with Children. *IDC '18 Proceedings of the 17th ACM Conference on Interaction Design and Children*: 67–79. https://doi.org/10.1145/3202185.3202735

[53] Celine Latulipe, N. Bruce Long, and Carlos E. Seminario. 2015. Structuring flipped classes with lightweight teams and gamification. *SIGCSE 2015 - Proceedings of the 46th ACM Technical Symposium on Computer Science Education*: 393–397. https://doi.org/10.1145/2676723.2677240

[54] Lee, Kung Jin, Wendy Roldan, Tian Qi Zhu, Sungmin Na Harkiran Kaur Saluja, Britnie Chin, Yilin Zeng, Jin Ha Lee, and Jason Yip. 2021. The Show Must Go On: A Conceptual Model of Conducting Synchronous Participatory Design With Children Online. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–16. https://doi.org/10.1080/03601277.2019.1599556

[55] Crystal Ling and Hon Kai Yee. 2021. Parental mediation: Its impact on contexts of emotional behavioral adjustment among children in Kota Kinabalu district. *Cogent Social Sciences* 7, 1. https://doi.org/10.1080/23311886.2020.1870070

[56] Sonia Livingstone, Giovanna Mascheroni, Michael Dreier, Stéphane Chaudron, and Kaat Lagae. 2015. How parents of young children manage digital devices at home: The role of income , education and parental style. *EU Kids Online*, September: 3–25.

[57] Maarten Van Mechelen, Ann Laenen, Bieke Zaman, Bert Willems, and Vero Vanden Abeele. 2019. Collaborative Design Thinking (CoDeT): A co-design approach for high child-to-adult ratios. *International Journal of Human Computer Studies* 130: 179–195. https://doi.org/10.1016/j.ijhcs.2019.06.013

[58] David Mitchell and Dean Sutherland. 2020. From research to practice: understanding self-regulation. *What Really Works in Special and Inclusive Education*: 423–431. https://doi.org/10.4324/9780429401923-43

[59] Utsa Mukherjee. 2021. Navigating children's screen-time at home: narratives of childing and parenting within the familial generational structure. *Children's Geographies* 19, 6: 646–658. https://doi.org/10.1080/14733285.2020.1862758

[60] Elyna Nevski and Andra Siibak. 2016. The role of parents and parental mediation on 0–3-year olds' digital play with smart devices: Estonian parents' attitudes and practices. *Early Years* 36, 3: 227–241. https://doi.org/10.1080/09575146.2016.1161601

[61] Amanda B. Nickerson and Richard J. Nagle. 2005. Parent and peer attachment in late childhood and early adolescence. *Journal of Early Adolescence* 25, 2: 223–249. https://doi.org/10.1177/0272431604274174

[62] Peter Nikken and Jos de Haan. 2015. Guiding young children's internet use at home: Problems that parents experience in their parental mediation and the need for parenting support. *Cyberpsychology* 9, 1. https://doi.org/10.5817/CP2015-1-3

[63] Peter Nikken and Marjon Schols. 2015. How and Why Parents Guide the Media Use of Young Children. *Journal of Child and Family Studies* 24, 11: 3423–3435. https://doi.org/10.1007/s10826-015-0144-4

[64] Florence Nwankwo, Hyunjae Daniel Shin, Amin Al-Habaibeh, and Hiba Massoud. 2019. Evaluation of Children's Screen Viewing Time and Parental Role in Household Context. *Global Pediatric Health* 6. https://doi.org/10.1177/2333794X19878062

[65] Office of Communications. 2022. Children and parents: media use and attitudes report 2022. *Ofcom*, March: 11–35. https://doi.org/10.2307/j.ctv2d7x4jp.4

[66] Pinar Oztop and Michaela Gummerum. 2020. Group creativity in children and adolescents. *Cognitive Development* 56, December 2019: 100923. https://doi.org/10.1016/j.cogdev.2020.100923

[67] Weny Savitri S. Pandia, Margaretha Purwanti, and Debri Pristinella. 2019. Parental Mediation with Adolescent Users of I.T. Devices. *ANIMA Indonesian Psychological Journal* 34, 4: 222–230. https://doi.org/10.24123/aipj.v34i4.2582

[68] Stamatios Papadakis, Nikolas Zaranis, and Michail Kalogiannakis. 2019. Parental involvement and attitudes towards young Greek children's mobile usage. *International Journal of Child-Computer Interaction* 22: 100144. https://doi.org/10.1016/j.ijcci.2019.100144

[69] Caroline Pitt and Katie Davis. 2017. Designing together? group dynamics in participatory digital badge design with teens. In *Proceedings of the 2017 Conference on Interaction Design and Children.*, 322–327. https://doi.org/10.5040/9781474293884.ch-006

[70] Kyrill Potapov and Paul Marshall. 2020. LifeMosaic: Co-design of a personal informatics tool for youth. *Proceedings of the Interaction Design and Children Conference, IDC 2020*: 519–531. https://doi.org/10.1145/3392063.3394429

[71] Victoria Rideout, Alanna Peebles, Supreet Mann, and Michael B. Robb. 2022. The Common Sense Census: Media Use by Tweens and Teens, 2021.

[72] Karen Robson, Kirk Plangger, Jan H. Kietzmann, Ian McCarthy, and Leyland Pitt. 2015. Is it all a game? Understanding the principles of gamification. *Business Horizons* 58, 4: 411–420. https://doi.org/10.1016/j.bushor.2015.03.006

[73] Dong Rouchun, Zhou Zongkui, Lian Shuailei, Liu Qingqi, and Guo Chen. 2021. Family socioeconomic status and the parent-child relationship: Children's Internet use as a moderated mediator. *Current Psychology* 40, 9: 4384–4393. https://doi.org/10.1007/s12144-019-00356-0

[74] Mauricio Salgado, Luis González, and Alejandra Yáñez. 2021. Parental Involvement and Life Satisfaction in Early Adolescence. *Frontiers in Psychology 12*. https://doi.org/10.3389/fpsyg.2021.628720

[75] Diane J. Schiano, Christine Burg, Anthony Nalan Smith, and Florencia Moore. 2016. Parenting digital youth: How now? In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 3181–3189. https://doi.org/10.1145/2851581.2892481

[76] Dick Schoech, Javier F. Boyas, Beverly M. Black, and Nada Elias-Lambert. 2013. Gamification for Behavior Change: Lessons from Developing a Social, Multiuser, Web-Tablet Based Prevention Game for Youths. *Journal of Technology in Human Services 31*, 197–217. https://doi.org/10.1080/15228835.2013.812512

[77] Sepandar Sepehr and Milena Head. 2013. Competition as an element of gamification for learning: An exploratory longitudinal investigation. In *Proceedings of the First International Conference on Gameful Design, Research, and Applications.*, 2–9. https://doi.org/10.1145/2583008.2583009

[78] James Sherer and Petros Levounis. 2022. Technological Addictions. *Current Psychiatry Reports* 24, 9: 399–406. https://doi.org/10.1007/s11920-022-01351-2

[79] Hyunjin Shin and Gahgene Gweon. 2020. Supporting preschoolers' transitions from screen time to screen-free time using augmented reality and encouraging offline leisure activity. *Computers in Human Behavior* 105, April 2019: 106212. https://doi.org/10.1016/j.chb.2019.106212

[80] Wonsun Shin. 2018. Empowered parents: the role of self-efficacy in parental mediation of children's smartphone use in the United States. *Journal of Children and Media* 12, 4: 465–477. https://doi.org/10.1080/17482798.2018.1486331

[81] Linda Patia Spear. 2013. Adolescent neurodevelopment. *Journal of adolescent health* 52, 2: S7–S13.

[82] G. Terlouw, J. T.B. van't Veer, D. A. Kuipers, and J. Metselaar. 2020. Context analysis, needs assessment and persona development: towards a digital game-like intervention for high functioning children with ASD to train social skills. *Early Child Development and Care* 190, 13: 2050–2065. https://doi.org/10.1080/03004430.2018.1555826

[83] Gavin Tierney, Theresa Horstman, and Carrie Tzou. 2021. Youth co-design of responsive digital badge systems: disrupting hierarchy and empowering youth. *CoDesign 17*, 313–329. https://doi.org/10.1080/15710882.2019.1654522

[84] Elaine Toombs, Christopher J Mushquash, Linda Mah, Kathy Short, Nancy L Young, Chiachen Cheng, Lynn Zhu, Gillian Strudwick, Catherine Birken, Jessica Hopkins, Daphne J Korczak, Anna Perkhun, and Karen B Born. 2022. Increased Screen Time for Children and Youth During the COVID-19 Pandemic. *Science Briefs of the Ontario COVID-19 Science Advisory Table* 3, 59: 1–19. https://doi.org/10.47326/ocsat.2022.03.59.1.0

[85] Rabia ÜSTÜNDAĞ ALKAN, Alper ASLAN, Yiğit Emrah TURGUT, and Engin KURŞUN. 2021. Factors Affecting Parental Mediation Strategies in Children's Technology Use: A Systematic Review. *Journal of Computer and Education Research* 9, 18: 702–723. https://doi.org/10.18009/jcer.925859

[86] Ralph Vacca. 2019. Brokering data: Co-designing technology with latina teens to support communication with parents: Leveraging cultural practices of latinx youth through co-design. In *Proceedings of the 18th ACM International Conference on Interaction Design and Children.*, 197–207.

[87] Pamela Wisniewski, Arup Kumar Ghosh, Heng Xu, Mary Beth Rosson, and John M. Carroll. 2017. Parental control vs. teen self-regulation: Is there a middle ground for mobile online safety? *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing - CSCW '17*: 51–69. https://doi.org/10.1145/2998181.2998352

[88] Toshihiko Yamakami. 2013. Gamification literacy: Emerging needs for identifying bad gamification. *Multimedia and Ubiquitous Engineering. Springer, Dordrecht*: 395–403. https://doi.org/10.1007/978-94-007-6738-6_49

[89] Jee Bin Yim and Woohun Lee. 2021. Romi: Screen Peripheral Companion for Mediating Children's Healthy Screen Use. In *Interaction Design and Children*, 456–460.

[90] Kimberly S. Young and Cristiano Nabuco (Eds.) De Abreu. 2017. *Internet addiction in children and adolescents: Risk factors, assessment, and treatment.* Springer Publishing Company.