Designing Persuasive Technology to Prevent Internet Addiction in Young Children: Promoting Healthy Digital Behavior

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Abstract

In this digital age, children are given various online activities from early childhood. Young children are vulnerable to internet addiction due to some personal limitations and influence from the environment (e.g., families and peers). Previous studies reported the high risk and prevalence of internet addiction in young children, especially in developing regions. Given the potential of persuasive technology in supporting health behaviors, its use may be beneficial to preventing internet addiction in children. Therefore, this research aims to investigate, design, and evaluate a persuasive technology intervention to prevent or reduce internet addiction risk in children aged 7–11. My research employs the design thinking framework, co-design approach, and persuasive design principles to achieve the objective. This research is divided into three main phases: 1) understanding the problem space, 2) developing the intervention, and 3) evaluating the intervention. The preliminary findings from the first phase suggest the need to develop an intervention to continuously increase the motivation and capability of children to have healthy internet use and for parents to provide appropriate parental mediation. The proposed intervention will be a digital tool (software) to facilitate and mediate families in shaping healthy digital behavior in children. Potential functions to achieve the objective may include device use management, substitution activity suggestions, competency development to combat addictive behavior, healthy internet use education, and personalized parental mediation decision-making support.

Keywords

Co-Design, Children, Digital Behavior, Design Thinking, Internet Addiction, Persuasive Technology, Problematic Internet Use

1. Introduction

The internet provides significant benefits in supporting our lives and work. Nowadays, parents provide their children with various online activities since early childhood [1, 2]. In this digital age, the internet offers useful functions and content to support children's activities (e.g., learning and entertainment) [3, 4]. However, the increasing number of online activities among young children raises our concerns about addictive behavior due to internet use. World Health Organization and the American Psychiatric Association have recognized behavioral disorders related to internet and gaming activities as a recognized mental health issue that needs further studies [5, 6].

Internet addiction is a behavioral disorder caused by excessive and uncontrolled internet use that has negative consequences on one's health [7]. Multiple studies reported the harmful effects of internet addiction in children, such as anxiety, eye problems, musculoskeletal pain, declining school performance, sleep disorders, and antisocial behavior [7-11]. Young children are vulnerable to this problem because they typically have limited self-control, limited digital literacy, and incomplete brain development [12, 13]. Their environment (e.g., families and peers) may also negatively influence their

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internet use [14, 15]. Internet addiction in young children can be jointly influenced by factors related to children (e.g., behavior, emotion, engagement, and motivation toward internet use), families (e.g., socioeconomic condition, dysfunction, media use behavior, digital literacy, and parent–child relationships), and social environment (e.g., digital environment, peer technology access, and peer influence) [15].

Some interventions have been developed to prevent or reduce internet addiction risk in children, such as education, parenting rules or guidelines, encouraging more physical activities, and therapy [7, 16]. However, prior studies highlighted the limitations of the existing interventions (e.g., the temporariness of the program, limited parental capability, and limited accessibility) [16-18]. They also suggested the need for digital intervention to provide sustainable effects and holistic features in addressing the problem. Although often viewed as paradoxical, like "fighting fire with fire," using digital intervention may be beneficial for improving the knowledge and capability of children and their parents/ guardians in having healthy internet use to prevent addictive behaviors [17, 19]. Some digital interventions, such as parental control software and digital well-being applications, have been available in the market to help monitor and manage users' screen time. However, there is a lack of studies on how digital intervention can be utilized to support encouraging healthy internet use and preventing internet addiction in children.

Internet addiction is categorized as a behavioral disorder because it is driven by a compulsive, uncontrolled, and repeated behavior pattern that leads to harmful effects [7, 20]. To address this behavioral problem, we need to prevent or reduce risky digital behaviors that can lead to internet addiction [7, 15]. Persuasive technology has been proven to have great potential in improving desirable health behaviors [21-23]. Prior studies also highlighted that persuasive technology could have positive impacts on motivation and capability to support healthy digital behavior [15, 24]. However, there is a lack of studies utilizing persuasive technology as a preventive intervention for internet addiction in young children. Therefore, my research focuses on developing a persuasive digital intervention to prevent or reduce risky digital behaviors that can lead to internet addiction in young children.

2. Aims and Research Questions

The high risk of internet addiction in children, the intervention gaps to prevent the problem, and the potential of persuasive technology to address the problem have motivated me to investigate persuasive technology as a preventive intervention for the problem. Therefore, this research aims to investigate, design, and evaluate a persuasive technology intervention to prevent or reduce internet addiction risk in young children (aged 7–11) by promoting healthy digital behavior. This research is expected to contribute to knowledge and design practice in investigating and designing persuasive technology to prevent internet addiction in children.

Children typically start using the internet regularly for school, learning, and entertainment at primary school age [4]. This underlies why the intervention developed in my research is intended for primary school children (7–11 years old). This research is conducted in the Indonesian context, a developing country with more than 30 million child internet users [25]. Previous studies reported that people (including children) in developing regions with lower income and quality of life tend to have higher internet addiction risk [26, 27]. Align with these studies, Indonesian children and adolescents were also reported to have a high risk and prevalence of internet addiction [27, 28].

In this research project, three research questions were formulated:

RQ 1: What is the problem space of the persuasive technology intervention to prevent internet addiction in young children?

RQ 2: How can persuasive technology intervention be designed to prevent internet addiction in young children by promoting healthy digital behavior?

RQ 3: What is the effect of the intervention on promoting healthy digital behavior and preventing internet addiction in young children?

This research is conducted in three serial phases to achieve the objective. The findings from the previous phases will be the primary input for the subsequent phases. For example, the problem space findings (RQ1) will be the basis for developing the intervention (RQ2), whereas the intervention design findings (RQ2) will be the basis for evaluating the intervention (RQ3). The overall findings of these

three phases will be the basis for writing my PhD thesis. To date, I have identified the problem space and defined the direction of the intervention (RQ1). The summary of the key findings from the RQ1 is explained in section 4 (preliminary findings and future work). The design (RQ2) and evaluation (RQ3) phases will be conducted in 2024–2025.

3. Methodology

This research integrates a design thinking framework, co-design approach, and persuasive design principles. Design thinking is a problem-solving framework emphasizing human-centered, creative, systematic approaches [29]. This framework has an interdisciplinary approach, human-centered processes, creative tools, and iterative nature that may be beneficial to address a complex problem like internet addiction in children [30, 31]. The design thinking framework consists of seven stages: 1) understand, 2) observe, 3) define, 4) ideate, 5) prototype, 6) test, and 7) reflect [29]. To answer the research questions, this research is conducted in three main phases following the design thinking framework, including 1) understanding the problem space (understand, observe, and define), 2) developing persuasive technology (ideate and prototype), and 3) evaluating the intervention (test and reflect).

The co-design approach is used to develop the best feasible intervention in collaboration with children and parents. This approach has been proven promising in creating design-led innovation with meaningful user engagement [32]. This research develops a Digital Behavior Change Intervention (DBCI) to prevent internet addiction in young children by promoting healthy digital behavior [22]. Two persuasive design models with promising validity and robustness are adopted in the design process to guide us in creating appropriate persuasive strategies in the intervention: Design with Intent (DwI) and Persuasive System Design (PSD) [33-35].

3.1. Phase 1: Understanding the Problem Space

The data collection of this phase was performed from September to November 2023. In this phase, I conducted a mixed-methods study utilizing survey, diary, and interview methods to explore the problem space and the design requirements of digital intervention for preventing internet addiction in young children. I involved three groups of participants: 1) parents who are primary guardians of children, 2) health practitioners (child therapists) who are experts in internet addiction treatment and prevention, and 3) product developers who are designers of online apps and games for children. The participants were recruited from parenting communities, hospitals/psychology bureaus, and digital product companies in Indonesia.

I conducted an online survey via Qualtrics (1,627 participants) and a one-week electronic diary study (22 participants) to explore parents' perspectives and experiences about children's online activities, internet addiction risk, and parental efforts to promote healthy digital behavior. The survey questions were adopted from the Digital Screen Exposure Questionnaire (DSEQ) and the Parent-Child Internet Addiction Test (PCIAT) [36, 37]. The diary study provided a deep exploration of the children's digital behavior and parental efforts, whereas the survey explored related behaviors that may increase the risk of internet addiction. I interviewed six therapists to explore their experiences, challenges, and considerations in reducing internet addiction risk in young children. Six product developers were also interviewed to explore their experience and considerations in designing digital products for children and preventing internet addiction in children. In addition, I explored the perceptions of all groups of participants about using digital intervention to prevent internet addiction in children. I performed statistical analysis for quantitative data and thematic analysis for the qualitative data [38].

3.2. Phase 2: Developing the Intervention

This phase will be conducted from May to November 2024. This phase will consist of six co-design workshops (3 rounds with children and 3 rounds with parents) and prototyping. I will involve 24 participants consisting of 12 children aged 7–11 with regular internet use and 12 parents of the

participating children. The co-design participants will be recruited from parenting communities in Indonesia and the participants from the first phase who are willing to participate. The design workshops for parents and children will be conducted in separate sessions to avoid biases due to the parent-child relationship. Each participant will be randomly assigned into two groups of six parents and two groups of six children. All workshops will take place in a university meeting room in Bandung City, West Java, Indonesia. Each workshop will last for 90 minutes. The co-design findings will be synthesized as the primary considerations in developing the final design and the high-fidelity prototype of the intervention.

Co-designing with children will consist of three rounds: 1) exploring potential solutions, 2) designing digital intervention ideas, and 3) evaluating the ideas. In the first round, we will explore children's perspectives on potential solutions to prevent internet addiction through a focus group discussion (storytelling). In the first workshop, the children will be involved in a focus group discussion through storytelling. There will be three storytelling sessions (20 minutes each) with different topics: 1) preventing excessive internet use, 2) encouraging positive internet use, and 3) encouraging more real-world activities. The children will take turns telling stories within their group about what they perceive towards the topic discussed, and others may give responses to the story. In the second workshop, they will brainstorm design ideas on the digital tool features to help them prevent internet overuse. The findings from the first round and choice-based cards will be the prompts in the ideation process. The use of choice-based cards was inspired by prior co-design studies [39, 40]. They will also be encouraged to make simple interface sketches to illustrate their ideas. In the third workshop, they will present the ideas they generated in the second workshop. They are welcome to give a judgment and feedback on each idea discussed.

The structure of the co-design workshops with parents will be similar to the children's workshops. In the first workshop, the parents will have three focus group discussion sessions with three topics: 1) managing children's internet use, 2) parental mediation strategies, and 3) internet use education and role modeling. In the second round, the participants will brainstorm design ideas on the digital intervention features to support them in preventing internet addiction in their children. The findings from the first round and persuasive inspiration cards will be the prompts in the ideation process. Each card includes potential persuasive patterns inspired by the Persuasive System Design model [33] to create persuasive features or content in the digital tool. They will also make simple interface sketches to illustrate their ideas. After the ideation process, they will discuss the ideas generated and group them using the affinity diagram. In the third workshop, they will present their ideas and provide feedback on each other's ideas.

3.3. Phase 3: Evaluating the Intervention

The evaluation phase will be conducted from January to June 2025. This phase aims to assess the quality of the intervention based on potential users' perspectives. The participants will be recruited from will be recruited from parenting communities in Indonesia and the participants from the first phase who are willing to participate. This phase will be divided into formative and summative tests. In the formative test, usability testing will be conducted involving ten children aged 7–11 with regular internet use and their parents using cognitive walkthroughs, quantitative survey (System Usability Scale), and qualitative interviews [41, 42]. The findings will be analyzed thematically, and the prototype will be refined based on the findings before conducting the summative test.

In the summative test, I will conduct mixed-methods field testing involving 15 children aged 7–11 with regular internet use and their parents to assess the efficacy and persuasiveness of the intervention in preventing internet addiction and improving parental mediation. The evaluation will use a pretest-posttest design (4-week implementation). Three efficacy measures will be used: PCIAT, DSEQ, and Parental Mediation Scale for children's internet use [36, 37, 43]. The persuasiveness of the intervention will be assessed using a behavior diary (measuring use experience and behavior changes) and the Perceived Persuasiveness Questionnaire [44, 45].

3.4. Ethics Approval

Ethical approval for the first phase of this research has been obtained from the Swinburne University of Technology Human Research Ethics Committee with reference number 20237278-16490 (approval date: 24 August 2023). The ethics application for the subsequent phases is currently under submission and review. Written or electronic informed consent is required for each research participant prior to the data collection.

4. Preliminary Findings and Future Work

At the time of this writing, I have obtained the findings from the first phase of the research. According to the findings, internet addiction risk in young children was associated with online entertainment activities (e.g., gaming, social media, and watching videos for entertainment) on mobile devices (e.g., smartphones and tablets). Productive internet use (e.g., doing schoolwork and learning new languages) and the use of television were not associated with addiction risk.

From the first phase, I identified risky digital behaviors and parental mediation behaviors associated with internet addiction risk in young children (e.g., excessive mobile screen time for entertainment activities, bad internet use habits, boredom proneness, and inadequate parental supervision and regulations). Based on the identified risky behaviors, I defined the target behaviors expected from parents and children through digital intervention use (e.g., children understand healthy internet use, children are motivated to use the internet for positive activities and spend more time for real-world activities, parents are motivated and capable of providing appropriate parental mediation for children's internet use, and parents proactively educate children on healthy internet use, and parents can be role models of internet use for their children). The persuasive technology intervention is developed to support and encourage the desirable behaviors identified.

The participants of the first phase highlighted the vital role of parents/guardians in developing healthy or risky digital behavior in children. Although children may be influenced by others (e.g., peers and siblings), they argued that parents typically have a more significant influence on shaping children's digital behavior and foundations to combat addictive behaviors. However, I found that many parents do not have the awareness, capacity, and capability to direct their children away from risky digital behavior. Besides, health practitioners reported that they might not be able to reach all families to provide education and prevention materials about this problem. In addition, there are no standardized guidelines for recommended internet use for Indonesian children currently. Therefore, the use of digital intervention may have great potential to overcome the limitations by improving parents' capability and motivation in managing their children and facilitating health practitioners or the government in promoting addiction prevention strategies to families.

The preliminary findings suggest the need to develop a persuasive technology intervention to continuously increase the motivation and capability of children to have healthy internet use and for parents to provide appropriate parental mediation for children's internet use. The intervention may also facilitate health practitioners or the government to provide addiction prevention materials or guidelines for families. The proposed intervention will be a digital intervention (software) to facilitate and mediate families in shaping healthy digital behavior in children. This system can connect and manage multiple devices as parents and children may use more than one device (e.g., smartphones, tablets, and laptops). The potential functions to combat internet addiction in children may include managing internet use, suggesting attractive substitution activities, building children's competencies to combat addictive use, educating parents and children on healthy internet use, and facilitating personalized parental mediation decision-making to manage children's internet use. For future work, I will conduct the subsequent phases (co-design and evaluation) to achieve the objective of this research. The findings from the first phase will be the primary considerations in developing the intervention.

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