
Teaching with an Interactive E-book to Improve Children's Online Privacy Knowledge

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Abstract

We designed the Cyberheroes interactive e-book and conducted a preliminary user study to test its effectiveness in educating children aged 7 to 9 about online privacy risks. Children and parents found the book to be fun and engaging. Our study included pre and post interviews and knowledge assessment. It showed that the interactive e-book successfully improved children's understanding of privacy risks while exhibiting excellent retention in knowledge after one week.

Author Keywords

Child-Computer Interaction; Mobile Learning; Interactive E-Book; Enhanced E-Book; Privacy

ACM Classification Keywords

H.5.1 [Information interfaces and presentation]: User Interfaces – *Prototyping*

Introduction

Children's mobile device use is on the rise, with 72 percent of children aged 8 and under regularly having access to a mobile device to engage in a variety of online activities [7]. Frequent connectivity increases children's exposure to online privacy risks. Although parents have always been concerned about children and adolescents' privacy, young children are particularly vulnerable because they do not have

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IDC '16, June 21-24, 2016, Manchester, United Kingdom

ACM 978-1-4503-4313-8/16/06

<http://dx.doi.org/10.1145/2930674.2935984>



Figure 1: Screens from Cyberheroes. A) Home Screen; B) Online Trust; C) Digital Trail; D) Cyberpowers

the maturity, experience, nor the knowledge to safely navigate online spaces. A recent qualitative study [13] showed that parents have a desire to educate young children about online risks, but they also want to shelter them from online negativity. Concerns were raised about exposing children to inappropriate educational content (e.g., designed for tweens or teens). Parents also had varying opinions about the appropriate age for accessing various types of online tools and services like social media, and were thus cautious about children's early exposure to these subjects.

We set out to design age-sensitive education material for children under the age of 10 about online privacy. The result is Cyberheroes, an interactive e-book that gently introduces children to essential online privacy knowledge through a fictional storyline (see Figure 1). We conducted a preliminary user study to evaluate its effectiveness. Thus far, results from nine child-parent dyads suggest that both parents and children highly enjoyed reading the interactive e-book. The interactive features were found to be fun and engaging. Three privacy proficiency tests showed that children's privacy knowledge significantly improved after reading Cyberheroes, and that the educational effect was sustained after one week.

Related Work

We define children's interactive e-books as digital books with multimodal enhancements such as sounds, animations, and narrations. Interactive (also called enhanced) e-books have the potential to change the way children read and consume content because of their interactivity and convenience [11]. While several works found that multimedia enrichments in interactive e-books had positive effects on children's user experience [2], comprehension of the story content [8], and narrative inference and language skills [12], others cautioned that some multimedia features

could distract children from reading [3] and hinder comprehension [5]. The literature shows that it is not yet clear whether interactive features in e-books positively or negatively affect children's engagement, comprehension, and absorption of the content.

Several authors proposed guidelines for creating well-designed interactive e-books. Korat and Shamir [6] argued that multimedia features should be strategically used to support children's attention to the text. Dünser and Hornecker [4] advised that interactive sequences should augment and illustrate the text and help to advance the story, and that clear signals should be provided when an interactive sequence is triggered. Roskos et al. [10] examined three research-based analytic tools (de Jong-Bus Tool, Clark-Mayer Tool, Blueprint Key Tool) for evaluating interactive e-books, and highlighted the distinguishing features that each tool offer. Schugar et al. [11] outlined four considerations for using interactive e-books with young readers: vocabulary and inference support; ratio of supporting and extending interactions to distracting interactions; time required to engage in interactions; and frequency and placement of interactions. The general consensus among these guidelines is that the effects of multimedia on children's comprehension should be given careful consideration in the design of children's interactive e-books. From this perspective, we present the design of Cyberheroes, an children's interactive e-book about mobile online privacy.

Design of Cyberheroes

Cyberheroes¹ is an interactive picture e-book designed for children aged 7 to 9. Screenshots from the interactive e-book are shown in Figure 1. The central story is that Cyber-

¹The Cyberheroes interactive e-book app is available for free online at <http://www.versipass.com/edusec/cyberheroes> and in the App Store (currently for iPads only).

ID Principles and Key Features	
Multimedia	Include both words and graphics
Contiguity	Place printed words near corresponding graphics
Redundancy	Do not add audio narration to on-screen text
Coherence	Avoid extraneous audio, graphics, and words
Personalization	Use conversational (child-friendly) language

Table 1: Instructional design principles for e-learning adapted from Clark & Mayer [1]

heroes (a play on superheroes) must maintain their secret identities on the Internet. Due to the popularity of the superhero genre through comics and film, we believe the story would resonate with children and make the concept of privacy easy to understand. The 13-page storybook centres around two Cyberheroes, Ally and Bobby, who lost their cyberpowers and must face the consequences. Each cyberpower is a privacy-related lesson about personal information, online trust, location sharing, cyberbullying, and passwords (summarized in Figure 1D).

We digitally created the majority of the illustrations in Adobe Illustrator using a Wacom graphics tablet. In some cases, we adapted royalty-free stock images for the backgrounds. Finished graphics and royalty-free sounds were imported into GameSalad Creator² to create the interactive features.

The design of Cyberheroes is based on instructional design principles for e-learning (see Table 1 for a summary of the principles) adapted from Clark and Mayer [1]. Based on the Multimedia principle, we created illustrations that are congruent with the instructional message. We filled each page with colourful illustrations and kept textual instruction to a minimum to support children's limited vocabulary and to stimulate the imagination of our target age group. All text in the interactive e-book is given careful typographic consideration to ensure that they work with the illustrations to support the Contiguity principle. Certain words are enlarged to emphasize their importance. In the children's e-book genre, it is popular to provide both text and audio that narrates the text. However, research [1] shows that explaining text with audio could hurt learning. Based on the Redundancy principle, we designed the interactive e-book with no voice narration. We avoided extraneous content to support the Coherence principle. The interactive features were designed

²GameSalad Creator is an application for making interactive games.

with a purpose, whether it is to show cause and effect relationships, advance the story, or to infer moods and feelings of the characters or the situation. For example, the 'online trust' page (see Figure 1B) shows that some people online are not who they say they are. When the user taps on the character on the top right, the image of 9-year-old 'Alex' changes to 42-year-old 'Mr. R'. Ally responds to the change with a surprised expression and a shriek. On the 'digital trail' page (see Figure 1C), the trail fades away when the user attempts to 'erase' it by dragging the pink eraser, but it always reappears. The interface is simple with visual cues to highlight the interactive areas on screen (marked with a rotating star or a pulsing hand symbol for movable objects). The Cyberheroes interactive e-book has a 'mute all sounds' option to support individuals' reading preferences. Lastly, we used the Personalization principle to give advice in child-friendly language from the second person point of view to (e.g., "be careful of who *you* trust online").

Methodology

Participants and Recruitment

In our ethics-approved study, parents and children (aged 7 to 9) were recruited through social media and email. The sessions took place in quiet rooms at public locations such as city libraries. Nine child-parent dyads participated in the study. The mean age of the child participants was 8.2 years old, with four male, and five female participants. All children regularly used a mobile device and were online for at least 20 minutes daily. Their primary activities on mobile devices were playing games (9/9), watching YouTube (8/9), and taking pictures (8/9). Six children had prior experience reading e-books, and five had received some prior education about privacy or online safety from a parent or a teacher. Seven of the children were accompanied by mothers and two by fathers. The adults were between the ages of 30 to 44 and had a college diploma or a bachelor's degree. Four mothers

Procedure & Materials	
Session I	
	Q: Adult Demographic
<i>Adult</i>	Q: Child Demographic
	Q: Pre-Evaluation
<i>Child</i>	I: Pre-Test
Co-reading (parent & child)	
<i>Adult</i>	Q: Post-Evaluation
<i>Child</i>	Q: Post-Evaluation
	I: Post-Test
Session II	
<i>Child</i>	I: One-Week-Test

Table 2: Study procedure and materials. Q – Questionnaire; I – Interview (structured)

were stay-at-home moms and the rest of the adults were working professionals.

The adults signed two informed consent forms (adult & child). The child participants provided verbal assent. Participants were assigned an anonymous codename (e.g., P1 – P9 for adults; C1 – C9 for children). For analysis purposes, the child-parent dyads were coded in such a way that the pair can still be matched (e.g., C1 is the child of P1). The 50-minute study had two sessions. Each participant received a \$10 honorarium for a total of \$20 per family.

Procedure and Materials

The study procedure and materials for children and adults are summarized in Table 2.

Adults: In Session I, parents completed an Adult Demographic Questionnaire (age, gender, education, and occupation), and a Child Demographic Questionnaire (age, gender, grade, device use and activities, and the house rules regulating these activities). Parents also completed a Pre-Evaluation Questionnaire where they sorted and ranked the importance (1 – least important; 5 – most important) of five criteria (i.e., fun, age-appropriateness, ease of use, educational value, and effectiveness) for choosing educational e-books. Next, the parent co-read the interactive e-book with their child on an iPad provided by the researcher. Parents and children were given full control of the reading session. The parent completed a Post-Evaluation Questionnaire that contained nine 5-point Likert-scale questions and three open-end questions to elicit their opinions.

Children: In Session I, the Pre-Test Interview with children focused on seven themes to gauge their understanding of privacy risks: 1) privacy & online privacy; 2) personal information, 3) online trust, 4) location sharing, 5) cyberbullying, 6) passwords, and 7) digital trail. Theme one in-

quired about children's conception of privacy. Themes two to seven contained situation-based interview questions where children responded to scenarios (e.g., your best friend wants to borrow your password) and explained what they would do and why. Next, the child co-read the interactive e-book with their parent. They completed a Post-Evaluation Questionnaire with assistance from the researcher. An Again-Again Table [9] about whether they would like to read the interactive e-book again ('yes', 'maybe', or 'no') was used to measure engagement. In the analysis, the Again-Again Table evaluations were coded as 3 for 'yes', 2 for 'maybe' and 1 for 'no'. To elicit opinions of the interactive e-book, the children answered five 5-point Likert-scale questions based on the Smileyometer [9]. Each question was coded from 1 (least positive) to 5 (most positive). A Post-Test Interview repeated the questions from the Pre-Test Interview to assess learning effectiveness.

Session II took place after one week. The children completed another interview to assess learning effects and retention. The One-Week-Test contained alternate scenarios from the pre-/post-tests and questions about the interactive e-book. The interviews were audio recorded and transcribed for analysis. Interview answers from all three tests were coded 3 for an excellent response, 2 for a marginal response, and 1 for a poor response. Scores for each question were summed to get a total 'privacy proficiency score' out of 30.

Preliminary Results

Co-reading Interactions

The participants took on average 9 minutes and 22 seconds to read Cyberheroes. The interactive e-book supported various reading and interaction preferences of families. Four children preferred to listen to their parent read; two children preferred to read on their own while sitting with the parent;

three child-parent dyads took turns reading out aloud.

Prototype Evaluations

Adults: In the Pre-Evaluation, parents ranked ‘fun’ ($M = 3.2$) as the most important criteria for an educational app for children, with ‘educational’ ($M = 2.3$) and ‘effective’ ($M = 2.4$) as secondary criteria. Most parents agreed that ‘age-appropriateness’ ($M = 1$) and ‘ease-of-use’ ($M = 1$) are the least important because they felt that adults could act as intermediaries to help the children. The Post-Evaluation showed that parents thought Cyberheroes was fun ($M = 4.2$), educational ($M = 4.3$), and effective ($M = 4.1$), but they also found it to be age-appropriate ($M = 4.3$) and easy to use ($M = 4.7$). Most said they are very likely to read the interactive e-book again with their child ($M = 4.6$) and use it as an educational tool ($M = 4.7$). Parents felt that they interacted well together with their child during the reading session ($M = 4.4$), and that the interactive e-book helped to facilitate conversations about online privacy ($M = 4.2$).

Open-ended feedback showed that parents thought the interactive e-book was “fun”, “easy to create discussion about privacy”, and “very informative and right to the point” (P5). The superhero angle facilitated “direct connection of identity with the topics” (P3). The interactive e-book was a “good introduction to the concepts. It was basic enough to prompt the child to ask for more information and details about what’s going on” (P8). The interactive features on every page “kept [the child] interested” (P1).

Children: Children found reading Cyberheroes fairly engaging. The Again-Again Table evaluations showed a mean score of 2.6/3 ($n = 5$ for ‘yes’, $n = 4$ for ‘Maybe’, $n = 0$ for ‘no’). Their Smileyometer evaluations showed a mean score of 4.4 for fun, 4.4 for ease of use, 4.1 for learning, 4.1 for character likability, and 4.2 for willingness to tell other kids about the interactive e-book. Open-ended feedback from

the children suggests that they highly enjoyed the interactive features, the characters, and the superhero theme.

Children’s Interviews

We used Wilcoxon signed-rank tests to understand whether there was a difference in children’s privacy knowledge before reading (i.e., pre-test), after reading (i.e., post-test), and one week later (i.e., one-week-test). Seven out of the nine child-parent dyads completed all three tests. Figure 2 shows a summary of the total scores from these participants. We found a statistically significant change in these children’s privacy knowledge after reading Cyberheroes ($Z = -2.21, p < 0.03, r = 0.85$), comparing the scores from the pre- and post-tests. This statistically significant effect in children’s privacy knowledge also held true after one week ($Z = -2.37, p < 0.02, r = 0.91$), comparing the scores from the pre- and one-week-test. The post-test and the one-week-test results showed that children’s privacy knowledge also improved after one week ($Z = -2.03, p < 0.05, r = 0.78$), suggesting excellent information retention. The median scores were 18.47 in the pre-test, 23.29 in the post-test, and 25.43 in the one-week-test. These results suggest that children’s understanding continued to improve once they had time to reflect on the content. The parents said that they did not discuss the subject with their child between the two sessions.

Conclusions and Future Work

Both children and parents liked Cyberheroes. The interactive e-book improved children’s understanding of privacy, and this improvement was sustained after one week. We are in the process of recruiting more participants and working towards the inclusion of a control group. Interview analysis consistency checks and inter-rater reliability tests will also be conducted. Cyberheroes was designed as a tool to facilitate discussion about online privacy between the

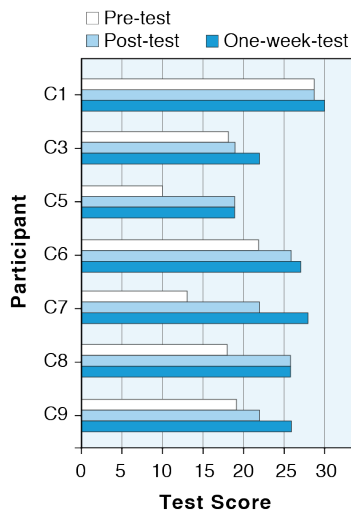


Figure 2: Privacy proficiency scores per child. (C2 & C4 did not complete the tests. Their interview data was excluded from the analysis.)

parent and child; it would be interesting to test whether traditional methods of parental intervention (e.g., having a conversation with the child about privacy) are as effective as using Cyberheroes. We hypothesize that traditional intervention methods about privacy may have positive effects immediately after instruction, but the interactive e-book tool with its visuals, interactive features, and narrative would have more sustaining long-term effects (i.e., after one week) on the retention of privacy knowledge.

Acknowledgements

This project has been funded by the Office of the Privacy Commissioner of Canada (OPC); the views expressed herein are those of the authors and do not necessarily reflect those of the OPC. S. Chiasson acknowledges funding from NSERC for her Canada Research Chair in Human Oriented Computer Security.

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