
Evaluation of a Persuasive Digital Literacy Game for Children

Sana Maqsood
Carleton University
Ottawa, Canada
sana.maqsood@carleton.ca

Abstract

Children need education about digital literacy issues appropriate for their age. We conducted a user study to evaluate the usability and effectiveness of a digital literacy game for 11-13 year old children. Results showed that children's digital literacy knowledge and intended behavior improved significantly immediately after playing the game and one week later.

Author Keywords

Persuasive Games; Procedural Rhetoric; Evaluation;

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous; K.8.0 [Personal Computing]: Games

Introduction

Digital literacy is an important educational topic for children, given that many are online at a young age [3, 5]. Digital literacy represents the skills children need to create and consume media in the 21st century [6]. These include finding and verifying information, ethics and empathy, privacy and security, digital health, and consumer awareness [7]. Given the importance of digital literacy, many schools have incorporated it in their curriculum [9, 10]. Persuasive games can be an effective medium for educating children about digital literacy, given their use in other domains such as

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Figure 1: Main screen of the Jo's game



Figure 2: Scenario introduction screen



Figure 3: Scenario choices screen

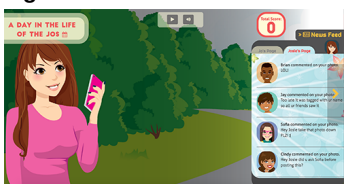


Figure 4: News feed showing the consequences of a choice

math, health, and the environment [1, 2, 11]. These games either improve player's knowledge of a domain or change their behavior. While the effectiveness of knowledge based games can be easily evaluated by administering a knowledge questionnaire before and after playing the game, it is more difficult to evaluate the effectiveness of behavior or attitude change games. That is because in most cases, we cannot measure a change in user's behavior shortly after playing the game, because we need to wait until they take part in the target behavior. In some cases, such as games that teach children how to behave safely in dangerous situations, it is impossible to measure behavior change because we do not want users to encounter these situations in real life.

Because of these challenges, many persuasive games lack evidence of their effectiveness, which can hinder adoption, especially in formal education environments, which use games for assessing student performance. Given this, we suggest that instead of measuring behavior change, persuasive games should measure the behavioral intent. This paper provides an application of this approach on a digital literacy game for children. We conducted a two-part study to evaluate the usability and effectiveness of the game with 11-13 year old children. In our study, behavioral intent was users' self-reported adherence to digital literacy advice. Results from our study show that children's digital literacy knowledge and behavioral intent improved significantly, immediately after playing game and one week later. Our work can be used by designers to evaluate the effectiveness of persuasive behavior change games that have the same measurement challenges as digital literacy games.

Background

Digital Literacy Game

A Day in the Life of the Jos is a web-based game designed to improve 11-13 year old children's digital literacy knowledge and skills [8]. The game is meant to be used in a classroom setting with assistance from teachers, and will be licensed to schools across Canada. In the game, players follow the main characters of Jo and Josie through a series of events in their daily life and help them make smart decisions online. By playing the game, children are able to see the consequences of their choices in a simulation before making them in the real world.

Figure 1 shows the opening screen of the game, where the calendar represents a typical school month for the player. The game consists of 25 scenarios organized into five days (5 scenarios per day), where each day addresses a different literacy topic including cyberbullying, online tracking, privacy, sharing online, and authentication. To begin, players select a day from the calendar which directs them to the main screen of the day, providing access to five related scenarios. Each scenario shows Jo or Josie going through a situation where they require the player's help in deciding how to behave safely. At the end of each scenario, players are provided with three choices and have to pick the choice that Jo/Josie should make in that scenario. Options reflect the choices children make in the real world, which have many grey areas between correct and incorrect behavior, sometimes with unexpected consequences. Each choice has different consequences on Jo/Josie's life, and players can see the consequences of their choices in the news feed component (Figure 4), which acts as an aggregator of the characters' digital media platforms. Figures 2- 4 show part of a scenario.

Methodology

The study had two parts. The first session took about an hour, and the second lasted about 15 minutes. The second session took place one week after the first, and assessed whether children retained the knowledge learned in the game. In the first session, participants completed a pre-test questionnaire and a short interview. Next, they played the game and completed a post-test questionnaire and interview. To keep the session length manageable, children played three of the five days in the game. In the second session, children completed a questionnaire and an interview. Participants were recruited through social media parenting groups and snowballing. Children were compensated with \$20, and their parents were reimbursed for parking costs when applicable. Sessions took place in our research lab or at other quiet, mutually convenient locations.

The pre-test questionnaire included demographic questions and 15 digital literacy knowledge questions (three questions per day of the game). An example knowledge question was: *When using your mobile device, how often would you respond to someone who posted mean comments on your photo?* For each question, participants responded by choosing an option from always, often, sometimes, rarely, and never. The post-test questionnaire collected children's opinion of the game and repeated the 15 digital literacy knowledge questions. These questions were also repeated in the one-week questionnaire to see if children improved and retained knowledge from the game. The interviews evaluated whether children could apply their knowledge to new situations. They were provided with five situation-based questions (one per day of the game), regardless of which days they played. For each, we asked what they would do, how it would affect their privacy, and how it would affect the privacy of others. For example, a situation-based

pre-test question was: *All your friends are playing a popular online game so you decide to sign-up for the game as well. When you sign-up the game asks you to provide your full name (first and last name) and your home address, so that other players can contact you. What would you do in this situation? How might this affect your privacy? How might this affect others privacy?* We created three sets of the situation-based questions and used a Latin square to decide which set to use in the pre-test, post-test, and one-week interviews. The sets were similar in structure and evaluated the same topics, but had a different context to avoid children from simply repeating their previous answers. Each interview took about 10 minutes and was audio recorded. The game was instrumented and recorded user choices, time to complete tasks, and the number of points earned. We also used an eyetracker to track children's gaze as they played the game. Participants were encouraged to think aloud while playing, and the researcher took notes.

Participants

Thirteen children (6 girls and 7 boys) participated in the study. Seven were 11 and six were 12 years old. They spent an average of 1 hour and 40 minutes online each day. Most used social media platforms several times a day (71%), some used it once a day (14%), and others used it once a month (14%). Most children (85%) reported having some knowledge of how to protect their privacy online and how to behave on social media websites, and they learned it from school (77%), parents (85%), and friends (23%).

Results

Digital Literacy Knowledge

Children's digital literacy knowledge was computed by adding their scores for the fifteen knowledge questions, and giving them a total score out of 75 (5 points per question). Table 1 shows a summary of the knowledge scores

Measure	Pre-test	Post-test	One-week-test
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Knowledge	54 (4)	59 (6)	60 (5)
Behavioral Intent	29 (5)	34 (5)	36 (5)

Table 1: Children's digital literacy knowledge (out of 75) and behavioral intent (out of 45) scores at three time points. We note that these scores are generally lower than expected because children did not play the entire game but answered all the knowledge and behavior questions.

at different time points. We conducted a one-way repeated measures ANOVA to determine whether children's digital literacy knowledge scores changed over time. Using a Greenhouse-Geisser correction, we found statistically significant differences in children's digital literacy knowledge scores over the three time points ($F(1.65, 19.79) = 11.82, p < 0.001, \eta_p^2 = .50$). Post-hoc analysis using the Bonferroni correction revealed that children's knowledge scores improved significantly from pre-test to post-test ($p < .016$) and from pre-test to one-week test ($p < .003$). No significant differences were found between post-test and one-week scores ($p < 1.00$), indicating that children had retained the knowledge learned from the game.

Digital Literacy Behavioral Intent

Children's digital literacy behavioral intent scores were derived from the interview data. The interviews were transcribed from audio recordings and the responses were organized in Excel according to the 15 interview questions (3 questions \times 5 scenarios). A researcher coded each response on a 3-point scale (3 = very good, 2 = marginal, 1 = poor) for a total score out of 45 points. Because of high variability, the responses to one question could not be accu-

ately coded, so we assigned it the middle score of 2 for every participant. A second researcher independently coded all of the responses. A Cohen's Kappa (k) test showed moderate agreement between the two researchers' analysis of the pre-test ($k = 0.65, 95\% \text{ CI: } .6 \text{ to } .7, p < .000$), post-test ($k = 0.62, 95\% \text{ CI: } 0.5 \text{ to } 0.7, p < .000$), and one-week-test scores ($k = 0.57, 95\% \text{ CI: } 0.5 \text{ to } 0.7, p < .000$). In cases of disagreement, the two researchers discussed and consolidated the scores to be used in the final analysis. Table 1 shows a summary of children's digital literacy behavioral intent scores. We conducted a one-way repeated measures ANOVA on these scores to see if they improved over time. The analysis found that the scores significantly improved over the three time points ($F(1.81, 21.71) = 24.51, p < 0.000, \eta_p^2 = .67$). Post-hoc analysis conducted using the Bonferroni correction revealed that children's behavioral intent scores improved significantly from pre-test to post-test ($p < .001$) and from pre-test to one-week test ($p < .000$), but no significant differences were found between post-test and one-week scores ($p < .074$).

Usability

The usability of the game was evaluated using a post-test questionnaire and interview. Six Likert scale (5-point) questions in the questionnaire measured ease of using navigation controls, ease of finding navigation controls, enjoyability of the storyline, interest in the storyline, fun, and challenge. Questions in the interview evaluated children's perception of the game characters, what they liked in the game, and what can be improved. Figure 5 shows that participants were very positive in their responses to the questionnaire. Most were able to find and use the navigation controls easily, and found the game content easy to understand. Most found the storyline interesting and enjoyable, because they learned new concepts (e.g., how to use the rumor busting website Snopes), liked the overall design and artwork, liked

the characters, and found it realistic and relatable.

The interviews were transcribed and a thematic analysis was performed on the responses. Most children had positive things to say about the characters. 62% thought that the characters were nice, interesting, and likeable. Some (23%) thought they were relatable, logical, independent characters who made good choices. One participant stated *They like to search up things and always know if it was real or not. And they always cheered up their friends and asked them if they wanted to post something or not.* These results show that participants were clearly engaged with the characters and had formed opinions of them. The aspects of the game that children liked the most were the scenarios (23%), the ability to make choices (31%), and the review screen (31%) which allowed them reflect on their choices. Children liked the scenarios because they were realistic and represented situations that they would encounter in their lives. One child stated *I liked that the scenarios were realistic. They could mentally prepare you if you encounter them in the future, so you would know how to deal with them.*

Discussion and Conclusion

Evaluating the effectiveness of persuasive games for behavior change is a challenge, because we are unable to measure a change in users' future behavior. An approach is to measure a change in user's behavioral intent instead of their actual behavior. Behavioral intent represents players' self reported adherence to the advice provided by the game. It has been successfully used to evaluate improvements in attitudes from using educational security and privacy tools [4]. In this paper, we evaluated the usability and effectiveness of a children's digital literacy game for behavior change by conducting a two-part user study with children. We measured improvements in children's behavioral

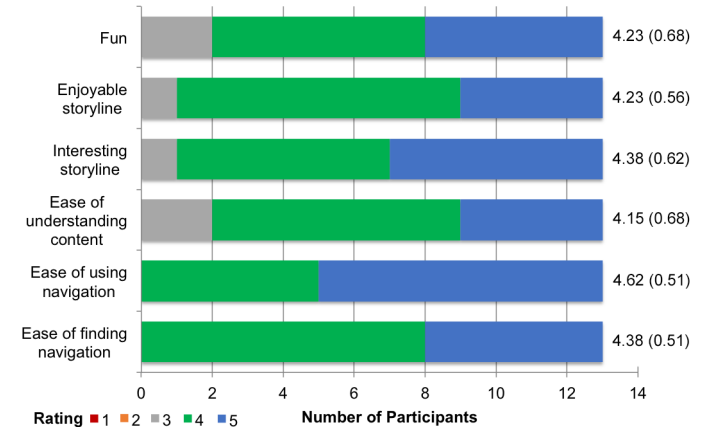


Figure 5: Children's usability evaluation of the game (1 = most negative, 5 = most positive)

intent by asking them scenario based questions that require them to use the information learned from the game. Results showed that children's digital literacy knowledge and behavioral intent both improved, immediately after playing the game and one week later. Children also found the game usable, fun, and formed positive associations with the game characters.

We based the questions in our behavioral intent interview on common questions used to measure the behavioral intent in security and privacy tools. Thus, we recommend that game designers create questions in their behavioral intent interview by consulting subject matter experts in their domain or using empirically validated questions. This will ensure the reliability of the questions. Typical user studies evaluating the usability of games with children, often involve the child playing the game and then completing a post-test questionnaire. In our study, we observed that by administer-

ing additional questionnaires/interviews to measure behavioral intent increased the time it took to complete our study, which can potentially fatigue participants. This can be problematic, especially for child participants. Thus, to prevent participant fatigue we suggest that designers evaluating a game with children, should evaluate the game usability in a separate session than effectiveness, reduce the time it takes to complete other tasks in the study. The digital literacy game evaluated in this paper will be licensed to schools across Canada later this year, so results from this study will give confidence to teachers using the game in their classrooms. Our next step is to evaluate the game with teachers to ensure that it meets their needs.

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REFERENCES

1. Acey Boyce and Tiffany Barnes. 2010. BeadLoom Game: using game elements to increase motivation and learning. In *Proceedings of the Fifth International Conference on the Foundations of Digital Games*. ACM, 25–31.
2. Stephanie J Brown, Debra A Lieberman, BA Gemeny, Yong Chan Fan, DM Wilson, and DJ Pasta. 1997. Educational video game for juvenile diabetes: results of a controlled trial. *Medical Informatics* 22, 1 (1997), 77–89.
3. Statistics Canada. 2013. Canadian internet use survey. (2013). <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3580154>.
4. Serge Egelman and Eyal Peer. 2015. Scaling the security wall: Developing a security behavior intentions scale (sebis). In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, 2873–2882.
5. US Government. 2010. U.S. Census Bureau. Current population survey. (2010). <http://www.census.gov/hhes/computer/publications/2010.html>.
6. Tibor Koltay. 2011. The media and the literacies: Media literacy, information literacy, digital literacy. *Media, Culture & Society* 33, 2 (2011), 211–221.
7. MediaSmarts. 2015. USE, UNDERSTAND & CREATE: A Digital Literacy Framework for Canadian Schools. (2015). Retrieved January 20, 2017 from <http://mediasmarts.ca/teacher-resources/use-understand-create-digital-literacy-framework-canadian-schools>.
8. Christine Mekhail. 2016. *[Thesis] A day in the life of the Jos: The design of an educational game on privacy*. Master's thesis. Theses.
9. United States. Department of Education. 2010. *A blueprint for reform: The reauthorization of the elementary and secondary education act*. US Department of Education, Office of Planning, Evaluation and Policy Development.
10. Government of UK. 2017. UK Digital Strategy. (2017). Retrieved September 1, 2017 from <https://www.gov.uk/government/publications/uk-digital-strategy>.
11. Zhihui Zhang, Paul Shrubsole, and Maddy Janse. 2010. Learning environmental factors through playful interaction. In *Proceedings of the 9th International Conference on Interaction Design and Children*. ACM, 166–173.