Designing Dialog Boxes for Children by Age: A Field Investigation

Charlotte Tang, Mohan Raj Rajamanickam and Joanna McGrenere
Department of Computer Science, University of British Columbia
scctang/mohanr/joanna@cs.ubc.ca

ABSTRACT
We highlight findings of a three-phase study conducted with a total of 195 children aged 3 to 12 in a local science center for exploring how age-specific and usable dialog boxes should be designed for children. In the exploratory phase, we observed how 111 children interacted with dialog boxes of a painting program. We identified the challenges of causality, purpose, hindrance, communication, consequence, and patience faced by the children. Design solutions for addressing these challenges were then developed and prototyped in the design phase. In the evaluation phase, we observed 84 children to interact with the prototypes. We gained a better understanding of how the design solutions impacted children's interaction. The study also contributes preliminary implications to guide the design of dialog boxes for children.

Author Keywords
Child computer interaction, dialog box, design.

ACM Classification Keywords
H5.m. Information interfaces and presentation: Misc.

General Terms
Design, Human Factors.

INTRODUCTION AND RELATED WORK

This research aimed at designing age-specific usable interfaces, in particular dialog boxes, for children. In interactive software, dialog boxes are crucial for the exchange of information between the user and the computer. They present information that demands users' attention to act upon given choices. These choices often lead to different outcomes including disruptive consequences like file deletion. Although the number of children using computer has tripled in the last decade and the age at which children started to use a computer has become younger [6], the design of current computer software for children including dialog boxes often does not take into account the age differences of children in their physical, cognitive, affective, and other abilities [1,2,4,5]. Designing usable dialog boxes for children is also likely more challenging as children's capabilities vary to a great extent [1,3]. However, despite much work has been done in interface design [e.g., 7], there is a paucity of research on designing dialog boxes. We are thus motivated to explore how dialog boxes should be designed to meet the different needs of children at different ages so that they can interact with a computer independently. We posit that dialog boxes can be designed for effective communication through a

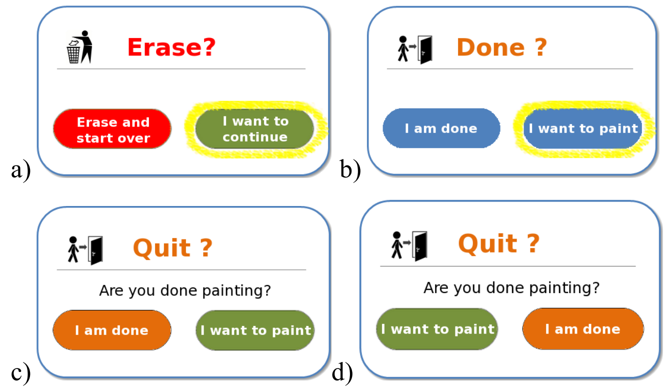

Fig. 1. Redesigned dialog boxes with different design solutions: (a) Color coded buttons; (b) Non-color-coded buttons; (a+b) Highlighting the safe option; (c+d) Buttons switched positions

good interface design that guides a user's attention to the information presented [7,10].

We conducted a three-phase study with children of ages 3 to 12 in a public science center. We set out to broadly explore children's interaction with a painting program but we soon found out that dialogs were particularly problematic for the children. We thus focused on children's interaction with dialog boxes and the challenges they encountered. This paper reports several key findings and makes several contributions. First, we identified a set of challenges faced by children when interacting with computer dialogs. Second, we developed design solutions for improving dialog interfaces for addressing the identified challenges. Third, we identified the impacts of the design solutions on children's interaction with computer dialogs. Finally, we proposed guidelines for designing computer dialogs for children of different ages.

THE STUDY

Our study consisted of three phases: exploratory, design, and evaluation phases to reflect the main goal of each stage. A painting program, Tux Paint [9], was used in our study because it was designed for children and it was one of the most popular free open-source programs used in schools.

The exploratory and the evaluation phases were both conducted using observations in a local science center where a variety of scientific shows, exhibits, and events are available for children to explore and experience for fun and learning. Tux Paint was running simultaneously on two computers and a recruitment poster was placed nearby. A total of 195 children aged 3 to 12 participated in our study. We observed children to use Tux Paint to create their own drawing. Observation data were collected by note-taking and interaction data were automatically logged. There was no fixed amount of time for the study sessions so the children could leave at any time. The collected notes were thematically analyzed using grounded theory and the logged data were analyzed using descriptive statistics.

Exploratory phase

Five days of exploratory observations were conducted with 111 children. Each study session lasted approximately 12 minutes on average. The initial goal was to broadly explore children's interaction with computer interfaces. But we shifted to focus on children's interaction with dialog boxes from the second day when we realized that dialogs were surprisingly problematic to the children.

We identified three groups of children by age for the purpose of designing age-specific dialogs. They are pre-literates (3-5), semi-literates (6-7), and literates (8-12) to reflect their demonstrated behaviors including their reading ability of computer dialogs during our study and their general literacy according to developmental psychology literature [5]. We also identified challenges faced by children when interacting with computer dialogs, affecting children of different ages in varying degrees. Pre-literates were affected mostly by problems related to causality, purpose, hindrance, and communication, semi-literates by consequence and to some extent communication and patience, and literates primarily by patience.

Causality. How did it appear all of a sudden? The children had difficulty in making the link between their action and the resultant dialog.

Purpose. Why is it here? The children did not understand that the software was trying to have a conversation with them, that is, providing them with some information and asking them to make a choice.

Hindrance. Why is it in my way? The children had difficulty understanding the modal nature of a dialog box as to why they cannot continue interacting with the software.

Communication. What is it saying? The children had difficulty understanding the message communicated through the dialogs, mainly because they were not able to read the text on the dialog and/or not able to understand the underlying abstractions.

Consequence. What should I do now? The children did not understand the full implications of their choices and did not know how to deal with negative consequences resulted from their choice.

Patience. Whatever… The children just wanted to get rid of the dialogs, that is, they did not want to spend time in reading and understanding the message.

Design phase

We brainstormed design solutions for addressing the challenges identified in the exploratory phase. Low-fidelity prototypes of dialogs implemented with the design solutions were created and were iteratively evaluated by experienced HCI researchers. The resulting set of design solutions was then prototyped in Tux Paint dialogs for evaluation in the next phase. We did not alter Tux Paint in any way except the dialogs. Table 1 shows the design solutions and the corresponding dialog modifications. However in this paper, we only present design solutions and their evaluation related to the challenge of *communication* and *consequence*.

Table 1: Design solutions for challenges faced by children

Design solution	Modification	To improve
Call out dialogs	Resemble a comic book style call-out	causality
Split dialogs	Place question and choices in separate dialogs	purpose
Title text	Add a clear title that summarizes the purpose of the dialog.	communication patience
Title icon	Add a descriptive icon to the title	communication patience
Button icon	Add a descriptive icon to each button	communication patience
Body text contrast	Display body text in different contrasts	patience
Progressive disclosure of buttons	Make safer choice to appear first	consequence
A safe button	Add a "I don't know" button	consequence
Color coding	Use colors to signal consequence: green for safe choice, orange and red for riskier choices	consequence
Highlighting	Highlight safe choice	consequence

Designs to improve communication and consequence

As most pre-literates cannot read yet, our design solutions focused on the use of non-textual visual cues to facilitate the information processing particularly by pre-literates so that these young children could dialog with the computer independently. In most cases, our design made use of visual cues to help guide the children to pick the safe button in situations when they did not completely understand the choices. A safe button is one that will not lead to negative consequence if clicked. For example, "I want to continue" button is a safe button relative to the "Erase and start over" button in the Erase dialog (Fig. 1a) as the latter could lead to loss of data.

"I don't know" button. In some dialogs, we added an "I don't know" button. This button was designed to be functionally redundant with one of the other buttons in the same dialog such that it would dismiss the dialog without performing any operation. As this button was consistently displayed in the same position in the dialogs, it offered a consistent way for children who could not or did not want to process information to get out of the dialog safely. Dialogs with this additional safe button were evaluated against dialogs without. Our goal was to find out the impact of the provision of a "universal" safe button in dialogs.

Progressive disclosure of buttons. Buttons were revealed one after another from right to left with a short delay in between such that the safer button was displayed first. We posit that if the child's intention was to get rid of the dialog without understanding the information on it, either for lack of ability or patience, it is likely that the first button that

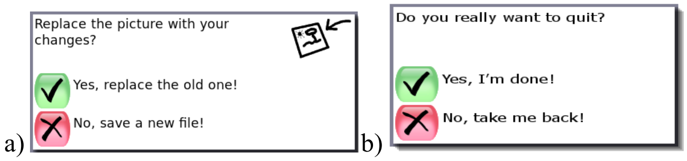

Fig. 2. Original dialog boxes in TuxPaint (a) Save (b) Quit.

appeared would be selected. Dialogs with progressive disclosure of buttons were evaluated against those without.

Button positions. Button positions were only evaluated in dialogs with two buttons. By default, the safe button was positioned on the right. Dialogs with default button positions were evaluated against those with switched button positions (Fig. 1c&d).

Color coding. All our redesigned dialogs were initially color coded to make them different from the original Tux Paint dialogs which use green for "Yes" options and red for "No" options (Fig. 2). However, their "Yes' options are more disruptive and less safe than their "No" buttons. In our color coded dialogs, the safe button was in green and the remaining button was in red (Fig. 1a&c) to ensure visual distinctness of the colors and to follow the conventional semantics of color – red represents danger and green represents safety [10]. Color coding was not evaluated in the first two days but color coded dialogs were evaluated against non-color-coded dialogs in the last two days when we found that the children's interaction appeared to be impacted by color coding. All the buttons in the non-color-coded dialogs were in Blue (Fig. 1b), a neutral color.

Highlighting the safe button. The safe button within a dialog was highlighted with a halo effect around it (Fig. 1a&b). Green highlighting was initially used but switched to yellow on the third day as the green highlighting seemed to be interfering with the green color of the safe button. Dialogs with a highlighted safe button were evaluated against dialogs without highlighting.

Evaluation phase

Four days of observations were conducted to gain a better understanding of the impact of the design solutions on the children's interaction with dialogs. Participants in the evaluation phase were 84 children: 23 pre-literates, 37 semi-literates, and 24 literates. Three types of dialog boxes in Tux Paint were implemented with the refined design solutions: Save, Erase, and Quit. All default dialogs were disabled. The instrumented dialogs were set to appear at pre-defined time intervals automatically without being triggered by any user action. We recognized that this might confuse the participants. But given our goal of observing children's interaction with the dialogs, we opted for this study design to ensure that participants would encounter a higher number of dialogs during the sessions, increasing the possibility of observing more interactions with dialogs.

Table 2: Impact of design solutions on children's interaction with dialogs (no change; + faster and ++ fastest interaction; x slower and xx slowest interaction)**

To address	Design solution	Pre-literates	Semi-literates	Literates
Purpose	Split dialog	**	+	++
Comunication & consequence	Color coding buttons	++	+	xx
	Highlighting	++	++	xx
	Button positions switched	++	+	xx
	"I don't know" button with Delayed-click	x	**	xx
Patience	Presence of title text & body text	xx	xx	++
	Supporting skimming	xx	++	**

Several sets of dialog designs were used for evaluation. Each set was prototyped with one or more design solutions. Participants were randomly assigned to a set of dialog boxes. Rapid prototyping took place throughout the evaluation phase in response to our observations. Design solutions that clearly showed no benefit were removed and new or existing design solutions were added or modified at the end of each day for evaluation on the following day. Table 2 summaries the impact of the design solutions.

Reaction time (RT), the time from a dialog appeared to the time when the first mouse click on a dialog button took place, was the primary quantitative measurement in the study. However noise has likely affected the precision of the RTs due to the naturalistic setting where the study took place. Therefore we report only the observational findings that were corroborated by the RTs. For example, both the RTs and observational finding supported that highlighting benefitted pre-literates and semi-literates but hindered literates.

Color coding benefitted pre-literates but hindered older children. Without color coding, pre-literates' RTs were proportional to the amount of text in a dialog but the RTs of older children were not proportional to the amount of text. With color coding, pre-literates' RTs remain unchanged but the RTs of literates and semi-literates were higher as the amount of text increased. As age increased, color coding increased RTs, thus leveling the RTs across age groups.

Color coding was partially successful at indicating consequences. Color coding slowed down clicking on the potentially disruptive option, possibly because children were made to think twice before clicking. However, color coding seemed to increase the probability of clicking on a potentially disruptive choice (in red) while delaying the interaction. The attention grabbing nature of the red color [10] could be the reason for this increase in frequency. The safer option was always the one clicked most often.

Highlighting benefitted pre-literates and semi-literates but hindered literates. Highlighting lowered the RTs when the highlighted (i.e. safer) option was chosen while the RTs remained the same when the non-highlighted options were chosen. Both pre-literates and semi-literates responded faster with highlighting although pre-literates did not respond as fast as with color coding. Literates responded slower with highlighting but not as slow as with color coding. We also found that highlighting was redundant when color coding was present.

Highlighting color mattered. Green highlights seemed to slow down the interaction especially when the buttons were also color coded (in green) while yellow seemed to speed up the interaction. The increase in RTs when green highlighting was used on green-coded button could be analogous to the “Stroop effect” [8] where interaction of parallel information sources increases RTs.

Switching button position led to mixed results. We did not find strong patterns that showed preference for button on a particular side. When the button positions were switched, we also did not observe strong reactions such as surprises or annoyance from the children.

Progressive disclosure of buttons benefitted safe choice. A safe “I don’t know” button added to some of the dialogs was always the rightmost button. Thus this button was always revealed before the other buttons in dialogs with progressive disclosure of buttons. We found that children tended to choose this button as soon as it was clickable (i.e., when all the buttons appeared) but almost all children were impatient of the wait. We found that children clicked this “I don’t know” button faster in progressive disclosure dialogs than in dialogs without progressive disclosure.

DESIGN IMPLICATIONS

The goal of this study was to explore the design space for dialogs and to identify design solutions that showed positive impact on facilitating children’s interaction with dialogs. We propose the following as preliminary guidelines for the design of dialog interfaces for children.

Simple and consistent design without superfluous cues for literates. Literates perform well with textual information and poorly with non-textual cues so powerful visual cues such as color coding should be avoided for literates. Yet subtler cues such as highlighting could be used. Also interface elements should be positioned consistently as their performance could be reduced otherwise.

Keywords plus visual cues for semi-literates. For semi-literates, information is ideally presented using a combination of textual and non-textual cues. They also perform better with minimal amount of text. Thus providing them with mainly non-textual cues together with a few keywords would be beneficial. Graphical icons can also be used to increase their enjoyment.

Strong visual cues with minimal text for pre-literates. Pre-literates are the biggest benefactors of non-textual cues such as color coding and highlighting. They also prefer graphical objects such as icons. Although interfaces designed for pre-literates is recommended to use mainly non-textual cues for communication, a small amount of simple text can be added to the interface for the benefit of those pre-literates who can read, to encourage and educate others who cannot read yet, and for the benefit of adults who want to help the children.

Avoid using abstractions for pre-literates and semi-literates. Abstractions particularly those for complex systems such as file systems in the digital domain as well as the underlying actions associated with these abstractions such as save and overwrite should be avoided when designing for pre-literates and semi-literates as they are conceptually difficult for young children to understand.

In general when presenting multiple options, designers should try to maximize both visual and semantic distinctness between the options to facilitate decision making. Intentional delays of any kind should also be avoided because children’s patience can easily be challenged. The colors used in color coding should be carefully selected as they may lead to unintended consequences. For example, we found that color coding with red increased the probability of being clicked but the interaction took longer. Therefore colors such as red may delay users by acting as a visual warning but they could also attract attention, thus resulting in getting chosen more often. Lastly, redundant cues are not recommended for dialog designs as they may interfere with each other and thus hinder children’s information processing.

CONCLUSION

Our research goal is to design age-specific and usable interfaces for children. We conducted a three-phase study with 195 children between ages 3 to 12 at a local science center. We explored how 111 children interacted with Tux Paint and identified three different age groups: pre-literates (3-5), semi-literates (6-7), and literates (8-12) and the respective challenges they faced. We then developed and evaluated design solutions for addressing the challenges.

Some design solutions helped achieve effective communication, some did not. Our research contributes preliminary guidelines for designing dialogs for children of different ages. Our next step is to conduct a controlled experiment to systematically evaluate the impact of the design solutions on children’s interaction with dialogs.

REFERENCES

1. Budiu R and Nielsen J (2010). Usability of websites for children: design guidelines for targeting users aged 3-12 years. 2nd edition. Nielson Norman Group, USA.
2. Druin A (2002). Age matters. SIGCHI Bull: interactions, 5.
3. Hourcade J (2008). Interaction design and children. foundations and trends in HCI, 1(4):277-392.
4. Lepper M & Gurtner J. (1989). Children and computers: approaching the twenty-first century. American Psychologist, 44(2):170-178.
5. Lueder R and Rice V (2008). Ergonomics for children: designing products and places for toddlers to teens. Taylor & Francis, New York.
6. Rideout V, Foehr U & Roberts D. (2010). Generation M2: media in the lives of 8 to 18 Year Olds. Kaiser Foundation.
7. Shneiderman B (1986). Designing the user interface: strategies for effective human-computer interaction. Addison-Wesley Longman Publishing Co., Inc.
8. Stroop J (1935). Studies of interference in serial verbal reactions. Journal of Experimental Psychology,18:643-662.
9. Tux Paint. http://tuxpaint.org/. Retrieved Jan 15, 2012.
10. Ware C (2000). Information visualization: perception for design. Morgan Kaufmann Publishers Inc.