Rethinking the Design of Hotspots in Children's Digital Picturebooks: Insights from an Exploratory Study

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Abstract. Finding the correct hotspots when interacting with digital picturebooks is oft challenging for children. Here, we present an exploratory study carried out with a group of third graders to inform the design of hotspot icons for a children's digital picturebook. Based on a selection and analysis of the most commonly used icons in digital picturebooks, especially apps, we created a low fidelity paper prototype to investigate children's preferences and understanding of the interactive navigation areas, configuration and menus. For this, we invited the children to draw new icons for each hotspot. Based on the analysis of the results we designed a proposal of icons that were implemented in a digital prototype for tablets. The prototype was then validated with a similar group of children, and the results provided valuable insights for the design of hotspots that can be useful for researchers and designers working and developing digital picturebooks for children.

Keywords: Interaction design · User-centered design · Children's book apps

1 Introduction

The ability to read and process multimedia texts is a fundamental skill, with an increasing number of readers becoming familiar with convergent interactive multimedia products [1]. Technologies that were originally unrelated are increasingly becoming integrated and unified as they develop and advance. "Today, digital picturebooks are often the first literature young children engage with" [2:1]. In this context, the use of digital picturebooks during childhood provides a good opportunity to develop these skills contributing to influence reading frequency [2, 3].

However, along with the opportunities provided by the wide variety of new educational platforms and interactive mobile devices parents and researchers have also raised concerns about the drawbacks that these new technologies may pose for the socio-cognitive development of young children [4]. There is also a lack of publishing standards and an absence of design guidelines for the design of children's digital picturebooks, and apps in particular [5]. The present criticism on children's digital

books refers mainly to the often indiscriminate and poor design of multimedia and interaction resources [2, 6]. The integration of the latter needs to be well planned in order to engage the readers, keeping their attention focused on the digital picturebook, contributing to the story or to the task at hand while avoiding interrupting the narrative flow or distracting the users [7].

The interaction areas in children's digital picturebooks, also called hotspots, are usually highlighted as problematic [8]. When poorly designed, when too much or accidentally incorporated into the digital picturebook, they provide unnecessary stimuli [3] that can lead to impaired learning [5], undermining the understanding of the story [7, 8], distracting and compromising the reading experience.

Prior work has investigated, how six-to-eight-years old children – the period where children acquire literacy skills – accompanied by reading mediators interact with children's story apps [9]. The study concluded that very often neither the children nor their parents were able to identify and to find the icon buttons of the interactive areas in the app and that one of the main interaction problems with story apps was the graphic design of the hotspots.

Building on this work, our research investigates aspects related to the design of hotspots in children's picturebook apps, namely: (a) icon's content, (b) visual representation of the icons, (c) location on the book pages and on the screen. We focus on navigation hotspots, menus, and configuration areas of the app. Here, we present an intervention aimed at identifying children's needs and preferences for these hotspots.

2 Function and Affordances of Hotspots in Children's Digital Picturebooks

In the early electronic books, which run on computers, the "hotspots" originally indicated the areas on which the readers needed to click to activate sounds, animations, videos and other features, or to navigate thought the digital book [10]. Nowadays, in a scenario where mobile interactive devices are popular, hotspots are understood as "specific areas on the screen where readers can touch, slide or squeeze the surface of the device to generate sounds, animations or even content during reading" [11: 510].

Hotspots in children's picturebook apps are linked to several modalities such as sonorous, visual and haptic, among others [12]. The quality of children's digital books depends largely on the interdependence of resources to create a unified literary experience [13]. The design and integration of hotspots needs to be careful considered to provide a multimedia convergence and appropriate interaction for the readers. In order to use the hotspots, the users need to understand their affordances [14]. Particularly for children it is important to adequate the graphic, verbal and iconic representations to their level of comprehension [5, 13] to benefit from a digital picturebook.

The design of hotspots in children's picturebook apps should guide the reader through verbal, pictorial or iconic instructions in a way that does not disturb reading, but instead integrating interactive features into the narrative [15]. Therefore, a design that promotes a deeper immersion while still being congruent with the story has the

potential to stimulate high levels of engagement and reading comprehension through interactive digital books [7]. In this sense, what may appear to be minor modifications in the design of hotspots may significantly improve the readers' experience and the potential of children's picturebook apps [16].

A recent study showed that there are at least 13 different kinds of hotspots according to their respective functions [15]. Among them are game hotspots, control of video and animations, hotspots of virtual or augmented reality interaction, and personalization of the book interface or the reading mode. Here, we focus on three types of hotspots [15] usually presented as buttons: (1) navigation hotspots, which are essential for the reader to access different areas of the book and turn the pages; (2) menu hotspots, which provide access to a list of options, e.g., book chapters; and (3) configuration hotspots, which allow the readers to configure the settings, such as sound and automatic reading.

3 Exploratory Study

Given the importance of involving children in the design of technology [17], which can strongly contribute to improve its quality by providing designers a better understanding of their needs [17, 18], we carried out an exploratory study with a group of children using a low fidelity paper prototype. The study aimed at assessing children's preferences for hotspots icons and understanding how to design them in accordance to children's interests. In the following sections we describe the intervention.

3.1 Participants

The study took place at a public primary school's library and it was carried out with a group of nine third graders ages eight and nine. The investigation was agreed with the school principal and the teacher, who had previously requested the parents' consent for their children to participate in the study. All the children were familiar with tablets, smartphones and digital books. The majority of them had access to tablet devices and internet at home and at least seven of them had already read book apps.

3.2 Study Design

Prior to the study, we carefully identified the most commonly used hotspot icons in a sample of ten commercial book apps for children, and choose for each hotspot the three icons that appeared most frequently. We printed each selected icon on a small paper card (5 cm × 5 cm) (see Fig. 1) and created a paper prototype that simulated two pages of a children's book app. One page represented the home page and the other represented an inner page. Additionally, we invited the children to draw their own version of the hotspots.

Fig. 1. The researcher observing the children choosing their preferred icon cards for the hotspots "start reading" (left) and "navigation to the home page" (right).

3.3   Procedure and Data Collection

One child at a time - chosen randomly by the teacher - come to the library. The paper prototype, and a set of color pencils were displayed on the table where the child and the researcher sat. A smartphone placed on a tripod with a fixed focus on children's hand movements recorded their interactions. The researcher started by presenting himself to the child and then explained the procedure. Next, he collected children' demographic data, such as use of mobile devices, internet use, familiarity with digital picture books. The same protocol was followed with every child. The study lasted about 30 min per child and comprised three assessment phases: (i) children's preferred icons, (ii) their preferences for the location of the hotspots, (iii) children's visual preferences of the hotspots. The data was collected through observation, field notes, photographs, drawings made by the children and video recordings. In the following we describe the assessment phases.

3.3.1   Assessing Children's Preferred Icons

In order to identify if the child knew the function of the hotpot icons represented on the paper cards, the researcher used the paper prototype representing the app and the paper cards representing the ten hotspots and asked the children to use them. For this he showed one representation of each hotspot (three cards). Then he displayed all the three representations for each hotspot and asked the children to order them according to their function (see Fig. 1). After that the researcher asked the children to choose a preferred representation for each function. Figure 2 (first row) displays children's most preferred items chosen from the ten hotspots selected for the survey. Children's preference for specific icons show their familiarity with other digital products, e.g., *YouTube*. For instance, the gear icon (f) is often used in games or for changing the language and other user settings. One of the microphone representations (i) for "recording reading" was significantly preferred over other and our hypotheses is that this is because the first one is an icon widely used in communication/message apps used by children.
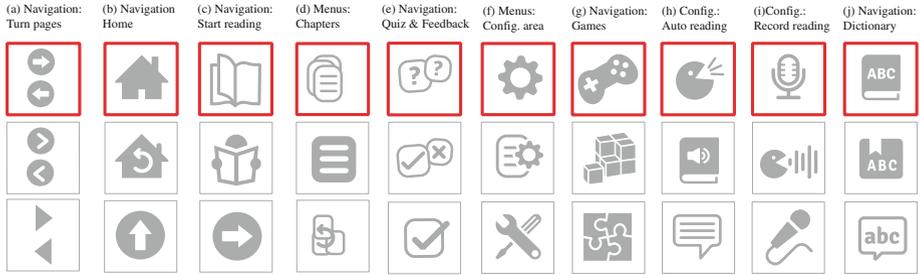
Fig. 2. The 3 different proposals for each hotspot where the first row displays children's preferred choices.

3.3.2 Children's Positioning of Hotspots

Following the first assessment, the researcher invited the children to position their preferred hotspot icon card on the picturebook app prototype. The researcher ensured that the child remembered the function of each hotspot and, if necessary, he explained the purpose of each button (see Fig. 3).

Fig. 3. Child observing the paper prototype with chosen hotspot cards, the home page (left) and an inner page (right).

From the interaction layouts created by the children we observed that they usually positioned the hotspot icons as buttons on the edges of the pages, and rarely on the inside area. An exception was the navigation hotspot (arrows), which some children positioned horizontally, on the middle of the pages.

Regarding the "home" representation, the children positioned similar hotspots together according to their function and icon appearance. For example, in most cases they placed the hotspots for the "games" and for the "quiz" side by side. The "microphone" icon (used to record reading) was placed close to the "speech" icon (used to hear a narrated version of the story). In general, in the inner app pages the "home" hotspot was positioned on the top left-hand corner of the paper prototype, whereas, the

"configuration" and the "menu" hotspots (to access different pages and chapters) were placed on the opposite bottom side, near the edge of the paper (see Fig. 3).

The positioning of the hotspot icons by the children shows that they are used to manipulating digital devices and are influenced by the layout of games *and YouTube* videos.

3.3.3   Children's Hotspot Creation

In the third stage of the intervention, we invited the children to draw icons for each of the hotspots (see Fig. 4). We made clear that they were free to reproduce an icon that they liked and that represented a certain interaction, or instead to create new icons, that could better represent the activity linked to it. We observed that the task was easy for most of the children, but they had some difficulties, specially to represent the "configuration" icon (f). To represent this icon the children did not create any innovative drawings, they just copied in their own way one of the options that we had previously showed them. Our hypothesis is that this is because this specific icon groups a menu for choosing different user settings (select language, enable/disable automatic reading and sounds), being a more complex representation if compared to other hotspots. Most of the drawings are re-readings of the previously chosen icons (see Fig. 2), however, interesting new ideas have also emerged in the intervention.

Looking at the illustrations of the ten groups of icons (see Fig. 4 - bottom), from a design and visual communication perspective [19, 20], we observed that the most expressive graphic elements on these are: (a) two-dimensionality; (b) simplification of shapes and colors; (c) line structures; (d) organic graphic style. This predominantly visual style follows the principle of graphic simplicity of shapes and colors commonly found in the current language of computer icons, flat and not skeuomorph.

Only few children filled the inner area of the drawings, so the line is the main element that creates the structure of the icons. Also, only very few children wrote text near the hotspot, showing a preference for a predominantly iconographic, nonverbal language. The graphic style that prevailed is organic, even the geometric shapes when drawn are a little curved and the strokes are tremulous, which is an expected characteristic in children's drawings.

Regarding the symbolic content of the icons, few of them are innovative when compared to the paper cards that the children used. This means that the previous proposals were well accepted and incorporated by the children in their creations. However, it is important to highlight some creative solutions draw by the children. To represent the "start reading" hotspot, one of the children represented the perspective of the reader holding the book, as opposed to the hotspot printed on the cards. For a representation of the "automatic reading" hotspot – which enables automatic reading by the device – one child drew one ear while the others drew microphones or the icon of a person talking. A child redesigned the symbol for the "quiz" and the "feedback" hotspot by replacing one of the question marks with the exclamation mark (see the red highlighted icons in Fig. 4).

(a) Navigation Pages   (b) Navigation (home)   (c) Start Reading   (d) Navigation (other chapters)

(e) Quiz and Feedback   (f) Configuration Area   (g) Game   (h) Automatic Reading

(i) Record Reading   (j) Dictionary

Fig. 4. Children drawing (top) the ten new hotspot icons (bottom). (Color figure online)

4 Design of Hotspot Icons for a Children's Digital Picturebook

Outgoing from the data collected in the intervention we developed a digital prototype, which contained the home page and four pages of the picturebook. To better design the new icons, we analyzed and compared all the collected data following three principles for designing graphical interfaces for children [21]: Obvious visibility; Visual resemblance; and Conceptual resemblance.

Fig. 5. The redesigned hotspots (top) in the digital prototype on the app home page (bottom left) and on an inner app page (bottom right).

These three principles emphasize that icons should be visually conspicuous to attract the attention of the users and resemble the visual features of the metaphors that they represent, so that the users can recognize them immediately [21]. From the predominant visual style, we designed the icons (see Fig. 5 - top) to resemble a children's drawing with a crayon. All icons are simplified in two-dimensions, in just one color and without internal filling.

In the design of the hotspot icons for the digital prototype, we diverged from children's preferences regarding the position on the interface of the hotspot icon to turn the pages. Instead, we positioned the pages navigation hotspots on the bottom of the page (see Fig. 5 - bottom). Besides being more convenient to use when the reader holds the digital device, this position avoids compromising the illustration areas on the inner pages, since these will contain hotspots for triggering characters and scenarios' animations. We also considered size and ideal distances recommendations between interactive buttons [21], keeping in mind that children users have less motor control of fine gestures [14].

4.1 Validation Session

A second research session was conducted in the school's library with a similar group of nine third graders ages eight and nine, to validate the icons designed in a digital prototype. The sessions lasted between 10 and 15 min per child. The children were invited to read the app on their own (without researcher intervention), and then to perform a set of tasks: (i) start the reading, (ii) navigate between pages and (iii) between chapters, (iv) change the language settings) enable/disable auto reading, (vi) return to the home page, (vii) access games, quiz and dictionary, and (viii) simulate a audio recording of reading. Each task was linked to one of the redesigned hotspots. In general, the children were able to complete all the tasks.

Besides verifying that the majority of the children were able to locate and identify the hotspot icons without problems, we noticed that they followed different paths to accomplish the same tasks. For instance, some children wanted that each page of the book contained at least the essential hotspots to navigate between pages, to reconfigure reading modes and to access the most important menus, namely: "chapters" and "home

page". This indicated the need of integrating specific hotspots on pages which initially were not designed to include them.

5   Results and Conclusion

In order to design digital books for children, it is important to know children's preferences and interests. This intervention showed that children's preferences for the hotspots are tightly linked to their familiarity and use of other digital products, namely: *YouTube*, games, *Whatsapp* or other virtual messenger systems.

By involving children in the design process we received valuable insights for the design of hotspots in children's book apps. Further, a co-creation design process with children can also provide unexpected and creative graphic solutions, e.g. the "start reading" hotspot using the reader's perspective, the "automatic reading" hotspot as an ear, or the microphone hotspot as a "person talking". Or, the "quiz" and the "feedback" hotspot with an exclamation mark (see the red highlighted icons in Fig. 4).

The children also provided a simplified solution for the app navigation, choosing shorter ways to perform tasks by including essential hotspots on the book pages that were not previously included. This is, they placed the most used hotspots (to turn pages) in the internal pages close to the illustration areas of the story, which provided an efficient reading flow between pages avoiding interference with other hotspots. Children's attractive and playful drawings of the hotspot icons inspired the design of the hotspot icons for the final digital prototype. They favored a predominantly iconographic, nonverbal language, and their drawings of the hotspots showed a preference for the outline leaving the inner area empty. This demonstrates their preference for simple and "clean" icons. However, this may be related to the available materials: colored pencils, markers and crayons. Children's ideas and insights may as well be of value to researchers and designers working in the design of hotspots for children's digital picturebooks.

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