

Touch to Read: Investigating the Readers' Interaction Experience in Mediated Reading to Design Story Apps

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Abstract. A story app is a children's digital book which takes advantage of the multimedia and multimodality resources of mobile interaction devices. However, the poorly design of the interactive areas (hotspots) in story apps can compromise the reading activity and children's literacy acquisition. This is even more serious in mediated reading between children and parents, since the latter may not know how to use the hotspots or even feel that their presence is superfluous due to the digital resources. Outgoing from this scenario, we have carried out a user study with six parent-child dyads to investigate the effects of hotspots on the readers' experience during mediated reading of three-story apps to identify design problems and opportunities. The study measured five aspects of the interaction with hotspots, namely: 1) understanding, locating and recognizing hotspots; 2) balanced versus unbalanced number of interactions; 3) reading flow versus reading difficulties during the interaction; 4) engagement versus distraction in reading caused by the interactions; 5) distance versus closeness in mediation. The analyses indicate that hotspots are usually not designed for mediated reading, which may lead to parents' disengagement. Poorly located or misrepresented hotspots caused navigation errors negatively impacting reading. Contrary to findings reported by previous studies, we observed that the interactive game areas can provide a common point for intergenerational convergence stimulating mediated reading.

Keywords: Children's digital book · Interaction design · Hotspots

1 Introduction

Interactive digital books can support children's reading development. However, they do not substitute reading instruction or adult's involvement [1, 2]. The gains in children's learning, e.g., story comprehension and the acquisition of new vocabulary, are significantly better when their reading is supported by a more experienced reader also in the context of digital books [2]. A mediator can assist the children in case of reading difficulties, encouraging them to focus on the story, avoiding distraction caused by superfluous

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multimedia and interaction resources [3]. However, most commercial children's digital books have been designed with the purpose of entertaining children, keeping them occupied. This increasingly nullifies the need for adult's participation [4, 5]. In order to create an interactive area for children's' development of gestures and communication with mediators [6], as well as to create and mediate meaning through multimedia [7], it is essential to develop new approaches for the design of story apps.

Especially hotspots – the interactive areas in story apps – when poorly designed or in excess can generate understanding problems, potentially impairing children's learning [3, 8, 9]. Previous research has identified that 75% of the 137 most popular children's e-books in the USA contained hotspots, but just 20% of the hotspots contributed in some way to the story [10]. This is even more problematic in case of mediated reading. A previous study carried out with three to five years old children verified that 48% of parents had difficulties in guiding their children to interacting with hotspots in mediated reading of digital books [11]. Moreover, highly interactive books can create a frustrating reading experience for children and mediators, as these artifacts are generally not designed for

Table 1. Types of hotspots in story apps according to their functions or interaction mode [12].

No.		Description
1	Navigation	To navigate between pages or to access other content areas
2	Menus	Interactive areas or lists to choose options
3	Video/Animation	To enable and control audiovisual content
4	Game/Playful activities	Playful activities and interactive games linked to the story
5	Dictionaries/Extras	To access explanations and more advanced vocabulary
6	Quiz and Feedback	Interactive areas to check, track and measure learning
7	Hyperlinks	External links to websites, social networks or other apps
8	Integrated into physical media	Interactions enabled by handling a printed book connected to the digital device
9	Settings	To enable and control reading options such as sound tuning, font size, language, automatic reading
10	Personalisation	To incorporate new content into the story or recreate it, e.g. recording reading
11	Augmented Reality	Interaction that allows to superimpose the virtual on the real world (usually using QR codes)
12	Interaction via hardware	Interactions enabled by (gyroscope and accelerometer) movement (360°) of the device by the reader
13	Sound Interaction	To enable and interact with story content/characters through the reader's voice interactions

mediated reading [8]. Both, professionals and publishers recognize that there is a lack of patterns and of validated models in digital publishing for children [9]. Outgoing from this context, this work aimed at investigating the effects of hotspots on the readers' experience during mediated reading in order to identify design problems and opportunities.

2 Hotspots in Story Apps for Children

As extensive bibliographic review and an analyzes of commercial story apps has identified at least thirteen different types of hotspots according to their function and mode of interaction [12], (see Table 1). Outgoing from this classification, we conduct a user study to measure the readers' interaction experience with hotspots during mediated reading of story applications.

3 User Study

In the context of User-Centered Design, interaction goes beyond usability, taking into consideration an emotional dimension, which aims at meeting the users' desires and expectations [13]. An investigation focused on the user's experience allows understanding the phenomenological and pragmatic dimensions of the user's interaction with the artifacts and to generate greater satisfaction when interacting with products [14].

Table 2. The set of metrics for evaluating the readers' experience with story apps.

Metrics	Description
1- Understanding, locating & recognizing hotspots	Children can only benefit from story apps if they easily find and understand how to interact with them, for that, it is necessary to have adequate graphic, verbal, iconic, auditory representations, among others [15]
2- Balanced versus unbalanced number of interactions	An excess of interaction areas may compromise learning [3, 8] or overload cognition. However, children's engagement is significantly better in story apps that have hotspots compared to those that do not have them [16], even in cases of mediated reading [8]
3 - Reading flow vs. difficulties	Continuous interruptions of the reading activity due to the interaction can negatively influence the story comprehension [17]
4 - Engagement versus distraction in reading caused by the interactions	Well-designed hotspots that are congruent with the literary content tend to provide more engaged learning and positively influence reading frequency. However, some hotspots can be included for mere entertainment purposes and lead to playing rather than engaging the children in reading [1, 5, 15, 16]
5 - Distance versus closeness in mediation	In general hotspots are designed for a single user and not for shared or mediated reading [5]. Parents may have difficulties and feel frustrate when they do not know how to interact with them [8]. Nonetheless, hotspots can be designed to create possibilities for mediation, thus stimulating an intergenerational activity [18]

3.1 Measuring the Reader's Experience with Hotspots

Building on literature, we established 5 metrics as a bipolar scale to measure the reading experience while interacting with hotspots on children's story apps (see Table 2).

3.2 The Sample of Story Apps

Prior to carrying out the study, we selected three commercial story apps that present different types of hotspots. The selection was made from renowned prize lists for children's literature, such as the most important Brazilian children's book award, the *Prêmio Jabuti*[1] and top sellers story apps from the Appstore. The selected apps were (a) *Quanto Bumbum!*[2], (b) *Marina está do Contra*[3], and (c) *Hat Monkey*[4]. All these apps are available in Portuguese language and appropriate for the age group under investigation. These story apps presented a total of ten different types of hotspots (see Table 3). Three interactive areas were left out as they were not available in these apps: Dictionaries (5), Hotspots integrated into Physical Media (8) and Augmented Reality Hotspots (11).

Table 3. The different types of hotspots in the three selected story apps

No.	Hotspots/Story apps	Story app A	Story app B	Story app C
1	Navigation	✓	✓	✓
2	Menus	✓	✓	✓
3	Video/Animation	✓	✓	✓
4	Game/Playful activities	✓	✓	✓
5	Dictionaries/Extras			
6	Quiz and feedback		✓	✓
7	Hyperlinks	✓	✓	✓
8	Integrated into physical media			
9	Settings	✓	✓	✓
10	Personalisation		✓	
11	Augmented reality			
12	Interaction by hardware		✓	
13	Sound interaction			✓

[1] The *Prêmio Jabuti* website can be accessed under the link: https://www.premiojabuti.com.

[2] Editora Caixote: Quanto Bumbum! - livro interativo para crianças. Version 1.4.1 (2016). Accessed 12 April 2018 from http://twixar.me/mzdn.

[3] Editora Caixote: Marina está do Contra. Version 1.1.5 (2018). Accessed 12 April 2018 from http://twixar.me/Wzdn.

[4] Haughton, C.: Hat Monkey app. Fox and Sheep, version 1.9 (2014). Accessed 12 April 2018 from http://twixar.me/Jzdn.

3.3 Participants and Procedure

The users' sample was composed of six parent-child dyads. The children were aged between six and eight years old. At this age children already have some reading independence but can still benefit from the guidance of a more knowledgeable person. All the participants were selected from a Portuguese elementary public school. The study was conducted after classes at the school's library. Each parent-child dyad participated in three reading sessions. We have received written informed consent from all the parents and from the head of the school to carry out the study.

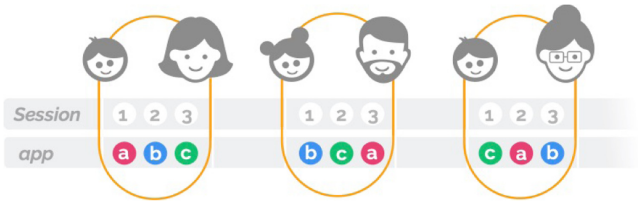


Fig. 1. The research sessions with the pairs of readers of three different story apps and the respective distribution of app per session/pair.

Each session was conducted in a different day and with a different app (see Fig. 1). In order to avoid any bias, such as initial shyness of the children and the mediators' lack of familiarity with story apps, we have alternated the reading order of the apps. In total, eighteen reading sessions were carried out from April to July 2018.

3.4 Data Collection and Methodology

We took particular care to select appropriate approaches to carrying out research with children. The method, tools, protocols and procedures are summarized in the following (Fig. 2).



Fig. 2. The methodology: research tools, procedures and data collection.

3.4.1 Reading Habits Questionnaire

In the first session, the researcher applied a questionnaire to the parents to gather information about their and their child's reading habits as well as their familiarity with digital books and electronic reading devices. This survey took approximately 5 min per participant.

3.4.2 Reading Sessions

In each of the three reading sessions we provided a different story app on an *iPad* device to each parent-child dyad, and instructed them to read as they usually do at home (Fig. 3). Each reading session lasted around 20 min.

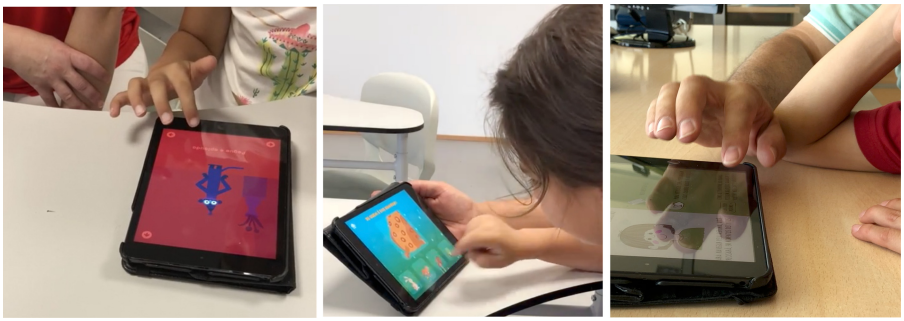


Fig. 3. The children and their parents interacting with the three different story apps.

3.4.3 Assessing Children's Preferences and Understanding of Hotspots

After each parent-child dyad reading session, we conducted a survey with the children to assess their preference and understanding of the different hotspots. For this, we used the Paper Ladder rating scale [19] combined with the Five Degrees of Happiness rating scale [20].

Paper Ladder is a method specially designed for carrying out research with children, it deploys a graphical and tangible version of a Likert scale [21]. Paper Ladder allows children to express their preferences by positioning printed cards with graphical representations of the items under evaluation on the printed ladder. The higher the rung on the ladder, the more the child likes it, on a scale from one to five. In order to make it more understandable for the children we incorporated the graphic emoticons proposed by the Five Degrees of Happiness tool [20] into the Paper Ladder. This also facilitated the positioning of the cards by the children, who placed the printed cards exactly on the emojis (see Fig. 4).

We asked each child to position the cards representing each hotspot on the Paper Ladder. First the researcher made sure that the child could identify the hotspots printed on each card, and then asked her/him to position each card on the Paper Ladder according to his/her opinion. E.g. to check metric one (understanding, locating & recognizing



Fig. 4. The adapted Paper Ladder [19–21] and the printed cards representing the Hotspots present on the story app C.

hotspots), he asked the child to position a hotspot card on the ladder according to whether it was easy (top steps) or difficult (lower steps) to find on the app. According to the chosen position, the researcher then asked the child about his/her preferences. This procedure was carried out at the end of each session and lasted approximately 5–10 min.

3.4.4 Mediators

At the end of the reading sessions the parents were also invited to evaluate their experience with the hotspots during mediated reading, using a five-point Likert scale together with the printed cards that represented each hotspot. In total there were between six and nine different types of hotspots per application and five metrics (see Table 3, Sect. 3.2). Each mediator answered approximately 30 to 45 questions (see Fig. 5).

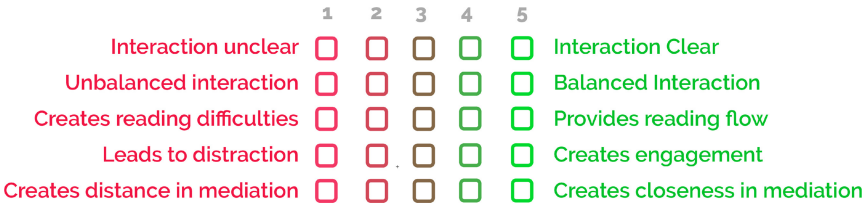


Fig. 5. Likert Scale with metrics for evaluating the mediators experience.

For each reading we also asked the parents how they considered in general their child's interactive experience with the application and about their own experience (see Fig. 6) during mediated reading.



Fig. 6. Likert Scale with metrics for evaluating the whole mediated reading experience.

3.4.5 Data Collection

The data was collected through observations, field notes, photographs and video recordings of the children and the mediators' interactions with the apps. Additionally, we created a check list to map and track the reader's interaction with the hotspots. In cases that the child and the mediator did not interact with some hotpots - even when we have requested them to carry out specific tasks at the end of the reading - we also took this into consideration for the data analyses.

3.4.6 Data Measurement

As mentioned above, the parental responses were assessed for each of the five metrics for each type of hotspot using a five-point Likert scale, where 5 and 4 corresponded to good, 3 and 2 corresponded to problematic and 1 represented a bad interaction experience. Some hotspots were present in all apps, therefore, they were evaluated in the eighteen reading sessions, while other hotspots were available in just one or in two apps (evaluated in six or twelve sessions respectively). In the following we present the hotspots with the most expressive results for each evaluated metric.

4 Observations and Results

All the six participant parents' had smartphones, tablets, computers or videogame devices at home and, with the exception of smartphones, most of them give their children access to these devices. The most used device was the tablet, in general the parents granted their children permission to use it for one hour daily.

Regarding the reading habits, three out of the six participating parents, read books daily with their children. One mother reads books once a week with her child and the remaining two do not have this habit. Only two parents had already read digital books with their children, the other had never used story apps.

During the reading sessions we observed that generally the children themselves assigned mediation roles to their parents, e.g. asking them for the meaning of words. The parents also guided the children helping them to focus on reading.

4.1 Children's Hotspots Preferences

According to the children's preferences, which were assessed using the Paper Ladder, their preferred hotspots were Games and Videos Hotspots. We speculate that this is because these areas provide a more playful interaction, enabling access to attractive multimedia content. In contrast, Navigation and Menus Hotspots were the ones that the children liked the least. Most probably because these hotspots are merely a functional

feature. On the one side, it is appropriate that Menu and Navigation Hotspots are secondary during interactive reading in order to avoid casual interactions, on the other side, these hotspots may remain unnoticed by the readers or be underexplored as an interactive narrative resource.

4.2 Mediators' Hotspots Preferences

All the parents considered that the mediated reading experience with the apps was in general enjoyable, assigning it an average of 4.4 points. The parents considered it a very valuable experience for their children (4.5 average). When asked about what was missing for a complete enjoyable experience, most of the parents answered that the story apps should include more games with more levels. This aligns well with the children's preferences for the Game Hotspots.

By mapping the data obtained through the Likert scale with the observation notes we have realized that two recurring features may have impaired the mediators' experience: i) the Video Hotspots were usually controlled just by the children while the mediators, as viewers, often had to wait long and visualize the videos before they were able to continue reading; ii) the mediators that have identified Hyperlinks Hotspots in the apps avoided interacting with them and also prohibited their children to do it, since these interactive areas worked merely to direct the readers to e-commerce.

4.3 Understanding, Locating and Recognizing Hotspots

The icons for the Hyperlink Hotspots were the most difficult to locate and to understand. As these hotspots were available in all the three apps, they were evaluated in eighteen reading sessions. In four of the sessions the participating dyads considered that the Hyperlinks were easily identifiable (assigning a score of 4 and 5), in five of the sessions the participating dyads had some difficulties to identify these hotspots (assigning a score of 3 and 2) and in one session the participants did not identified the Hyperlink Hotspot (assigning a score of 1). In eight of the reading sessions the parent-child dyads did not find the Hyperlinks, although they were asked to perform a specific task that should lead them to find these hotspots on the apps.

Especially one of the story apps revealed a serious problem with the Navigation Hotspots due to the misleading representation of its icon. The Home icon (a symbol of an arrow pointing up) and the Navigation icon (to advance reading) were very similar. After reading the first page some children clicked to move to next page and continuing reading but instead she was redirected to the home page. Some of the children mistakenly clicked the Home icon to advance reading being redirected to home page instead of the next reading page as they have expected.

Overall, the analysis indicates that the first interaction problem faced by the users when reading a story app is the appearance and the location of the hotspots. In our analyses, we have identified three main aspects that need to be taken into consideration when designing hotspots for children's story apps: i) the design of the symbols has to be understandable for children, compatible with their visual cognitive repertoire and familiarity; ii) the design of each different type of hotspot should be different and graphically

consistent with its function; iii) the hotspots' position on the screen or on the sections of the app needs to be carefully considered as this influences their identification.

4.4 Balanced Versus Unbalanced Number of Interactions

Concerning the Game Hotspots present in the three-story apps, in ten of eighteen reading sessions the parents of each participating dyad considered that the number of interactions was appropriate, assigning it a score of 4 and 5. The remaining eight participating dyads assigned it a score of 3 points. When asked the reason for their score the parents explained that they would like to have more game areas with more levels. We think that this is due to the fact that the game areas offer more possibilities for joint interaction between the children and their parents, in some cases the children prompt their parent to play together.

Overall, the Game or Ludic Activity areas promoted children's haptic interactions with the apps and higher levels of dialogue and body expressions between the children and their parents than the other interactive areas. However, this preference may pose difficulties. This is, it "may lure children's attention away from the narration and turn the activity into a game instead of a reading experience" [8:192]. Based on the results of this study, we provide two guidelines for the design of Game Hotspots: (i) provide short games that are only played once within the narrative and (ii) if available, design more complex games with more levels in a distinct area, apart from the reading pages. These games can be open to more than one player and used to reinforce the learning activity.

4.5 Reading Flow Versus Reading Difficulties During the Interaction

Regarding the Menu Hotspots - the interactive areas such as chapters or lists that enable accessing the app's activities - in ten out of eighteen reading sessions the parents considered that the interaction with these Hotspots provided a good reading flow (assigning a score of 4 and 5). However, in six reading sessions the participating dyads have attributed low rates to these hotspots (assigning a score of 3 and 2). This means that the interaction with the Menu Hotspots disturbed reading. In the other two sessions the readers have not found the Menu Hotspots, even after being requested to use them. This is mainly because none of the three apps contained Menu Hotspots in the inner pages. These were only displayed on the apps' Home Page. As a consequence, the readers always had to go to the Home Page or navigate page by page when they wanted to choose or return to a specific page. This interrupted the reading and frustrated the readers. Especially the parents have shown fatigue while guiding their child back to the reading activity. E.g., avoiding distraction caused by the child's attempt to access the games on the Home Page Menus'. To avoid this, we suggest that whenever possible, the story apps have main Menu Hotspots, especially chapter menus, in the inner pages. This allows the users to quickly and without distraction access menus that are relevant to the reading activity without leaving the page that they are reading.

4.6 Engagement Versus Distraction in Reading Caused by the Interactions

Regarding engagement, the Personalization Hotspots' were the most problematic. This hotspot was only available in one story app (C), as an interactive audio recording mechanism, which allowed the readers to record their own reading. Four out of the six parent-child dyads did not interact with this hotspot. The two other declined to rate it since they did not complete the recording of the first page. Apparently, this type of hotspot has not engaged the readers to interact with. However, this may be due to a lack of time of the parents, as they understood it as a complex activity or as an activity that would involve rereading the story.

4.7 Distance Versus Closeness in Mediation

Regarding the degree of closeness between the mediators and their children, during the interaction with the videos and animations, in ten out of eighteen reading sessions, the parents assigned it a score of 4 and 5. In two reading sessions, the parents have evaluated these hotspots as problematic (assigning a score of 3 and 2) and in four reading sessions the parents considered that the videos negatively impacted the reading activity and compromised the engagement between the children and their parents (assigning a score of 1), as both were merely spectators. In two of reading sessions the mediators have not even remembered app's video and animation areas, consequently, they have not evaluated these hotspots.

However, while the visualization of long videos turned the mediators into merely spectators, the Game Hotspots created closeness between the parents and their children. The children spontaneously prompted their parents to "play" with them and sometimes they started a competition. This probably explains why both the parents and the children wished to have more such interactive areas in the apps, as above-mentioned. The hotspots that promoted the highest interaction level between the parents and their children in mediated reading were those that provided the possibility to simultaneously interact with the app.

5 Conclusions

This paper presents the research process and the results of a user study, carried out with six parent-child dyads during mediated reading. Our goal was to identify positive and negative aspects of the readers' experience with different types of interactive areas - hotspots - on children's digital books to inform the design of such areas. The results indicate that:

1) it is fundamental that the users are able to easily identify the hotspots and their function, therefore it is important that the distinctive design of the hotpot icons' is aligned with children's visual repertoire and cognitive development, as well as the appropriate location on the app's interface;
2) contrary to previous studies that generally discourage the implementation of games in digital books, the children and the parents that have participated in this study

expressed the wish to have more Game Hotspots, providing that these promote more dynamic interaction moments between the parents and their children and engage them in the story. We conjecture that when such areas are well integrated into the story, they have the potential to provide additional opportunities for joint and mediated reading;

3) the reading flow can be improved when the most relevant Menu, Configuration and Navigation Hotspots are conveniently placed, especially on the reading pages that provide reading customizations and navigation between pages or sections;
4) interactive features that demand complex interactions, require a great amount of time to interact with or are perceived as an extra task will probably not engage the readers, may distract them or even lead to ending the reading activity;
5) the engagement between the child and the mediator is more intense when the app provides space for the children, who usually controls the device, to invite the adult to help them, e.g. explaining unknown words, or to "play". However, long videos and animations can fatigue the mediators, as they may feel that their presence is superfluous.

Overall, although story apps may offer highly interactive resources that may contribute to help and engage children in reading, they do not replace the presence of reading mediators. In this paper we have present some observations which may contribute to improve the design and integration of hotspots in children's digital books, and to facilitate mediated reading with these devices aimed at children that are learning to read and can benefit from assisted reading.

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