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THE MAGIC WAND: ENRICHING SHARED STORYBOOK READING

Chris Heger and Andrés Lucero
Eindhoven University of Technology
P.O.Box 513, 5600 MB, Eindhoven, The Netherlands
c.j.j.heger@student.tue.nl; a.a.lucero@tue.nl

ABSTRACT
This paper introduces the 'Magic Wand', a system that works next to existing physical books and adds an extra dimension (i.e. sound) to shared storybook reading for adults and children by providing a simple and intuitive interaction. The 'Magic Wand': 1) enriches the shared book-reading experience by adding supporting sounds, 2) provides a low-tech and accessible way of identifying sounds by handling books in their pure form, 3) creates a reading ritual for children ages 3 to 6, motivating them to first discover books and later develop a reading habit, and 4) fits and can be used by children, parents and teachers in different contexts (i.e. home, preschool). Evaluations show the 'Magic Wand' evoked physical and emotional reactions in children without distracting them from the story, and invited children to engage in fantasy play beyond the shared storybook experience.

KEY WORDS
Shared storybook reading, Support for creativity and learning, children, tangible interaction.

1. Introduction

Shared storybook reading is an activity in which adults (i.e. parents and teachers) read to children, helping them transition from the simplest picture books to the first storybooks. In the age group three to six years most children cannot read for themselves yet and require the involvement of an adult or older skilled reader to gain the full benefit of books or magazines [1]. Parents and teachers can enrich the material by linking it to the children's real-life experiences, triggering discussions, and elaborating together on the books with children. However, people are reading less and less mainly due to increased busyness of present lifestyles and the substitution of reading by watching television [2]. The precipitous decline in book reading has especially been a drawback to the personal process of developing children's imagination hence the importance and meaning of forming reading habits in children.

1.1 Related Work

Several projects have supported reading for children (and parents) at different stages of the process (i.e. learning to read, reading itself, and storytelling). The MagicBook [3] consists of a normal book that is used as a transport mechanism to seamlessly move users between physical reality, augmented reality (AR) and virtual reality (VR). Although the book can be read without additional technology, to experience the AR and VR environments, handheld displays, an InterSense tracker, and a camera are required. StoryMat [4] supports children's everyday collaborative storytelling by recording and recalling children's narrative voices and the movement toys make on a large embroidered cotton mat. A projector, a wireless mouse and speakers placed under the mat are used. Listen Reader [5] combines the look and feel of a real book with the rich evocative quality of a movie soundtrack. While conceptually close to our design principles in respecting and cherishing the experience of reading and handling a book in its pure form, sensors are inserted in the binding of the book while RFID tags are embedded in every page of the book. Moreover, a large wingback chair with speakers in each wing with a subwoofer under the seat is necessary, plus a wooden swing arm table are part of the final setting of the system. Read-It [6] is a multimodal, tangible and collaborative tabletop system that supports children in learning to read. In a memory-like game, children flip tangible bricks to uncover objects that are unveiled with its corresponding textual (graphemes) and audible (phonemes) information. The system requires two projectors and a camera to track the bricks using computer vision.

Figure 1. A child follows the story read by her mother, while the mother also triggers sounds using the 'Magic Wand'.

All the previously mentioned projects have reading or storytelling as a starting point but then rapidly evolve into creating an 'enhanced' and new experience, ultimately drifting away from the original simplicity associated with reading a book. We believe that one of the most important aspects of reading lies in inviting children to make an attempt to generate their own world and thus develop their imagination [7]. Therefore, we believe in creating a new experience that evolves around reading a simple, regular book, as opposed to creating an interactive book experience. Most of the magic is in the book itself. Second, most of these related projects require either custom-built rooms and/or high-tech equipment such as projectors, cameras, microphones, speakers and other equipment that make reading and storytelling inaccessible for most families. Third, regarding the developmental stages according to Piaget [8] these children are in their preoperational stage that is marked by self-centred thinking or egocentrism believing that everyone thinks as they do. Children do not yet have a clear understanding between reality and fantasy and perceptions dominate their judgment. As such, it seems appropriate to introduce the element of magic into our system to foster fantasy thinking and play. Fourth, computer mediated tools aimed at supporting reading require abilities to handle standard devices (i.e. mouse) that most children in this age group do not yet master [9]. We explore making these technologies more accessible for children by making them more tangible [10]. We concentrate the magic on a tangible object that children are familiar with: a 'Magic Wand'.

2. User Study

2.1 Contextual Inquiries at Home

In order to get a better understanding of shared storybook reading, we conducted two ethnographic studies. In the first study, we used contextual inquiries [11] to get a better understanding of what happens during shared storybook reading at home. We contacted three families to allow us to enter their homes during a shared storybook reading session. We initially planned to sit together with them trying not to interfere, however we discovered very quickly that our presence in the room would distract children. We opted for videotaping the sessions, which created less distraction for children.

Figure 2. Shared storybook reading at home. (a) Child distracted by dog (left); (b) mother and child discuss the story (middle); (c) later resuming reading (right).

We present one of these sessions to illustrate and generalize our findings from the contextual inquiries. In the first part, we visited this family's home to explain the purpose of our visit to the participants, make our first observations on the spot, and hand them the video camera. This family filmed their shared reading activity for a week (in total three reading sessions). This is how one of these sessions would usually go:

"Four-year-old Sophie is very easily distracted from the story, mainly by outside influences (Figure 2a). Her mother Hennie gets a bit frustrated by this and asks Sophie to pay attention and focus on the story, interrupting the shared reading in an unpleasant way."

Although children this age can get easily distracted while they are being read to by their parents, we discovered that some breaks in the story are not distracting to children when they are related to the story:

"Hennie leaves the story a couple of times to talk about things related to the story (Figure 2b), asking Sophie questions about specific things in the story or similar situations she may have experienced in her life. When the talk is over they return to the story and continue as if nothing had interrupted it (Figure 2c)."

These pauses in the story to talk can vary from about 20 seconds to several minutes and do not seem to be experienced as distraction or as an obstacle for children to understand and enjoy the story. From this study we discovered that if we add elements to the shared reading experience these elements must be directly connected to the story. Children must understand the general idea behind the story or what is happening with the characters. If children do not understand the story due to distracting elements, they will lose interest in the story.

2.2 Observation Session in Pre-School Environments

In the second study we did an observation session of a 'shared storybook reading table' ('voorlees tafel') (Figure 3) in 'Sam Sam', a day care centre in Neijmegen, currently one of the most successful shared storybook reading techniques used in pre-school environments in the Netherlands. In these sessions, teachers not only read the book and show the pictures to the children, but they also act out the story with cuddly toys and materials that match the figures and materials in the book (Figure 4a). These toys are located in a special basket.

These sessions sometimes take place with the assistance of another teacher. As the story develops, teachers invite children to take over the role of acting out the story with the toys (Figure 4b), and then children go back to their seat again. Children are able to pick up the story where it was left off and continue with it while trying to keep the storyline and atmosphere. Children acting as spectators can remain focused on the story because the characters are related to the story and therefore do not form a distraction from the story. These findings are inline with our previous study. Children can also play with the toys and the story when they are not in a reading session.

Figure 3. 'Voorlees' table. The teacher uses the toys and materials found in the basket to act out the story.

Figure 4. (a) A child uses the toys from the basket to act out part of the story (left); (b) Children extend the reading session by making related drawings (right).

During the session it was very clear that this 'shared storybook reading table' technique is some kind of ritual for children that evolves around the characters in the basket. The ritual starts when the teacher gets the basket and picks the book and it ends when all the characters are back in the basket. When the session ends children extend the shared reading experience by doing things related to the book like acting the story out for themselves (role playing) and drawing pictures of the story (Figure 4b).
From this study we understood the importance of creating a ritual for children. Children know exactly what to expect when the teacher takes the basket with the characters and starts reading the story. Hopefully that ritual will later lead to developing a reading habit in children. Additionally, we discovered that our system should allow children to extend the experience beyond shared reading with other activities such as role-play.

3. Design

From our previous studies, we have identified requirements from parents, teachers, and children to support shared storybook reading. We propose an interactive 'Magic Wand' (Figure 7) that: 1) enriches the experience of shared storybook reading between parents and their children by adding supporting sounds to existing physical books, 2) provides a low-tech and accessible way of identifying sounds by handling books in their pure form, 3) creates a reading ritual for children ages 3 to 6, motivating them to first discover books and later develop a reading habit, and 4) fits and can be used by children, parents and teachers alike in different contexts (i.e. home, pre-school environments).

3.1 Adding Supporting Sounds

Based on our previous findings we have decided to include sound as the primary added dimension to enhance shared storybook reading, one reason being it is easier for children to relate concrete sounds to a story than other abstract representations (i.e. colored lighting). The sounds offered should be in relation to the events and characters appearing in the story, and in line with the story as it progresses. Users should also have the freedom to skip (forward and backwards), and to decide when to play a given sound. Giving this level of control to users will allow them to become active storytellers, and give parents the possibility to skip and replay sounds that their children like or dislike. Finally, allowing users to set the pace of the story allows the system to support and stimulate shared storybook reading instead of taking over the activity.

3.2 Handling Books in Their Pure Form

Shared storybook reading takes place in all levels of the Dutch society. Families have their own private collections of children books and can also borrow books from the local library. We wanted our tool to support this simple and open access to books that families currently have. We tried to achieve this by creating a simple tool that works next to existing books thus keeping the emphasis on the book in its pure form. We believe that most of the magic behind shared storybook reading lies in two things: the book itself and the close contact between parents and children. We deliberately avoided altering or replacing existing books with an 'interactive' book. The book itself is the key support for the system. In this way the book stays the main source for shared reading and is not overshadowed by an abundance of technology.

3.3 Creating a Ritual

Reading invites children to generate their own world and develop their imagination [7]. We hope that creating a reading ritual will stimulate children and parents to read together on a regular basis, which then helps children to develop a reading habit. Creating a shared storybook reading ritual with a clear start and end of the session is a strong way to motivate children and create expectation towards the shared storybook reading activity. We implemented this principle into our design by letting the 'Magic Wand' create the ritual. Parents or teachers determine the start time of the ritual. When it is shared storybook reading time the 'Magic Wand' starts glowing in the colours of the rainbow while it stands in its dock station. The end of the ritual is indicated when the Magic Wand is placed in its dock station again. The wand lights up and then fades out. The 'Magic Wand' makes an invitation at an opportune moment to both parents (or teachers) and children to start shared reading. As such the wand applies the principle of suggestion [12] to stimulate shared reading on a regular basis.

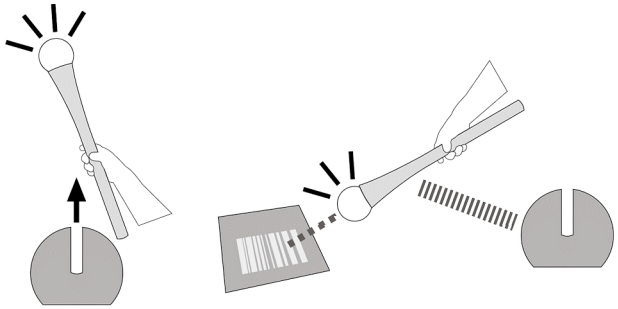

Figure 5. (a) The wand glows to begin the ritual and is removed from the base (left). (b) Scanning the barcode to identify the book and communicating with the base to download relevant content (right).

3.4 Fitting in Different Contexts

Shared storybook reading happens in different places such as in a reading group in pre-school environments or in different rooms within a home. Therefore, the system should be easy to transport and use in different contexts. The 'Magic Wand' allows users to add supporting sounds to existing books without making any changes in the room, except for placing the wand itself and a small dock station that houses all the necessary power, communication, and sound elements in the room. By creating such a compact design, the system can easily be transported and set in another location both inside the house and at another remote location.

4. Interaction

4.1 Start of the Ritual

We will now describe the main aspects of the interaction with the 'Magic Wand' by means of illustrations that refer to the case when a child user is handling the wand. The 'Magic Wand' system consists of a dock station and the wand itself. When it is time to start the reading session, the crystal attached to the wand's rod starts glowing in a continuous transition of colours thanks to the LEDs it contains (Figure 5a), indicating that the shared story reading ritual has commenced. When the child notices that the wand is glowing, the next step is to remove the wand from its dock station and pick a book for reading.

4.2 Selecting a Book

Once child and parent have selected a book the child uses the tip of the wand to identify the book by means of an infrared barcode reader (Figure 5b). When the barcode is successfully read, the wand communicates via Bluetooth with the dock station, which in turn connects to the Internet via a wireless connection. A set of corresponding sounds and images that belong to the book are downloaded and stored in the dock station's memory. The images representing sounds are uploaded into the wand.

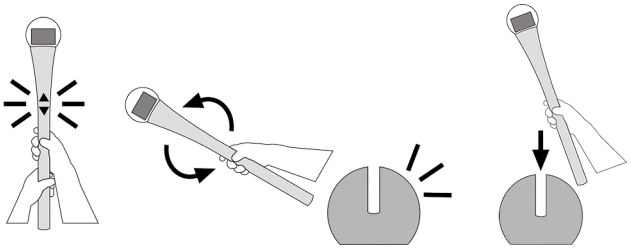

Figure 6. (a) Selecting a given sound (left); (b) Swinging the wand to trigger the chosen sound (middle); (c) Putting the wand back in the base (right).

4.3 Selecting Sounds

The cover of the selected book is now displayed on the crystal's LCD screen and thus the actual shared storybook reading can begin. The pictures are uploaded into the wand in the same order as in the story. Using the arrow buttons on the rod children can navigate to a given sound (Figure 6a) linking the image displayed on the wand's crystal ball with the image or event in the book.

4.4 Triggering Sounds

When the wand is swung in the air the crystal ball lights up and the selected sound is played through the dock station's built-in speakers (Figure 6b), thus providing users with multimodal feedback. This simple but rich interaction movement is inspired by the magical principle of casting a spell by swinging a wand, which is very appealing for children making them feel as if the one holding the wand has 'super powers' [13]. Sounds are triggered when the wand reaches a certain level of acceleration in any direction allowing children to use their own imagination and creativity in swinging the wand. We decided to trigger the sounds in the simplest and most compelling way possible to motivate children to take over selecting and triggering sounds, especially when books have previously been read to them several times.

4.5 End of the Ritual

When parents and children think it is time to stop the shared storytelling experience, they can simply put the wand back into the dock station (Figure 6c). At this point the wand's crystal lights up and then fades out. The 'Magic Wand' is now ready for the next reading session.

4.6 Extending the Experience

This easy and fun type of interaction enables children to play with the 'Magic Wand' outside the shared storybook reading activity by taking the wand, scanning a book, and triggering sounds. Children might use sounds to support role-playing games or act out the story of a book. In this way children relive the reading experience and get motivated for the next shared reading moment. We designed a neutral wand shape for the 'Magic Wand' so it can be used with a wide range of stories.

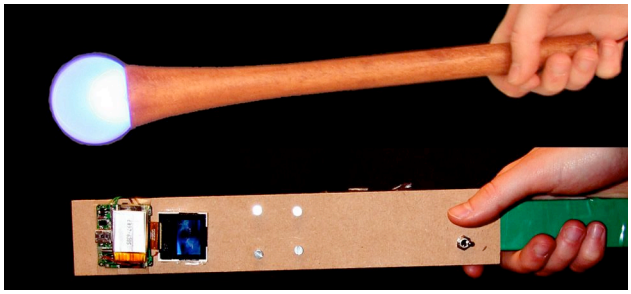

Figure 7. Both 'Magic Wand' prototypes. (a) the shape model (top); the technical model (bottom).

5. Evaluation

We took the 'Magic Wand' concept to the day care centre 'SamSam' in Nijmegen, the Netherlands. Here we conducted a qualitative user test, with seven children between three and four years old and with one teacher reading the story and three other teachers observing the test. For the testing we used the Dutch version of the popular book "We're going on a bear hunt" [14] including its illustrations. We wanted to test the usefulness of the system with adults and children. We were especially interested in aspects related to the general concept of the wand, the interaction, the sounds and the wand's shape.

5.1 Implementation

We created two prototypes: a shape model (Figure 7a) to let users have an impression of what the real 'Magic Wand' would look and feel like in terms of materials and shapes, and a technical model (Figure 7b) demonstrating the main functionality of the wand to select and trigger sounds. The shape model also allowed us to explain the reading ritual to our participants, as well as the multimodal feedback when the wand glows. The technical model consisted of a wooden plank to which a 1.1-inch colour LCD screen to display the pictures, an accelerometer Phidget to detect wand movement, and a simple switch to browse the different sounds were all attached. The wand was connected to a laptop computer that acted as the dock station, storing sounds and pictures as well as making the interaction of the wand work using Max/MSP software. The shape model consisted of a wooden rod and a semi-transparent plastic ball for the crystal. Inside the crystal ball there was an RGB power LED to make the wand glow and light up. The power cable from the LED was fed through the rod to a battery located outside the rod that could be switched on and off.

5.2 Procedure

The test was conducted in the shared storybook reading corner. We explained the 'Magic Wand' concept to the teacher and showed her how to browse and trigger the sounds. We then set up the room and placed the shape model in the centre of the reading corner. Then we invited everyone to enter the room, including the children.

Figure 8. Experiment setup. (a) Children listening to the story while seated on a couch (left). (b) The teacher telling the story while using 'Magic Wand'.

We showed the wand's shape model to the children and told them it was a 'Magic Wand'. We then explained the ritual part of the concept and switched the lights in the wand on. Later, the teacher took over to begin the reading session. The teacher was sitting in the reading corner (Figure 8b), while the children were seated on a couch on the opposite side of the room (Figure 8a). We handed the technical model of the wand over to the teacher; she explained to the children the concept of adding sounds to the story using the 'Magic Wand'. After this she started with the reading, using the wand to trigger supporting sounds connected to the story. Once the reading session was over, we invited children to play with the wand and to trigger sounds by themselves.

5.3 Findings

In the first part of our exploratory evaluations, we used the shape model to show how the 'Magic Wand' could create a ritual. When we switched on the lights in the crystal ball, children started calling out the names of the colours as they transitioned in the wand:

- *"Red, Blue, Yellow!"*

From this spontaneous reaction we can see that children liked the coloured lights in the wand as they were not asked to mention the colours but they felt the motivated to speak out the colour names.

The 'Magic Wand' triggered similar spontaneous reactions from children when the shared storybook reading began. When children heard the first sounds from the wand, they were anxious and some of them even a bit scared. They sat still and looked around to find out where the sounds were coming from. But after a few more sounds were triggered they became increasingly relaxed and started to pay more attention to the story and the related sounds. When the teacher got to three quarters of the book the children started to physically react to the sounds. By the end of the book all children were very enthusiastic and wanted the teacher to read the book to them once again.

When the teacher read the story to the children for the second time, children immersed themselves in the story and the sounds. Sometimes they paid all their attention to the sound itself to figure out what it was that they were hearing. However, they never lost track or interest in the story.

Figure 9. Children reacting to (a) the sound of stepping on deep mud by standing up and stepping on the floor (left), and to (b) the dark forest (right).

These are some examples of reactions from children that the story together with the sounds from the wand elicited:
- In one part of the book 'We're going on a bear hunt', the family that goes bear hunting has to go through a deep, cold streaming river. The children now hear a streaming river sound. From this point on, we saw that children started acting out what they were hearing.
- *"…Now the family has to go through deep, slimy, bubbling mud."* The children now hear the sound of footsteps in bubbling mud and start acting accordingly (Figure 9a). Later, with some sounds children reacted showing physical emotional reactions such as for scary and happy sounds:
- *"…The family now has to go through a deep, dark forest…"* The children now hear the sound of a dark forest (Figure 9b). Children also show empathy for the characters in the book:
- *"…The family that goes bear hunting has to go through a sweeping snowstorm…"* The children now hear the sound of a blizzard (Figure 10a).

Regarding the interaction with the 'Magic Wand', we noticed the teacher was a bit nervous the first time she read the book to the children using the wand. Although we showed her it was possible to freely swing the wand, she was afraid of breaking it. Therefore in the beginning she only swung the wand in a straight angle, just hard enough to trigger the sound. Before she started reading the book for the second time, we encouraged her to freely swing the wand, but this time faster. During the second session she started to use the wand more as a 'real' magician and she used her imagination when swinging the wand.

Regarding triggering sounds, we noticed it was easy for her to relate the sounds with the story. She triggered all the sounds in the right places, with the exception of the second sound in the first session. She quickly realized that she had forgotten to change the sound so she clicked on to the next sound and continued reading.

Regarding the feedback provided by the wand, we noticed that from the sounds it was very clear when a given sound had been triggered. However we noticed that she needed to look at the screen from a very short range before she could understand the content of the illustrations. Since we used the illustrations from the book, some of them were not clear enough as sometimes an entire picture from the book was displayed on the 1.1-inch screen.

Figure 10. (a) Reacting to the sound of blizzard (left); (b) Trying out shape and functionality models (right).

We also wanted children to play with the wands, but they were a bit too afraid, except for one child. He explored both wands and with some help from us he managed to trigger a few sounds (Figure 10b), which put a smile upon his face. After the evaluation we let the system running and all children started to play with it again, especially trying to trigger the sounds by swinging the wand in different ways, thus engaging in fantasy play. As a summary, in these first exploratory evaluations users saw the relevance of adding sound to shared-storybook reading. Teachers were very enthusiastic about the shape, the interaction, and the sounds of the wand. Although children were initially a bit anxious, they were quickly involved in the story and reacted to the added sounds by physically moving and verbalizing (i.e. calling out the names of the colours in the wand). Children wanted to be read to twice in a row for almost half an hour, remaining focused on the story. The teacher told us that normally children already find it hard to pay attention to one story.

6. Discussion

6.1 Adding Supporting Sounds to Books

A separate set of supporting sounds must be created for each book to match with the events in the story. In that sense, we feel that the choice of the book "We're going on a bear hunt" may have played an important role in how adults and children have perceived the system. This is an adventure book with large illustrations and with clear and exciting sounds to be triggered at every turn of the page (i.e. blizzard, dark forest, mud, etc.). For more complex books that have more characters, eventful situations, and larger number of pages it may not be as simple to identify the sounds in relation to the story. Interrupting the story with sounds every two lines may also distract children.

6.2 Handling Books in Their Pure Form

Regarding having the wand as a companion, we have noticed that children were able to follow the story and thus the wand was not a distraction in itself. However, we also noticed that children wanted to play with the wand afterwards, engaging in fantasy play pretending the wand was another element (i.e. sword, cane, stick, etc.). Our

main concern at this point is what would happen with the wand over prolonged use in the sense that it may become more of a toy for fantasy play than a companion for shared storybook reading, creating additional distraction.

6.3 Creating a Ritual

Children and adults only came in touch with the wand once. We did see children reacting positively to the lights emitted by the wand's crystal and we can assume that they would associate the activation of these lights with the ritual. But families must use the wand in shared storybook reading for several weeks and check how they react before we can claim that the wand creates a reading ritual.

6.4 Fitting in Different Contexts

The required technology and compact design of the 'Magic Wand' make it highly accessible for households when compared to previous attempts to support reading with new technologies. The dock provides the necessary power, communication and sound for a room at home or the classroom at school. We have successfully seen how children react to the wand in a school environment with other children their same age and with the presence of a teacher. However, only further studies would allow us to check reactions at home with only two people involved.

6.5 Interacting with the System

Adults and children liked the simple design and intuitive way to trigger sounds. However we did notice some difficulties in selecting and identifying the images that correspond to the sounds on the wand. Some participants had difficulties in understanding the contents of the image and had to come really close to the screen. Although having a slightly larger LCD screen could partially solve the problem, we believe that creating custom-made thumbnails or icons based on the illustrations from the book would improve the identification of sounds. Another limitation to really test the interaction with the system is the fact that we lacked the integration of all the functionality into one prototype. Having separate technical and shape models did create some confusion in children (Figure 10b). A full working model of the magic wand is needed to better test the interaction.

7. Conclusion

In this paper we present the 'Magic Wand', an interactive system that supports shared storybook reading for adults and children works by adding sound to existing physical books. The system provides a simple and intuitive interaction to select and trigger sounds, and can be used in preschool environments as well as at home. In an exploratory user study we explored the limitations of the system in terms of the proposed interaction style to select and trigger sounds, supporting shared storybook reading, and creating a reading ritual. The evaluations show that both adults and children were able to trigger sounds using the 'Magic Wand', that the sounds evoked physical and emotional reactions in children without distracting them from the story, and that the wand invited children to engage in fantasy play beyond the shared storybook experience. Additionally, we have identified a number of issues related to our system such as the types of books chosen, creating additional distraction, addressing different contexts of use, and identifying sounds, which could have an effect on future interactive systems to support reading in children.

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