

Towards a Tangible Storytelling Kit for Exploring Emotions with Children

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ABSTRACT

A key aspect of children's development is the ability to manage personal feelings, understand others' feelings and needs, and interact positively with others. Storytelling is one approach to help children develop emotional literacy and deal with their own feelings constructively. To facilitate and complement this process, we developed an interactive storytelling prototype to help children and parents explore emotional situations. Specifically, the tangible modular toolkit, enables the re-creation of different narratives using a multi-modal user interface. We evaluated the preliminary prototype with parents and children to get feedback on the design and to help us better understand the design space. Our findings revealed how children engaged with tangible storytelling, how they explored emotional states in narratives, and what challenges they faced. We also explored the routines and practices parents used and the issues they faced while helping their children express emotions more easily.

CCS CONCEPTS

•**Human-centered computing** → *User interface toolkits*;

KEYWORDS

Interactive storytelling; Children; Tangible interaction; Emotion

1 INTRODUCTION

A child's ability to accurately perceive, express, and regulate emotions is correlated with positive outcomes ranging from better social relationships with family and peers [8, 25] to increased self-control and cooperation skills [22]. In contrast, the inability to express and perceive emotions in a healthy manner has been associated with hyperactivity, depression, anxiety, and a feeling of loneliness

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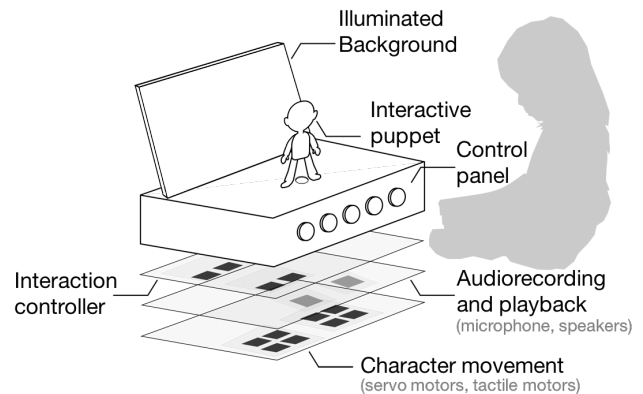


Figure 1: A tangible storytelling kit with interactive elements for exploring emotions with children.

in children [25]. Thus, helping kids better understand emotional states is crucial for their individual development.

Culturally, storytelling has been a powerful method to communicate emotions, values, and social skills [20]. Most parents already know about the benefits of reading bedtime stories to their children. A notable advantage of this practice is that it also helps kids better understand other people's thoughts and emotions in a variety of social contexts [2, 29]. To support storytelling, researchers have developed a wide range of interactive technologies, including Family Story Play [28], to support storytelling for children and grandparents over a distance; Bear-with-me [18], enabling the exchange of tangible emotional expressions; iTheatre [26], an interactive system to create stories using handpuppets; StoryRooms [1], allowing a room-size immersive storytelling experience. In our work, we specifically explore how we can support the parent-child storytelling practice for teaching emotions through a tangible interactive kit that can be personalized for different stories. The particular contributions of this note are:

- (1) A preliminary design of a tangible toolkit to support emotional storytelling between parents and children (Figure 1).
- (2) User study results that identify the needs of parents and children, and how the toolkit could potentially help explore emotional situations.

2 RELATED WORK

Interactive storytelling can be a powerful tool to engage children as authors and favors free expression, creativity, and fantasy play [20]. Storytelling technologies have had a long rich history both in HCI and in industry, and a variety of interactive approaches for engaging children with stories created by others as well as creating their own personal narratives have been explored. Commercial software applications include interactive books (e.g. TipToi¹), computer games, and flexible authoring tools (e.g. StoryMaker²). Additionally, toy designers have used playful plush characters (e.g. Kimochis³, Meebie⁴) to help children convey and explore emotions. Despite their popularity, these approaches have typically considered children as “story consumers” offering somewhat predefined experiences.

In contrast, research approaches have favored free expression and creativity by engaging children as story authors. For young pre-literate children, physical spaces with familiar objects have been used in the story telling process [1, 7]. Physical environments, created to explore stories but also to author and share stories such as KidsRoom [4] and StoryRoom [1] have been presented. PageCraft by Budd et al. [6] was developed to support narrative development for children. It provides a transition from physical objects to digital media content. Through this multi-sensory environment, kids are able to share narratives with caregivers and friends.

Stuffed toys have also been employed to aid in storytelling in various ways. Besides their tangibility, these objects have the advantage of being able to express emotions or play active parts in a story. The expressive nature of the toy can either be pre-defined or designed by the child. Examples of previous works include SAGE [3] and PETS [15]. SAGE presents an authoring environment for children to create their own storytellers. To encourage children’s engagement, the storytellers are embodied in an interactive stuffed animal. PETS provides kids with a modular robot set, to build personalized pets and in turn use these to narrate stories.

Previous works show that the process of authoring interactive stories in a collaborative context is associated with substantial benefits [11, 13]. Collaborative storytelling can be supported by authoring tools either within a shared physical space or in virtual environment. These authoring environments aim to involve kids into synchronous collaborative storytelling by providing various functionalities like drawing, typing, and hyperlinking content. Kid-Pad [16] provides a 2-dimensional space for collaboration, while StoryMat [30] and POGO [12] foster a more playful partnership using a playground metaphor. Virtual environments to collaborate over a distance have been explored in FaTe2 [19] and PUPPET [24]. FaTe2 enables children to collaborate in play and storytelling using a virtual space, while PUPPET is a virtual environment that allows children to play multiple roles in the creation of stories.

3 METHODS

Fundamentally, our goal is to explore the broader design space of tangible interactive storytelling, particularly as a tool that could



Figure 2: Interactive diorama for supporting affective storytelling with children.



Figure 3: Interchangeable emotional faces based on work by Ekman [17] and complementary characters and objects

be used between parents and children. As such we used our implementation as a probe to elicit feedback from both user groups and involve them early in the design process. The prototype served as a focal point for critique that highlighted possibilities and explored interaction mechanisms with children.

3.1 Exploratory Prototype

Our interactive prototype (Figure 2) consists of a base platform that houses characters, background scenery and accompanying scene elements. The main character of the story is represented by a male or female figure. The figure can move its arms and legs, can shiver, and has interchangeable facial expressions (Figure 3). The expressions are based on the basic emotions defined by Paul Ekman [17]. To support verbal expressions and ambient sounds, we included the option to record and replay audio.

The scene background can be interchanged to reflect different environments. For example, in our evaluation, we had backgrounds for a kitchen, a playroom, and various forests. The actual background is printed on a transparency (used commonly with overhead projectors) and affixed to an acrylic sheet. Therefore, to create custom backgrounds, all that is needed is a common desktop printer. An

¹<https://www.tiptoi.com/start/index.html>; last retrieved: 03-24-2017

²<http://www.abcya.com/storymaker.htm>; last retrieved: 03-24-2017

³<http://www.kimochis.com/about/what-are-kimochis/>; last retrieved: 03-24-2017

⁴<http://www.orkidtoys.com/>; last retrieved: 03-24-2017

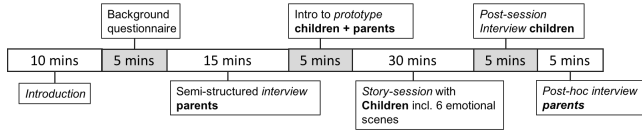


Figure 4: The story-session study plan for children and their parents. Each session included interviews with parents, story-reading sessions with children and post-hoc interviews.

RGB LED strip was used to better illuminate the background and to perhaps reflect mood. For example, a light green color in a forest background might be used to reflect a positive mood.

The prototype is approximately 30cm (length) x 25cm (width) x 30cm (height) and contains various buttons and potentiometers on the front panel to control characters, scene audio, and background colors. The electronics used to support these interactions are housed beneath the base platform. Our goal was to make the prototype as flexible and easy to use as possible so parents and children could potentially craft scenes themselves using commonly available equipment.

3.2 Study Design

The study consisted of a background questionnaire, a semi-structured interview with the parent(s), and a usability session with the child. In the semi-structured interview, we asked parent(s) to describe their child (e.g., personalities, introverted or extroverted), their joint practices for exploring emotions, and any difficulties or issues they faced in nurturing healthy emotions in their children. During the usability session, we introduced both the parents and the child to the prototype, followed by an explanation of how to move the main character, adjust scene colors and record sounds. We used a neutral scene for the introduction and to help children become comfortable with the prototype. We also explained all the complementary characters and objects. A more detailed timeline of the study is shown in Figure 4.

To facilitate interaction, we then read a pre-constructed story line with six scenes where each scene was associated with a specific emotion. The six emotions included anger, happiness, sadness, surprise, disgust, and fear. A brief description of the six scenes is given in Table 1. After every scene, we asked each child if s/he wanted to change the scene in anyway by using the controls or manipulating the face of the character. To gauge children’s responses, we used a form of contextual inquiry as described by Allison Druin [14], where one researcher served as the *interactor* and another took notes. The *interactor* initiated discussion and asked questions while the child was using the prototype. We used this method to prevent children from feeling like they were “on stage” and to facilitate natural feedback.

3.3 Analysis

We analyzed the gathered data from the contextual inquiry with two other HCI researchers from our lab. As a first step we summarized notes taken during the studies. We then used a two-step coding process beginning with basic coding to distinguish

Table 1: Brief scene descriptions from the story. The story has a happy ending, with the main character getting back home. The day transitioned from afternoon to late evening over the six scenes.

#	Scene description	Emotion
S1	The main character is playing in her room with different toys. She would like to buy a new wooden horse to play with and approaches her mom to ask.	Neutral
S2	The mom explains that the new toy is expensive and that they would have to save money to buy it in a couple of weeks. The main character however is impatient and wants to buy the toy now. She screams her dissatisfaction and leaves home towards the woods.	Anger
S3	The main character arrives to a beautiful, sunny forest. She interacts with a friendly squirrel who comforts her and offers her some hazelnuts.	Happiness
S4	While walking through the forest, she encounters three monkeys who she wants to play with. They, however, make fun of her and pelt her with acorns.	Sadness
S5	She escapes the monkeys and wanders the forest hungry. She then encounters a small bird and asks the bird for some food. The bird flies away and returns with a big brown worm for her to eat.	Disgust
S6	The forest gets darker and colder and the main character is having trouble finding her way home. She can hear wolves howling in the distance and she re-evaluates whether it would have been better to wait a couple of weeks for the new toy.	Fear

overall themes, followed by a more in depth interpretive coding to identify specific patterns within the data. As a last step, we compared the data collected from the parents interviews with the children’s actual behavior.

3.4 Participants

The understanding of emotional situations and facial expressions improve with age. Between preschool and elementary school, children gain most for their emotionally expressive capabilities [27, 33, 34]. Starting around the age of five, children can describe and understand basic emotions [5]. By age seven they are able to describe even more complex emotions such as guilt and shame [21]. As a result, we focused on children between the ages of 5 and 10 since they have the most potential for exploring emotional storytelling. We recruited 7 parents and their 6 children aged between 5 to 9

years. The study described in this paper was approved by our institute’s ethical board. Participants received a € 10 Amazon gift card for their time and effort.

4 RESULTS

4.1 Emotional Habits and Behaviors

The majority of children in our study were described as extroverted by their parents; only one girl (C6⁵) was reported as introverted. Parents found that their child was typically better at expressing clear and simple emotions such as happiness and sadness rather than more complex emotions such as embarrassment. Stressful life events were also described as harder to handle for children. P2 highlighted, “*Strong emotional situations she can’t really handle now, such as a relative dying or divorce.*”

Parents described a variety of methods their children used to express feelings. These included gestures (hugging, cuddling, shrugging), facial expressions (smiling, frowning, crying), mimicry, body movements (moving closer to a parent, walking away), posture (holding one’s knees), verbal communication, and physical actions (hitting, scratching, jumping, throwing). Although this list seems comprehensive, children had varying levels of success in employing these methods; parents still had trouble interpreting their child’s emotional state. Perhaps the biggest difficulty parents faced was their child’s inability to verbally communicate his/her negative emotions. P1 commented, “*When she (C1) is really sad, she stops herself and doesn’t show how sad she really is.*”. Another father (P3) added, “*Sometimes he (C3) gets sad, and we really don’t know why.*”. Some parents also misinterpreted their child’s emotional state due to confusing signals from the child. For example, P1 reported, “*Sometimes she says she is hungry when in reality she actually is really tired.*”. Another mother (P4) remarked about her child’s tendency to exaggerate her emotions, “*Sometimes [C4’s] emotions are overly extreme for the situation. She is impatient and has trouble waiting.*” With a few children, this inability to express negative emotions in a positive manner resulted in unhealthy behaviors such as pinching (P6, C6) and throwing objects at pets (P5, C5).

4.2 Practices and Routines

Parents mentioned a variety of practices to help their children express emotions more easily. These practices included crafting, reading, playing, taking a “time-out” or playing with pets. These routines differed depending on the temperament of the child. One mother (P1) commented how her daughter (C1) used coloring and drawing as an emotional outlet instead of a teddy bear. In contrast, P2 mentioned that her daughter sometimes “*played with a plush toy or puppet*” during difficult times. Similarly, one girl (C4), sought the comfort of the family dog when she was sad.

Another theme that emerged was children’s natural tendencies to take a time-out when they were feeling insecure or unhappy. These time-outs sometimes involved staying quiet and “*hiding behind mom*” (P5, C5), or spending time alone by the swing till the negative emotion(s) passed (P4, C4). P3 remarked on a creative time-out utilized by his son, “*Sometimes he builds himself a cave with chairs*



Figure 5: Children re-creating scenes based on the storyline.

and bed sheets to hide in. It needs to be dark and the maximum light allowed is a candle.”

With respect to teaching children about emotions and moods, parents reported that children learned about these issues from day-to-day experiences with other adults and children at school. One parent (P4) noted how her child (C4) often asked her explicitly about “*why a person feels a certain way based on a particular situation.*” Half the parents also discussed the use of picture books and storytelling to explore emotions both actively (i.e., books that specifically explore emotional situations) and passively (i.e., books based on a plot with natural emotional arcs).

4.3 Interactive Storytelling

We found children quickly adapted to our electronic prototype and our scene based storytelling approach (Figure 5). Although kids were initially shy, they grew more comfortable as the study continued. Overall, the electronic kit was favorably received by the children, with four out of six children completing all six scenes of the story (Table 1). One girl finished only five scenes and another girl utilized our toolkit to create her own story after the third scene. Regardless of the completion rate, and perhaps more importantly, we found children engaged during the storytelling process.

Kids actively identified themselves with the interactive character and often spoke on behalf of the puppet during the scenes. For example, during scene two, C4 audio recorded her angry response to the fictitious mother, “*I will not say anything! I’m really angry because I do not get a wooden horse, and I will not apologize!*” She was also the participant who veered off script on the third scene and remarked, “*I like recording everything and I want to tell my own story.*” In the subsequent self-constructed story (which involved all the kit’s characters) the main puppet’s wish for a wooden horse was satisfied by a magical friend of the bird. Children also stopped us naturally during different scenes to exclaim their insights. For

⁵We employ the prefixes C and P to identify children and parents in this paper (e.g., C1, P1)

example, during scene four, one girl (C5) interjected, *“It’s not raining acorns. It’s the apes!”*

With respect to specific prototype interactions, changing the facial expression of the main character was utilized by all children to reflect the emotions portrayed in the story line. Not all emotional faces however, were successfully interpreted. The neutral face was often replaced with the happy face on the first scene. Moreover, we had to clarify the emotional faces for disgust and fear for half the children in the study, even though they understood the concepts.

When expressing negative emotions like sadness, anger, fear or disgust, children often utilized the vibro-tactile motors to make the character shiver. One girl (C1) self-affirmed her decision to turn it on with, *“..because the apes are mean to her and she is alone.”* C2 also mimicked the physical shivering of the main character during negative emotions. For some children, shivering was used to reflect the cold environment of the story. While the vibro-tactile motors were primarily used to express negative emotions, the arm and leg movements of the character often reflected both positive and negative emotions including surprise, anger, and happiness.

Audio recordings were used to augment the story line in a multitude of ways. Some children used it for narration and to repeat the events of the scene. For example, during scene four, C6 exclaimed, *“The monkeys are laughing and the nuts are falling on Emmas head!”* Similarly, C3 recorded his future aspirations for the story, *“Hopefully the monkeys will not return.”* In other cases, kids used recording as a way to describe a character or situation in more detail. This included noises such as *“Ewww”* to express disgust or animal sounds (e.g., bird chirping, monkey gibber). One girl (C2) creatively used a candy wrapper to record a rustling noise in the dark woods.

While children successfully used different scene backgrounds as the story progressed, the use of background colors was inconsistent. We had expected children to vary the colors of the RGB LED strip based on mood, but we observed no pattern to what color they chose. Some children used shades of blue for negative emotional situations and green for positive scenes, but they did not have any reasons for their choices. For one participant (C3), the background color was correlated with time. He reflected, *“The color does not say anything about [characters name], it just shows the time of the day”*.

At the end of the usability study, we received positive remarks from the children regarding our prototype. Comments such as [C3]: *“Reading stories like this is fun!”* or [C2]: *“This was a lot of fun”* were common among the participants. Likewise, the parents, who had been observing the process, commented on the usefulness of the tool. One of the parents (P2), who used traditional picture books to explore emotions with her child, mentioned, *“This is a really good idea and it would be an interesting tool.”* Another parent observed how the puppet accurately reflected her child’s behaviors. P1 remarked, *“My girl showed the same behavior with the puppet as she would in real life.”* According to one mother, this ability to identify with characters and mirror emotions through interaction was considered critical for children suffering from adverse life events. She (P5) reflected, *“I know a girl whose parents got divorced and this would be very useful for the child.”*

5 REFLECTIONS

Having described both the design of our storytelling prototype and the results from our initial pilot test, we can now take a “step back” and take stock of the implications of this (admittedly still early) work. In this section, we reflect on the broader technological questions in exploring emotions with children by using our device as a springboard for discussion.

Mediating Children’s Emotions

Parents’ awareness of their child’s inner feelings strongly relies on parental inferences and what the child is willing to share, especially with respect to less observable issues such as sadness and anxiety. Research has consistently demonstrated the difficulty parents have faced in accurately recognizing and the reporting these internal issues [23, 32]. This was also confirmed in our first hand interviews with the parents. The majority of parents in our study faced various issues in understanding the emotional state of their children at some point in time. This problem is particularly salient with negative emotions since children often expressed these emotions in unhealthy ways (e.g., screaming, stomping). In our approach to this problem, we augment the culturally accepted practice of storytelling with a tangible, interactive toolkit. Early results indicate a promising ability of youngsters to effectively engage with our prototype. For example, C1, who was described by her mother as irresponsive when sad, utilized the vibration motion to express sadness in the puppet. Although, this example is not reflective of a real world scenario or how she actually felt at the time, children could potentially use these different feedback modalities to express their internal state. Technology, in this case, can be used by a child to confront what may be too painful or difficult to express otherwise. By telling a story with these interactive props, children can “play out” their feelings just as an adult may “talk out” their difficulties with a therapist [9]. We see our own tangible storytelling kit as an encouraging step in this regard.

Flexible Artifacts

Broadly speaking, we see our tangible interactive kit as an approach toward allowing emotion-based storytelling to blend with personal expression. Although we created a specific story line with accompanying elements and accessories, we never envisioned this idea to be associated with any one specific device or story. Rather we can think, more productively, in terms of designing multipurpose artifacts in service of an unbounded range of stories. This concept drives against the “one size fits all” tendency and aims to give children more expressive control over their environment. Using a candy wrapper to record a rustling sound in the woods (as C2 did) is exactly the type of engagement and customization we seek. Ultimately, the flexible nature of the story kit would give children control over how they express their emotions. This is important because children have very different ways of dealing with their emotions from building a bed-sheet cave (C3) to spending time on the swing (C5). Moreover, for some children (like C4), this kit could provide a means to explore emotions through their own self-constructed stories. There is however, a trade-off here between leaving children free to create their own stories and guiding them

towards emotional expression especially since our goals are to engender healthy emotional outcomes.

Choose Your Own Adventure

One approach to striking this delicate balance between an open-ended story crafting kit and a guided one is to adopt the style used by popular “Choose Your Own Adventure⁶” gamebooks. In these books, the reader (the protagonist) takes on a role relevant to the adventure such as private investigator, doctor or spy and makes choices that determine the main character’s actions and the plot’s outcome. Many children enjoy these books partially because they feel like they are in control of the stories [10]. An interactive and tangible version of this kind of book could explore different emotional situations. The child could choose both positive and negative emotions at various points in the story and see the resulting emotional consequences. For example, choosing to be angry could put the main character in unfavorable conditions. The tangible kit approach is ideally suited to recreating these kinds of stories, especially since various aspects of the characters and scenery (e.g., interchangeable background) can be changed. Ryokai et al. explored a similar concept where children video-recorded facial expressions that became part of an ebook’s illustrations [31]. By turning children’s facial expressions into manipulable elements, they provided a unique point of entry for engaging children in constructing their own narratives. It gave children an opportunity to collaborate, play, and reflect on their pretend stories. Our own work can be seen as a more tangible and emotional extension of research in this space.

6 LIMITATIONS

Our tangible storytelling prototype is still in a relatively nascent stage: it only accounts for a few scenes and is limited to a single main character. Moreover, it only supports a limited subset of interactions for expressing emotions through characters. However, we see our prototype as one possible implementation in the larger, burgeoning ecosystem surrounding tangible storytelling toolkits. Another possible limitation of our approach is the use of Ekman’s facial expressions in our design. It could be argued that many of the facial cues and advanced expressions, such as fear and disgust are very hard to recognize even for adults. While this may be true, we did not really observe children mixing these emotions or interpreting them incorrectly; children simply did not use the emotions they did not understand. We used Ekman’s expressions as a starting point in our design rather than a definitive solution.

It is hard to generalize our results based on a limited sample size, but for exploratory work, we found it valuable for getting rich qualitative data. Lastly, we acknowledge that instead of parents telling the story to their children as intended in later usage of the device, the story was told by one of our researchers. At this early stage, we wanted to explore the overall concept of tangible storytelling with children and their parents, to further refine the design and implementation.

⁶<https://www.cyoa.com/>; last retrieved: 05-20-2017

7 FUTURE WORK AND CONCLUSION

This paper lays the foundation for a new tangible storytelling kit for exploring emotions with children. Our findings show that children between the ages of five and nine were able to successfully recreate scenes from a pre-constructed story and even create their own personal narratives using our prototype. The different feedback modalities helped children to express emotional situations tangibly and reflect on their own emotional state. While some of the output modalities could not be associated with emotional expressions, we found others that were used frequently to express the mood of the main character.

We found that our participants had different methods for dealing with their emotions, and families had various routines and practices for supporting these differences. In future work, we aim to generalize the kit to be used for stories created by either children or stories that occur in day to day situations. Therefore, we will build on our results and design a modular kit, which gives the opportunity to craft characters that are part of stories. We will design a base platform to provide power as well as data connectors for interactive plug-and-play characters and scene elements. The parts will provide basic output and input modalities and can be personalized by children through crafting or painting. Our goals are also to conduct extended studies with parents and their children with a refined version of the device to gain deeper understanding of the interactions between parents and their children.

Designing technology to support children’s emotional growth is challenging, especially since they are still learning and exploring. Parents often misinterpret their child’s internal state and find themselves at a loss on how to help their child. Tangible, interactive storytelling has the potential to act as a mediating artifact to enhance the already existing practice of storytelling between parents and children.

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