StoryBox: Independent Multi-modal Interactive Storytelling for Children with Visual Impairment

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ABSTRACT

Storytelling promotes the development of imagination and creativity and facilitates the impregnation of linguistic, emotional and moral skills in children. Limited storytelling media for children with blindness and visual impairment (BVI) confines their access to this unique experience. *StoryBox* is a multi-modal storytelling agent, facilitating an independent and interactive storytelling experience for children (5-12 years) with BVI. The platform supports audio-based story narration and enables tangible interaction with story elements via sensor-enabled tactile clay figurines. *StoryBox* takes inspiration from *'kaavad baanchana'* - an oral storytelling tradition from Rajasthan, India. This paper presents the design of the proposed accessible multi-modal storytelling platform and findings from initial user evaluation with blindfolded participants.

CCS CONCEPTS

• **Human-centered computing** → **Accessibility technologies**; **Empirical studies in interaction design**.

KEYWORDS

interactive storytelling, multi-modal storytelling, independent access, children, blind and visually impaired, voice-based interaction, NFC sensors, *kaavad*

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1 INTRODUCTION

Visual impairment in childhood adversely affects imagination and creativity. Young children with severe vision loss experience delays in linguistic, social, and emotional development [19]. There are estimated to be 1.5 million children with blindness worldwide, with approximately 75% living in the underdeveloped and developing regions in Asia and Africa. It is estimated that at least 200,000 children under 16 years of age in India have blindness or severe visual impairment, and approximately only 15,000 children have access to schools for the blind. The estimated prevalence of childhood blindness is known to be 0.7/1000 [22].

Storytelling acts as an essential tool for learning, and an effective medium to foster imagination and creativity in children [14]. Stories impart moral and cultural values, convey emotions, and knowledge about diverse elements of human society. The advent of digital and interactive technologies, and rapidly increasing active internet users across rural and urban regions in India, presents us with an opportunity to make storytelling accessible, and enjoyable for children with blindness and visual impairment (BVI).

Visual media such as picture books, comics, cartoons, animations, movies, etc., are popular and highly engaging forms of storytelling for children. Several assistive technologies such as refreshable braille readers, tactile graphics, screen readers, text-to-speech, and speech-to-text systems can help provide access to stories for children with BVI. However, the limited availability and possession of these technologies due to lack of awareness and financial constraints drastically limits access to stories for such children [25].

There have been attempts to make storytelling accessible and inclusive of children with and without visual impairment in group settings such as classrooms. These offer opportunities for social interaction and collaborative activities among children [10, 30]. However, such solutions remain inaccessible to the significantly larger population of children with BVI who cannot attend schools. Remote learning and attending school online due to the ongoing Coronavirus pandemic adds to the limited availability of such solutions. Further, the increasing dependence on working parents, grandparents, teachers, siblings/friends, and caretakers in the absence of independently accessible storytelling media restricts their story experience.

These insights motivated the development of an affordable interactive storytelling platform called *StoryBox*, that is accessible to visually impaired children, enabling an independently engaging and self-assuring experience. *StoryBox* supports audio-based story narration while enabling tangible and voice-based interaction with story characters via sensor-enabled tactile clay figurines. A set of ten organically shaped clay figurines that elicit varied emotions and perceptions of character personas from participants were designed to represent story characters. These figurines enable representation of multiple characters and narration of multiple stories with varying plots.

The concept for *StoryBox* is suited for the Indian context, and takes inspiration from *'kaavad baanchana,'* an oral storytelling tradition from Rajasthan, India, which dates back to 400 years ago [29]. Traditionally, the *'kaavad'* is a wooden box with several folding layers of doors painted with elaborate depictions of mythological

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Figure 1: Kaavad, the Rajasthani storytelling tradition, depicts illustrations of deities on its doors [13].

deities (Fig. 1) [23]. The storytellers, known as *'kaavadiyas'* travel with the *kaavad* to people's homes and narrate stories. They first introduce the story characters and subsequently engage in a detailed narration of the tales. This craft is slowly declining in India, with rapid globalization and technological storytelling media taking the center-place. With *StoryBox*, we aim to promote this traditional and culturally rooted practice for narrating stories like *Panchatantra ki Kahaniya*[1], and *Akbar Birbal Tales*[2] that deliver strong moral values to children. The following sections of the paper discuss the prototype design, insights from preliminary user evaluation with blindfolded participants, and future work for *StoryBox*.

2 RELATED WORK

Childhood blindness and visual impairment adversely affect creativity, linguistic skills, social competence, and emotional development. Prior work shows that storytelling supports literacy development in children [2, 7], and enhances creativity, cultural understanding and knowledge [20]. Stories play an essential role in educational contexts and act as a bridge for children with diverse learning abilities [9]. Interactive technologies have emerged as a powerful tool for storytelling, providing opportunities for engagement with narratives and story elements. These forms of storytelling foster creativity and imagination while augmenting the benefits of traditional narration [12]. However, mainstream storytelling media and interactive solutions depend on visual abilities and senses to a large extent.

Children with BVI predominantly rely on two-dimensional media for storytelling, such as books printed in braille and tactile graphics. Several tactile graphics-based solutions [1, 28] have been developed to provide an accessible storytelling experience. Jeeeun Kim and Tom Yeh develop movable tactile pictures with the aim to make picture books interactive for children with BVI, while imparting concepts of mobility and appearance through active engagement during reading [15]. They present detailed design considerations and requirements for tactile pictures, which we leverage for the design of *StoryBox*. Other accessible storytelling media include commercial audiobooks and audio-based technologies. A text-to-speech technology, AudioStoryTeller [24] aids self-learning of linguistic skills by supporting story narration through an auditory interface. Audio Description [26] contributes recorded commentary of a broad range of visual media, and can provide verbal descriptions of storytelling media. Lopez et al. explore spatial audio and pronounced sound effects for designing accessible soundtracks to support plot comprehension for persons with BVI [17].

Persons with visual impairment primarily explore the world around them through tactile perception. Interacting with story elements through tangible artifacts provides new opportunities for interaction and enhanced learning. Research has shown that multisensory storytelling experiences enrich learning and memorization by providing possibilities for multi-modal input [21]. F. Somma et al. implement these ideas and conduct a pilot study with a visually impaired child for a hybrid storytelling prototype involving digital and tangible technologies. Their preliminary observations suggest an enriched experience, while observing that stimulating tangibles lead to greater engagement [27]. Through co-design workshops, Cullen Clare and Metatla Oussama posit that tangible representations of characters support imaginative thinking and creativity among children with BVI [10]. Another multisensory solution, In-Visible Island [30], achieves an engaging storytelling experience in a collaborative classroom environment, leading to positive social interactions between sighted children and children with BVI.

Although these solutions explore diverse affordances (haptics, tactile, audio, olfactory, and gustatory), supporting a wide range of stories with such hybrid interfaces is laborious and cost-inefficient due to the involvement of story-specific artifacts. This paper aims to explore an affordable and accessible audio-tactile interface for storytelling. Prior work shows that simple shapes and their properties such as roundness, sharpness, and complexity elicit human perceptions and emotions [3, 18]. *StoryBox* leverages these findings to support the narration of multiple stories without requiring additional setup. The use of such frugal technologies promotes easy scaling, and continual independent access to storytelling for children with BVI.

3 DESIGN METHODOLOGY

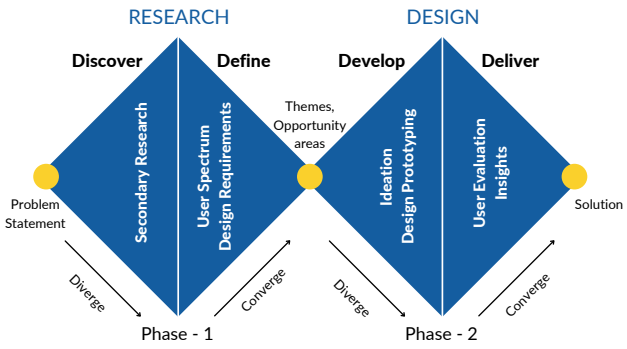


Figure 2: Double Diamond model followed for the study. Phase-1 focused on secondary research and identification of design requirements, followed by Phase-2 involving prototyping and preliminary evaluation for *StoryBox*.

This work was conducted from September 2021 to January 2022 in Delhi, India, following the Double Diamond design model (Fig. 2)

[1]Panchatantra: https://en.wikipedia.org/wiki/Panchatantra
[2]Akbar Birbal Tales: https://en.wikipedia.org/wiki/Birbal#Folklore_and_legacy

[16]. Four sighted participants belonging to the 5-12 years age group (two male, two female) were recruited using purposive sampling [31] for the study (mean: 9.75 years, std. deviation: 1.92 years). They participated in an exploratory study (referred to as Exp. 1) during the design process. Prior assent was taken from the participants, and their parents' consent was also taken. We refer to the four participants with pseudo-names: P1, P2, P3, and P4.

4 DESIGN OF *STORYBOX*

Based on insights from secondary research, the concept was realized in the form of a prototype named *StoryBox*. We select five stories, involving at most four characters for the initial prototype, as seen in Table 1. S1 and S2 are *Panchatantra* stories, which generally involve animal characters. S3-S5 are *Akbar Birbal Tales*, mostly involving characters in human form. The following subsections discuss the design of each feature in detail.

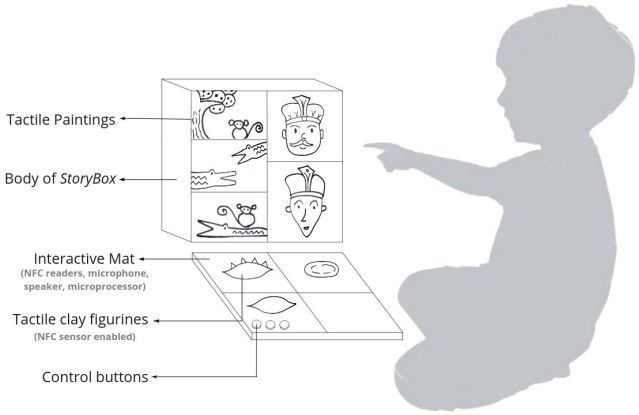


Figure 3: *StoryBox*: A multi-modal storytelling agent for independent access for children with BVI.

4.1 Design of Clay Figurines

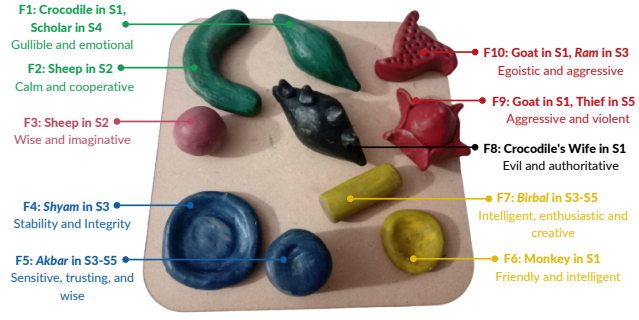


Figure 4: Organically shaped clay figurines selected based on participant feedback on fifteen shapes.

StoryBox uses organically shaped clay figurines to represent a broad range of story characters and their personas. Using clay as a medium for prototyping offered a smooth tangible experience, and the flexibility to revise shapes without the need for 3D printing equipment. The first author designed a set of fifteen figurines with varying characteristics such as simplicity and complexity, roundness and edginess, size and texture, with the aim of provoking thoughts and emotions among children through the sense of touch, as identified through secondary research [3, 18]. Following this, an exploratory roleplay (Exp. 1) was conducted with all participants (P1-P4), where they had to wear blindfolds and explore the figurines one by one with their hands. They were prompted to think out loud and express their feelings for each figurine if it were to be a story character [8]. We performed inductive thematic analysis to assign adjectives to each clay figurine, and outline the following insights.

Associating emotions with figurines. All participants were able to associate feelings with the organic shapes and provided descriptions of character personas. For most figurines, the participants' emotions were unanimous, whereas some figurines (F8 and F10, as seen in Fig. 4) elicited varying emotions. For instance, P2 found F10 to be *"evil, sharp and sneaky,"* whereas P3 visualized F10 as *"a superhero like Superman, who will kill all villains."* Lastly, we observed that adding textures to the surface, such as dots or stripes often made the character seem negative.

Identification of figurines. All participants reported that the shapes are easily identifiable, and could be distinguished from each other. After commenting on all fifteen figurines, P4 reported feeling slightly confused because of the large number of shapes.

Building relations between figurines. All participants identified pairs of figurines that were similar in form (F5 and F7, F4 and F6, F1 and F8, as seen in Figure 4). Participants P1 and P3 also identified that figurine F3 fits into F2, and commented that it represents *"protective"* and *"mother-child"* like relations.

Ten figurines were selected on the basis of the traits identified by participants during Exp. 1, while matching them with the characters' personas from the collection of stories presented in Table 1. Each figurine was embedded with a Near-field communication (NFC) sensor, and assigned a story character role and color (Fig. 4) to reflect the attributes identified by the participants. The use of high contrast colors for figurines facilitates object identification for children with low vision.

4.2 Design of Tactile Paintings

StoryBox takes inspiration from *kaavad*, a portable wooden shrine, made up of several door-like layers called *'kivads'* (Fig. 1). Traditionally, the doors are painted with intricate visuals of mythological characters, and *'kaavadiyas'* narrate stories by unfolding the doors to show relevant pictorials. With emerging social issues, *kaavads* are also being leveraged to narrate stories that promote healthy traditions and impart educational values to children [23].

StoryBox follows a similar style of story narration, and presents tactile paintings on the doors of the body to support narration for children with BVI. The tactile paintings depict defining moments in the story, 'The Monkey and The Crocodile' (S1), such as character introduction, scene depiction, conflict, rising action, and climax (Fig. 5b). The children are prompted to explore these diagrams during

Story	Story Name	Collection Name	Characters involved	Moral
S1	The Monkey and the Crocodile	*Panchatantra*	Monkey, Crocodile, Crocodile's wife	Choose your friends wisely
S2	Two Goats over a Bridge	*Panchatantra*	Four sheep (*Billy, Wooly, Pan, Bo Peep*)	Anger leads to sorrow and please leads to joy
S3	Who's Mango Tree is it?	*Akbar Birbal Tales*	*Akbar*, *Birbal*, *Ram*, *Shyam*	True ownership comes with responsibilities
S4	Just One Question	*Akbar Birbal Tales*	*Akbar*, *Birbal*, the scholar	Presence of mind helps solve every problem
S5	The Foolish Thief	*Akbar Birbal Tales*	*Akbar*, *Birbal*, the thief	Truth always prevails

Table 1: Stories with moral values from *Panchatantra ki Kahaniya* and *Akbar Birbal Tales* selected for *StoryBox*

(a) Prototype setup **(b) Tactile paintings** **(c) The body acts as storage for figurines** **(d) Mat tracks figurine positions**

Figure 5: Design prototype for *StoryBox*.

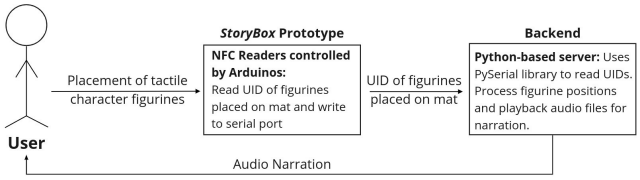


Figure 6: An overview of *StoryBox* prototype workflow

the narration of the story, with the narrator's guidance. The body can be used to store the clay figurines when not in use (Fig. 5c).

4.3 Design of Interactive Mat

The mat (Fig. 5d) is an essential component of the prototype, and enables onboarding and interaction with all story characters. The mat is divided into four sections, separated by tactile boundaries for ease of navigation. Each division is equipped with a separate NFC reader to identify the clay figurine placed within the division's boundaries. The current selection of stories has at most four characters in each story, thereby allowing tracking of each character's position during narration. For this initial prototype, each NFC reader is connected to an Arduino Uno[3]. All Arduino boards are connected to a computer via USB cables. The NFC readers take readings at intervals of 3 seconds and communicate the Unique ID (UID) of the NFC sensor embedded figurine placed within its boundaries. This information is used by a Python-based[4] server to deliver the story narration and facilitate the interactions described in section 4.4.3. Further, the mat has three buttons to take input from the users. Figure 6 represents the workflow and implementation for the prototype.

[3]Arduino Uno Board: https://en.wikipedia.org/wiki/Arduino_Uno
[4]Python: https://www.python.org/

4.4 Story Narration

4.4.1 Onboarding. When a child encounters *StoryBox* for the first time (Fig. 7), they are asked about their visual ability to include or exclude information about the color of figurines for character identification. The child is then prompted to select a story. Upon selection, the child will be provided with verbal descriptions of each character, and the corresponding figurine to be placed on the mat. In case the child places an incorrect figurine, the narrator will provide additional prompts about the shape. The onboarding is complete when all required character figurines are correctly identified by the child and placed on the mat.

4.4.2 Narration. The narrator plays a central role in facilitating interaction with characters, exploring the tactile paintings, and enabling comprehension of the story and its moral values. The dialogues for the narrator and characters from selected stories were recorded by volunteers in multiple voices. The story narration can be controlled by the child through the play/pause (center), forward (right) or rewind (left) buttons on the mat.

4.4.3 Interaction with Story Elements. *StoryBox* facilitates conversational interactions between the child and the story elements (narrator and characters) through Wizard of Oz [11]. The child could ask questions about the story plot, characters, and meanings of words at any time during or after the narration. They could discuss their feelings with characters and give them advice. Further, *StoryBox* explores conversations between story characters. This interaction is enabled when a child voluntarily picks up any two character figurines during the narration. For instance, picking up the Monkey and Crocodile figurines during the narration of S1 would initiate a pre-recorded conversation between the two characters, in context with the plot of the story.

5 PRELIMINARY USER EVALUATION

5.1 Methodology

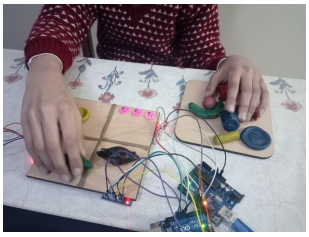
The participants from Exp. 1 were contacted again and recruited for the preliminary evaluation of *StoryBox*, while being blindfolded. First, they were allowed five minutes to explore *StoryBox*, and acquaint themselves with the figurines. This was followed by onboarding and story narration for S1. Data was collected in the form of audio and video recordings, field notes, and photographs for deductive thematic analysis [5]. Following the completion of the narration, the participants evaluated *StoryBox* for eight design characteristics on a 5-item Likert scale.

(a) Exploring figurines before onboarding

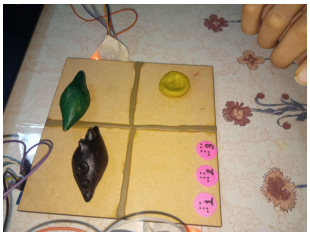
(b) P1 identifies similar pairs of figurines

(c) P1 identifies the Monkey

(d) P1 identifies the Crocodile's wife



(e) P1 identifies the Crocodile



(f) Placement of figurines for narration to begin

Figure 7: Tracking the onboarding process for Participant P1 during user evaluation.

5.2 Preliminary Insights

Findings from user evaluation indicate that the participants did not require any help from their guardian throughout the roleplay. *StoryBox* enables participants to have an independent and accessible storytelling experience. They found the story to be easily comprehensible, engaging, immersive, and satisfying. The participants found interactions with character figurines to be an integral part of their experience. They reported character interaction, exploring tactile paintings, and describing the figurine characteristics as the most enjoyable experiences.

Engaging with character figurines. All participants actively engaged with the tangible character figurines before, during, and after the narration. P1 often held the figurines next to their ears as a conversation ensued between the characters, and lightly clashed the figurines together during the narration of a conflict between the Crocodile and his wife. P2 moved the figurines up and down as their dialogues came up, and commented ecstatically that their description of the figurine shapes in Exp. 1 was very close to their character personas in the story. P3 actively picked up different combinations of figurines from the mat to hear their conversations throughout the narration. P4 attempted to recreate each scene by positioning different figurines. For instance, P4 placed the Monkey figurine on the back of the Crocodile figurine in the climax scene.

Interacting with story elements. Character interaction fostered empathy and excitement among the participants. They found interactions with the narrator to be natural and felt invested in the story, developing an instant connection with the monkey. All participants interacted with the monkey to warn him after learning the crocodile's plan. After the completion of the narration, P1 expressed their disappointment to the monkey, and said, *"See, I told you not to go, but you did not listen to me. It is good that you could escape, but you should have listened to me."* P1 also asked if there was a possibility to modify the plot of the story after giving advise to characters. P4 interacted with the crocodile after the narration, and said, *"You are a bad crocodile. The monkey gave you fruits to eat. You should not do this with your best friend. You trapped him."* *StoryBox* shows potential for developing linguistic skills, vocabulary, and moral values. P2 paused the narration to enquire about the meaning of the word *'malicious'* and received a satisfactory response from the narrator. P3 and P4 reflected on the moral of the story and talked to the narrator about their own experiences from interactions with friends at their school.

Exploring tangible paintings. All participants reported that the tangible paintings aided them in visualizing the scenes. P1 and P3 were fascinated with the monkey's long tail and found it to be easily identifiable. P3 said, *"The crocodile backs have a real-life-like texture, I can immediately tell it's the crocodile. And this is the monkey; it has such a long curved tail!"* P1 and P2 expected the monkey to be sitting on the tree in the top-most painting (Fig. 5b). P4 found the Jamun tree to be attractive and tried to count the Jamun fruits: *"Are these the Jamuns? Can I count them? I think there are ten on the tree. Are any Jamuns fallen on the ground?"*

6 DISCUSSION

This paper has introduced *StoryBox*, a multi-modal storytelling platform for independent access for children with BVI. Through the design process, we identify and reflect on children's informational and interaction needs considering varied visual abilities. The findings from the preliminary evaluation show that *StoryBox* enables independent access to stories, increases comprehensibility, and encourages moral and cultural development.

Enabling independent access. The limited availability to accessible storytelling media and low enrollment in schools constrains the story experience for children with BVI. Participants found *StoryBox* to be an accessible and independent storytelling platform. The prototype supports a broad set of stories without the added cost of equipment and setup. It implements the identified design requirements in a cost-effective, and easy to set up (plug and play) way to ensure independent access. Additional evaluation is required to validate these observations.

Increasing comprehensibility. Children with blindness and visual impairments often struggle with perceiving dimensions, shape, and texture. Occasionally, they do not know a word, knowing the meaning to which is essential for the narration to progress [4]. *StoryBox* exhibits potential to act as a tool for learning, by satisfactorily answering questions related to the story. *StoryBox* promoted continuous interactions between the participants and story elements. These opportunities for engagement prompt the children to express their thoughts and foster increased investment, curiosity, and comprehension of the story [6]. Further investigation is needed to confirm these initial findings.

Encouraging moral and cultural development. Stories convey moral principles and pass on cultural and traditional values through generations. We observe that *StoryBox* aids participants in empathizing with the characters, understanding emotional conflicts, and relating moral values to personal incidents. Taking inspiration from *'kaavad baanchana'* and ancient fables, *StoryBox* shows the capability to instill moral and cultural values among children.

7 CONCLUSION AND FUTURE WORK

Storytelling is an integral part of a child's overall psycho-cultural development. However, limited resources facilitate independent and affordable access to stories. This challenge is even more pronounced for children with BVI. This paper presents a novel design of a sensor-based multi-modal platform, *StoryBox*, that enables independent storytelling and an engaging learning experience. *StoryBox* not only provides access to stories for children with blindness but can also be used as an engaging experience for sighted children. Further empirical evaluation requires to be conducted, with both, children with BVI and sighted children, to validate the design prototype of *StoryBox*. We shall use qualitative methods along with a questionnaire based on the Technology Acceptance Model (TAM) to evaluate the system. The proposed voice-based interaction with story elements will be implemented, along with the design and development of a consolidated high-fidelity prototype. Additionally, we shall explore methods to expedite the onboarding process for character identification, such as using varying textures or materials for the tactile figurines. *Storybox* requires further explorations to support a wider range of interactions to provide an engaging and satisfactory experience despite multiple listens.

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REFERENCES

[1] Nupur Agarwal. 2019. First Ever Illustration Picture Book Series for the Visually Impaired Community. https://yourstory.com/mystory/beyond-braille-zgci2vuqaz/amp
[2] Denise E. Agosto. 2016. Why storytelling matters: Unveiling the literacy benefits of storytelling. *Children and Libraries* 14, 2 (2016), 21. https://doi.org/10.5860/cal.14n2.21
[3] Laurine Belin, Laurence Henry, Mélanie Destays, Martine Hausberger, and Marine Grandgeorge. 2017. Simple Shapes Elicit Different Emotional Responses in Children with Autism Spectrum Disorder and Neurotypical Children and Adults. *Frontiers in Psychology* 8 (2017), 91. https://doi.org/10.3389/fpsyg.2017.00091
[4] Jean D Brown. 1972. Storytelling and the blind child. *Journal of Visual Impairment & Blindness* 66, 10 (1972), 356–360.
[5] Jack Caulfield. 2021. How to do thematic analysis. https://www.scribbr.com/methodology/thematic-analysis/
[6] Bhavya Chopra, Khushali Verma, Sonali Singhal, and Utsav Singla. 2021. Reality Tales: Facilitating User-Character Interaction with Immersive Storytelling. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, Article 489, 7 pages. https://doi.org/10.1145/3411763.3451522
[7] Fiona Collins. 1999. The Use of Traditional Storytelling in Education to the Learning of Literacy Skills. *Early Child Development and Care* 152, 1 (1999), 77–108. https://doi.org/10.1080/0300443991520106 arXiv:https://doi.org/10.1080/0300443991520106
[8] Lynne Cooke. 2010. Assessing Concurrent Think-Aloud Protocol as a Usability Test Method: A Technical Communication Approach. *IEEE Transactions on Professional Communication* 53, 3 (2010), 202–215. https://doi.org/10.1109/TPC.2010.2052859
[9] Susan Craig, Karla Hull, Ann G. Haggart, and Elaine Crowder. 2001. Storytelling Addressing the Literacy Needs of Diverse Learners. *TEACHING Exceptional Children* 33, 5 (2001), 46–51. https://doi.org/10.1177/004005990103300507 arXiv:https://doi.org/10.1177/004005990103300507
[10] Clare Cullen and Oussama Metatla. 2018. Multisensory Storytelling: A Co-Design Study with Children with Mixed Visual Abilities. In *Proceedings of the 17th ACM Conference on Interaction Design and Children* (Trondheim, Norway) *(IDC '18)*. Association for Computing Machinery, New York, NY, USA, 557–562. https://doi.org/10.1145/3202185.3210775
[11] N. Dahlbäck, A. Jönsson, and L. Ahrenberg. 1993. Wizard of Oz studies — why and how. *Knowledge-Based Systems* 6, 4 (1993), 258–266. https://doi.org/10.1016/0950-7051(93)90017-N Special Issue: Intelligent User Interfaces.
[12] Franca Garzotto, Paolo Paolini, and Amalia Sabiescu. 2010. Interactive Storytelling for Children. In *Proceedings of the 9th International Conference on Interaction Design and Children* (Barcelona, Spain) *(IDC '10)*. Association for Computing Machinery, New York, NY, USA, 356–359. https://doi.org/10.1145/1810543.1810613
[13] Hiart. 2014. File: Kavad from Rajasthan, early 20th century, paint on wood, maker unknown. https://commons.wikimedia.org/wiki/File:Kavad_from_Rajasthan,_early_20th_century,_paint_on_wood,_maker_unknown.JPG
[14] Rebecca Isbell, Joseph Sobol, Liane Lindauer, and April Lowrance. 2004. The Effects of Storytelling and Story Reading on the Oral Language Complexity and Story Comprehension of Young Children. *Early Childhood Education Journal* 32, 3 (Dec 2004), 157–163. https://doi.org/10.1023/b:ecej.0000048967.94189.a3
[15] Jeeeun Kim and Tom Yeh. 2015. Toward 3D-Printed Movable Tactile Pictures for Children with Visual Impairments. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (Seoul, Republic of Korea) *(CHI '15)*. Association for Computing Machinery, New York, NY, USA, 2815–2824. https://doi.org/10.1145/2702123.2702144
[16] Maciej Lipiec. 2019. Beyond the Double Diamond: thinking about a better design process model. https://uxdesign.cc/beyond-the-double-diamond-thinking-about-a-better-design-process-model-de4fdb902cf
[17] Mariana Julieta Lopez and Sandra Pauletto. 2009. The design of an audio film for the visually impaired.
[18] Xin Lu, Poonam Suryanarayan, Reginald B Adams, Jia Li, Michelle G Newman, and James Z Wang. 2012. On Shape and the Computability of Emotions. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6749614/
[19] Miguel Pérez-Pereira and Gina Conti-Ramsden. 2019. *Language development and social interaction in blind children*. Routledge, London.
[20] Louise Phillips. 2000. Storytelling-The Seeds of Children's Creativity. *Australasian journal of early childhood* 25 (09 2000), 1–5. https://doi.org/10.1177/183693910002500302
[21] Michela Ponticorvo, Raffaele Di Fuccio, Fabrizio Ferrara, Angelo Rega, and Orazio Miglino. 2019. Multisensory Educational Materials: Five Senses to Learn. In *Methodologies and Intelligent Systems for Technology Enhanced Learning, 8th International Conference*. Springer, Cham, 45–52. https://doi.org/10.1007/978-3-

319-98872-6_6

[22] J. S. Rahi, S. Sripathi, C. E. Gilbert, and A. Foster. 1995. Childhood blindness in India: causes in 1318 blind school students in nine states. https://pubmed.ncbi.nlm.nih.gov/8543070/

[23] Nehal Rajvanshi. 2021. Kaavad: From Portable Shrines To Social Platforms. https://www.livehistoryindia.com/story/living-culture/kavad-art

[24] Jaime Sánchez and Iván Galáz. 2007. AudioStoryTeller: Enforcing Blind Children Reading Skills. In *Universal Access in Human-Computer Interaction. Applications and Services*, Constantine Stephanidis (Ed.). Springer Berlin Heidelberg, Berlin, Heidelberg, 786–795.

[25] Suraj Singh Senjam, Allen Foster, and Covadonga Bascaran. 2021. Barriers to using assistive technology among students with visual disability in schools for the blind in Delhi, India. https://pubmed.ncbi.nlm.nih.gov/32216556/

[26] Joel Snyder. 2005. Audio description: The visual made verbal. *International Congress Series* 1282 (2005), 935–939. https://doi.org/10.1016/j.ics.2005.05.215 Vision 2005.

[27] Federica Somma, Raffaele Di Fuccio, Lavinia Lattanzio, and Francesco Ferretti. 2021. Multisensorial tangible user interface for immersive storytelling: a usability pilot study with a visually impaired child. In *Technology Enhanced Learning Environments for Blended Education - The Italian e-Learning Conference 2021*. teleXbe 2021, Foggia, Italy.

[28] Abigale Stangl, Jeeeun Kim, and Tom Yeh. 2014. 3D Printed Tactile Picture Books for Children with Visual Impairments: A Design Probe. In *Proceedings of the 2014 Conference on Interaction Design and Children* (Aarhus, Denmark) *(IDC '14)*. Association for Computing Machinery, New York, NY, USA, 321–324. https://doi.org/10.1145/2593968.2610482

[29] Sharayu Sunil Talatule. 2021. What Is Kavad Art? Exploring The Ancient Art of Storytelling -. https://rajasthanstudio.com/what-is-kavad-art-exploring-the-ancient-art-of-storytelling/

[30] Ruhiyati Idayu Abu Talib, Predrag K. Nikolic, Mohd Shahrizal Sunar, and Rui Prada. 2020. In-Visible Island: Inclusive Storytelling Platform for Visually Impaired Children. *Mobile Networks and Applications* 25, 3 (Apr 2020), 913–924. https://doi.org/10.1007/s11036-020-01515-5

[31] Ma Dolores C Tongco. 2007. Purposive sampling as a tool for informant selection. *Ethnobotany Research and applications* 5 (2007), 147–158.