

Conceptualize This

*Making Picture Books Accessible for Preschool
Children with Visual Impairments*

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Department of Graphic and Industrial Design
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North Carolina State University

May 7th, 2019
Master of Graphic Design

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Thank you to my parents, Beth and Mark, for their constant love, support, and encouragement. And to Bev, for always making me laugh.

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ABSTRACT

Picture books can facilitate preschool children's literacy comprehension and ability to retain information. Through interactive reading with their parents, children begin to internalize the illustrations they see in stories and apply them to real-life experiences. Although picture books offer an array of potential benefits to young readers, they are not a fully inclusive medium for those with visual impairments. Their positive impact on a child's comprehension is reduced if that child has low vision or total blindness. While accessible interactive picture books are available, they typically use raised illustrations that are not applicable to multiple stories. Children feel the pictures alongside their parents, but cannot take accessible elements from one story and use them to conceptualize another; each book is its own entity with its own set of tactile visuals.

Currently, children and their parents have no extensive system that they can apply to existing picture books to make them both accessible and interactive. This presents an opportunity for design intervention. Using a combination of frameworks and design methods — including interviews with educators, literacy interventionists, and parents; journey mapping; prototyping; and user testing — this investigation demonstrates how picture books can be made accessible for preschool children with visual impairments to facilitate literacy comprehension and parent-child interactive story reading.

PART 1:

SETTING THE SCENE

CONTEXT

Go to almost any bookstore or local library, and there is a young children's section, a secluded friendly corner filled with squashy chairs, colorful wall art, and preschoolers sitting in their parents' laps. These children are reading picture books. Picture books utilize illustrations to engage their readers' attention, to tell stories through imagery rather than merely enhance written words. Children's artist and author Uri Shulevitz explains that, unlike story books, words in picture books provide supplementary support to the imagery (Shulevitz, 1985). There is a reason for that role-reversal. Picture books are created to be explored with young children who have not yet learned to read; the children hear the words and follow the story through illustrations (Shulevitz, 1985).

Indeed, picture books facilitate preschool children's literary understanding and ability to retain information. Zhihui Fang concludes that young readers often equate the images they see in picture books with real-life experiences, thereby creating their own representational schemas (Fang, 1996). Similarly, Strouse et al. (2018) observe that children who read picture books transfer problem solutions from the stories they have internalized to real-world contexts. If a child loses her stuffed animal, for instance, she can recall a story where the protagonist retraced his steps to recover a valuable lost object. The child can then apply that recalled knowledge to her own situation and revisit all the activities she conducted the day before (Strouse et al., 2018) (Figure 1.1).

Both Strouse et al. (2018) and Greenhoot et al. (2014) promote parent-child interactive story reading as a way to support children's literary comprehension. Guardians (whom I will refer to as parents from this point forward) are able to actively direct their children's attention and

Picture Books

Books where illustrations tell the reader the story rather than provide supplementary support to written words.

Parent-Child Interactive Story Reading

When parents direct their children's attention and understanding during read aloud sessions by interacting with the story.

Literacy Comprehension

The ability to process a book's contents and recall those contents to written words.

PART 1: SETTING THE SCENE

PICTURE BOOK SPREADS

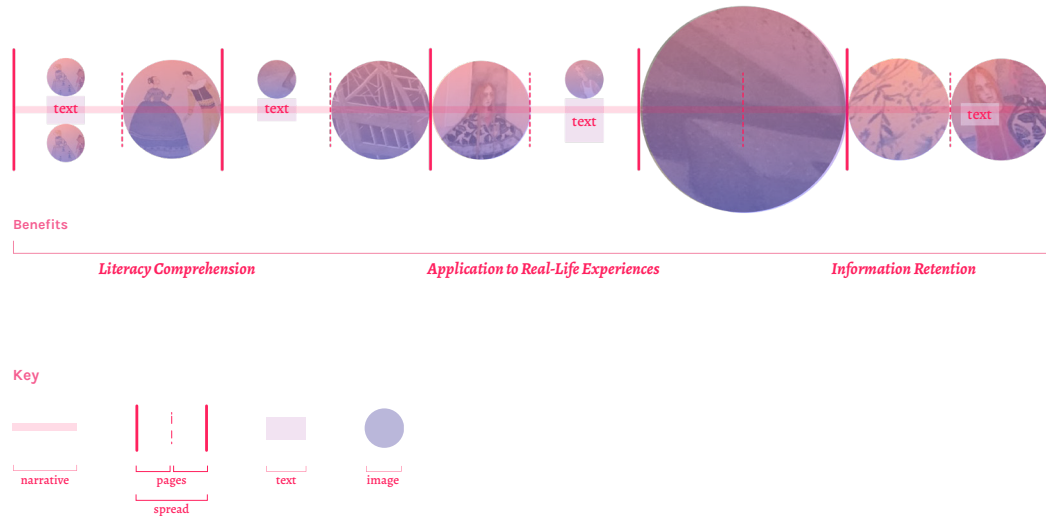


FIGURE 1.1:

(Above) Diagram of picture book benefits for preschool children, as identified by Fang (1996); Greenhough et al. (2014); and Strouse et al. (2018).

understanding during the reading session (Greenhough et al., 2014). Greenhough et al. find that illustrations enhance parent-child reading interaction, noting that the children whose parents read them picture books are able to remember more plot details from the shared story than those who are read non-illustrated books (Greenhough et al., 2014). Interactive picture book reading also incorporates a beneficial performative aspect: Parents recite the story aloud, acting out voices and scenarios, and pointing out details in the illustrations that their children may have missed. In response, children ask their parents questions, laugh at the images, and get involved in the story telling. Illustrations help facilitate that involvement and interaction because they enable children to follow along with their parents while still retaining their attention.

Although picture books have the potential to improve preschool children's literacy abilities, they are not yet fully or consistently inclusive. Their positive impact on a child's comprehension is affected if that child is blind or partially sighted. The text in story books can be read out loud, recorded and replayed, or translated into Braille. As a purely visual means of communication, picture book imagery has no direct, understood translation for those with vision impairments.

PROBLEM STATEMENT & JUSTIFICATION

Picture books can facilitate preschool children's literacy comprehension and ability to retain information (Fang, 1996; Strouse et al., 2018). Through interactive reading with their parents, children begin to internalize the illustrations they see in stories and apply them to real-life experiences (Strouse et al., 2018). As a visual means of conceptualization and communication (Shulvitz, 1985), picture books offer an array of potential benefits to young readers, but exclude those readers with visual impairments.

Visual impairments can develop in prenatal or postnatal environments and encompass a spectrum of vision functionality (Bishop, 1991; Duffy, 2018). Individuals with low vision, for example, cannot change their eyesight through glasses, prescription lenses, or medical treatment, but can perceive the difference between light and dark, while individuals with total blindness cannot perceive light or form (Duffy, 2018). Young children with congenital or early onset visual impairments have reduced access to visual references, which can lead to delays in their language development and reading comprehension (Tadic et al., 2010; Erickson et al., 2007). Additionally, without caregivers' encouragement, they are less likely to explore their physical environment and cultivate object manipulation skills (Ferrell et al., 1990, as cited in Erickson et al., 2007).

Erickson et al. (2007) suggest that parents utilize family-centered services to help children with visual impairments develop literacy abilities. In this case, interventionists (special education professionals) teach children and their parents how to learn through tactile and auditory indicators rather than by relying on vision (Erickson et al., 2007). Bishop (1991) also recommends early intervention for children with visual impairments, noting that parent

Visual Impairments

A range of vision functionality where an individual's eyesight cannot be modified through glasses, prescription lenses, or medical treatment.

Tactility

how an individual gains meaning through touch.

PART 1: SETTING THE SCENE

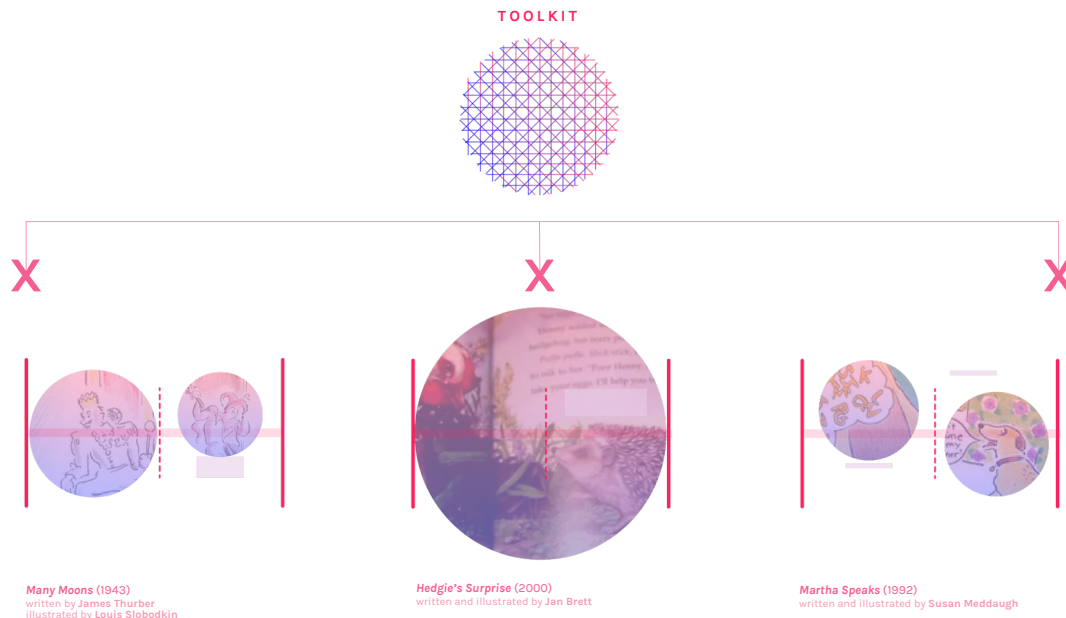
and teacher-provided interactive experiences (e.g., tactile explorations) can help with their concept and cognitive development. Similarly, nonprofit organization Reach Out and Read highlights how important it is for caregivers to be involved in their children's literacy progression and encourages parents to combine reading and playtime (<http://www.reachoutandread.org>, n.d.).

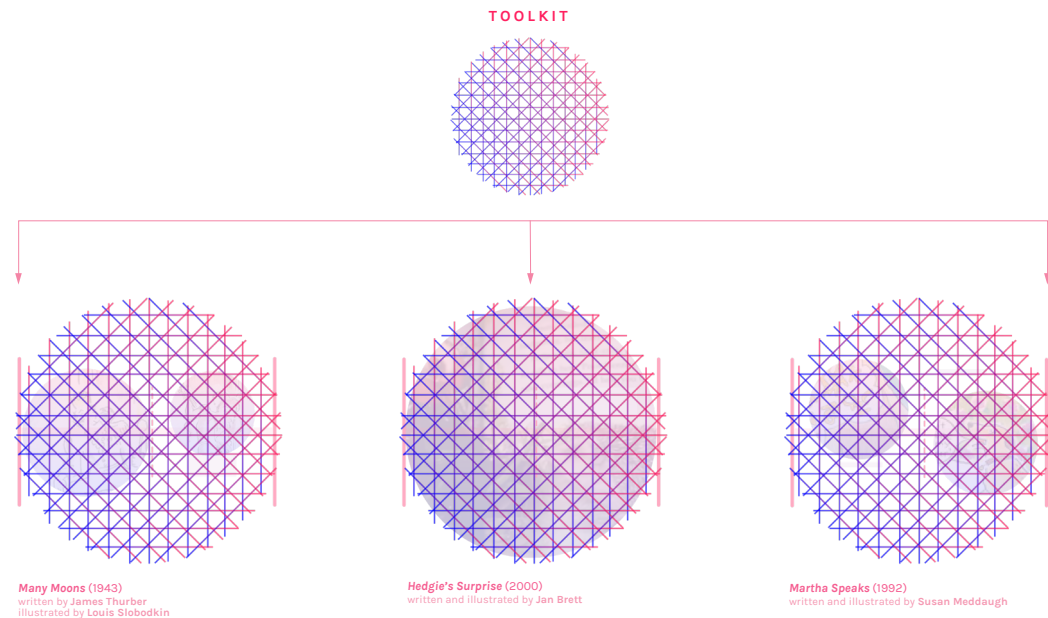
Scalability

A system's ability to adapt and manage an increased range or volume of tasks.

FIGURE 1.2:

(Below) Diagram illustrating the lack of an extensive, scalable accessibility system for picture books.





Early literacy development services offer an ideal opportunity for design intervention. For example, one of the interventionists involved in Erickson et al's (2007) study created an "imagination kit" for her assigned family filled with craft supplies and textural materials. The student and her mother used the materials to make tactile literacy tools and games to play together in between intervention sessions. These kits encourage tactile exploration and fine motor movement development (Erickson et al., 2007), but are time-consuming to create, difficult to transport, and not a scalable solution. I see potential for design toolkits to replace imagination kits.

In their seminal work, *Convivial Toolbox*, Liz Sanders and Pieter Jan Stappers apply user-centered design practices to participatory design to create a co-design process where users become "expert[s] of their experience" (Sanders & Stappers, 2013, pg. 24). Designers craft a toolkit and the experts use it to generate ideas and potential solutions; the designers then take those rough iterations to develop a refined prototype. In the design toolkit that I propose, parents and children with visual impairments will be the

FIGURE 1.3:
(Above) Diagram illustrating a design toolkit that could be applied to multiple picture books to make them accessible for preschool children with visual impairments.

Design Toolkits

A curated collection of materials that end-users utilize to generate ideas and potential solutions for a design problem.

PART 1: SETTING THE SCENE

Mobility

the ease with which an individual can move or manipulate an object.

experts, utilizing the toolkit to make their shared reading time accessible. Rather than developing ideas for later refinement as advocated by Sanders and Stappers, however, I propose that parents and children co-create that reading experience. This ensures that parents and children use tactility and mobility to conceptualize an existing story in the same way that the illustrations in picture books do, rather than generating their own storylines. Working with a design toolkit facilitates parent-child interaction, and, because the parent and child are using tactile objects to act out and explore the narrative, effectively combine reading and playtime. Over the course of this investigation, I develop a design toolkit that children with visual impairments and their parents can apply to existing picture books to create scalable, interactive, performative story reading experiences.

RESEARCH QUESTIONS

PRIMARY RESEARCH QUESTION

How can *picture books* be made accessible for preschool children with *visual impairments* to facilitate *literacy comprehension* and *parent-child interactive story reading*?

SUBQUESTIONS

- 01 How can a toolkit help children with visual impairments and their parents conceptualize existing picture book stories together?
- 02 How can tactility and movement generate an interactive, performative story reading experience for children with visual impairments and their parents?
- 03 How can a toolkit allow children with visual impairments and their parents to generate individual systems of meaning for characters and settings in picture book illustrations?
- 04 How can a toolkit establish representational fidelity for picture book illustrations without restricting imaginative potential?

ASSUMPTIONS & LIMITATIONS

ASSUMPTIONS

For the purposes of my investigation, I assume that preschool children with visual impairments want to engage in story reading as active and enthusiastic participants. While there is a design opportunity to build literacy toolkits for children and parents with visual impairments, I assume that the parents personified in my investigation are sighted. Developmental literacy services help young children with low vision to total blindness learn through tactile indicators (Erickson et al., 2007). I assume, then, that the parents of children with visual impairments have access to these early literacy services and intervention methods.

LIMITATIONS

In this investigation, I am focusing on preschool children who were either born with visual impairments or developed them before learning how to read with assistance from imagery. As such, their vision cannot be modified through medical treatment or corrective lenses. They also do not have concrete visual references that they can apply to new contexts, such as reading a picture book for the first time. Over the course of my research, I will examine how children and their parents can apply tactility and mobility to picture book illustrations to create accessible, performative story reading experiences. I will not utilize color to make picture books accessible because people with low vision can experience diminished color perception and those with total blindness cannot perceive color, light, or form (Duffy, n.d.). Additionally, I will not be incorporating sound into my investigation, beyond parents reading the picture book text out loud to their children. Sound can potentially interfere with child and parent verbal communications.

LITERATURE REVIEW

I reviewed existing literature to learn how traditional books function, understand the stages of emergent literacy development, and investigate literacy intervention for visual impairments. For my search, I used the following keywords: “preschool children,” “visual impairment,” “picture book,” and “emergent literacy.” I also examined article citations to find additional material. This review summarizes information relevant to my research and categorizes those summaries according to topic.

TOPIC 1:

PICTURE BOOK PURPOSES AND BENEFITS

Illustrations, Text, and the Child Reader: What are Pictures in Children’s Storybooks for?

Zhihui Fang (1996)

Fang explains that picture books are an integral part of children’s literature because they directly compare pictures with text. Art in picture books is focused on storytelling. Fang notes that they function in multiple ways, specifically to establish setting; describe and develop characters; extend or develop plot; provide readers with a different perspective; contribute to textual coherence; and reinforce text. Illustrations also encourage young readers to interact with words, explore hidden objects and characters, and predict plot outcomes.

KEY THEMES:

Picture book functionality

Illustrations in relation to text

Interaction and exploration to predict plot outcomes

KEY THEMES:

Information
comprehension and
application to real life
Improved literacy
comprehension
Scaffolding story concepts

**More than Pretty Pictures? How Illustrations Affect
Parent-Child Story Reading and Children's Story Recall**

Andrea Follmer Greenhout, Alisa M. Beyer, Jennifer Curtis (2014)

According to Greenhout et al., illustrations captivate children's attention, facilitating their comprehension and ability to recall what has been read to them. Children who experience information both verbally and pictorially are more likely to construct memory representations and later retrieve that learned information. Greenhout et al. conducted further research to determine the extent to which illustrations influence parent-child reading interactions, observing how preschool children's literacy comprehension changed when their primary caregivers read them illustrated or non-illustrated stories. The authors concluded that, while illustrations definitely do improve young readers' recall abilities, this is partially due to caregiver interaction. Parents frequently use pictures to scaffold story concepts by helping their children understand how imagery is relevant to the plot.

**Writing with Pictures: How to Write and Illustrate
Children's Books**

Uri Shulevitz (1997)

KEY THEMES:

Picture book functionality

Picture books tell stories primarily using imagery, says Shulevitz. Typically, the pictures explain, complement, or elaborate on the text. When storybook authors do use words, they play an auxiliary role. Shulevitz goes on to explain that picture books are intended for young children who have not yet learned to read; they can see the pictures and hear the corresponding story without having to understand the printed words.

The Role of Book Features in Young Children's Transfer of Information from Picture Books to Real-World Contexts*Gabrielle A. Strouse, Angela Nyhout, Patricia A. Ganea (2018)*

Like Greenhout et al., the authors of this article note that picture books can help young children learn new concepts and language and transfer that information to real-world situations. They explain that developmental factors impact learning (the ability to remember and recite information) and transfer (the ability to apply that information to new contexts) from picture books. One of these influencing factors is symbolic insight. Preschool children are trying to understand that books are objects that hold symbolic representations of the world; a drawing of a cartoon dog on the page is representative of a dog in real life. To transfer more complex information, they need to develop analogical reasoning to understand concepts that they have not personally experienced. By reading books, they are exposed to material beyond their own knowledge domain. Additionally, young children are still determining what information they receive is fictional and what is reality, a process called the reader's dilemma. They must understand that a story is representative of something that may or may not exist in the real world.

KEY THEMES:

Information
comprehension and
application to real life
Symbolic representation

TOPIC 2:

EMERGENT LITERACY DEVELOPMENT

A Framework for Early Literacy Instruction: Aligning Standards to Developmental Accomplishments and Student Behavior

Elena Bodrova, Deborah J. Leong, Diane E. Paynter, Dmitri Semenov (2000)

KEY THEMES:

Literacy development
Symbolic representation

Bodrova et al. provide a detailed framework for early literacy instruction based on their review of existing research, theory, and developmental patterns in young children. They then identify literacy development standards (the information and skills students should understand and be able to perform) and benchmarks (the subcomponents of those standards). While the authors divide these categories into reading and writing strategies, they acknowledge that the writing skills preschool children learn will also support their reading development.

According to their Standard 1, preschool children should show competence in “general skills and strategies of the reading process.” The first benchmark for this standard, and the one most pertinent to my research, specifies that children should understand basic written language concepts. This includes knowing that a symbol represents an event or object; understanding that there are made-up symbols that have personal meaning in addition to conventional symbols; and using conventional symbols, specifically letters and numbers.

Picture Book Reading with Young Children: A Conceptual Framework*Kathryn L. Fletcher, Elaine Reese (2005)*

Fletcher and Reese argue that picture book reading promotes preschool children's language and literacy skills. Children who regularly participate in interactive story reading from an early age are more likely to score higher on language examinations throughout their education. To help facilitate this literacy and language development, the authors advocate for parental involvement. Parents often ask questions about illustrations during storytime, which helps guide their children's participation and attention. To maximize that language learning potential, adults should structure interactive book reading so that it is sensitive to their child's respective development level. Therefore, Fletcher and Reese's conceptual framework identifies three components in story reading interaction: an adult, a child, and a book. Each component interacts with the others to produce corresponding levels of attention, attachment, and overall experience quality.

KEY THEMES:

Improved literacy

comprehension

Story reading interaction

TOPIC 3:

LITERACY INTERVENTIONS FOR VISUAL IMPAIRMENTS

Preschool Children with Visual Impairments

Virginia E. Bishop (1991)

KEY THEMES:

Visual impairment
manifestation
Factors that impact
functional vision
Delayed motor
development
Spatial references

Bishop provides early education teachers with an overview of visual impairments in preschool children; she then explains how visual impairments affect development and why early intervention is important. While this article is not a comprehensive guide on intervention techniques, the author did give me a foundational understanding of how visual impairments manifest. Bishop describes, in detail, which factors most impact functional vision and why. Medical/visual factors include age of onset; the integrity of the child's visual system and motor abilities; and whether or not the child's nervous system is intact. Psychological factors depend on children's cognitive abilities, personalities, and dependencies on other senses to gather information. Color, time, illumination, and contrast are all environmental factor examples.

Visual impairments most noticeably delay motor development, says Bishop. Vision is a sense that motivates young children to mimic observed behavior and refine motor skills through repetition. Children with low vision do not have spatial references from which they can draw information. They also may have difficulty participating in imaginary play if they do not understand how certain objects function. A shovel digs in the sand, but can also function as a magic wand in a make-believe setting.

Promoting Emergent Literacy Skills in Toddlers with Visual Impairments

Deborah Chen, Jamie Dote-Kwan (2018)

Unlike Bishop's overview, Chen and Dote-Kwan's article primarily focuses on literacy intervention methods. Based on existing research, foundations for reading involve children being able to participate in story reading, displaying awareness of books, and understanding the different sounds of language. The authors concur that young children with visual impairments are at risk for delayed language, listening, and concept development, in part because they have limited access to environmental references. To combat these challenges, they recommend that families tailor their language input (the way they are speaking and about what they are speaking) to their child's experiences, a technique called child-directed speech. For example, if they went to the park together recently, the parent might draw from that experience to verbally describe something to the child in a new context: "That dog on TV feels like the one we petted together in the park yesterday." Repeating short phrases in a higher pitch with long pauses and exaggerated intonation also helps keep children's attention and encourage language development.

Dialogic reading is another intervention method that Chen and Dote-Kwan support. This technique encourages adult-child interaction during story reading, where the child plays an active role. The adult asks questions about the story ("What's happening on this page?") to expand understanding and the child responds. The adult can also include descriptions to better explain the story's context ("That's a fuzzy rabbit") and get the child to repeat the addition. These interactions help children become engaged participants and facilitate their language development.

KEY THEMES:

Literacy intervention methods
Delayed language, listening, and concept development
Child-directed speech
Dialogic reading

KEY THEMES:

Inability to learn through
visual references

Delayed fine motor and
object manipulation skills

Family-centered approach
to literacy intervention

Imagination kits

Literacy in Early Intervention for Children with Visual Impairments: Insights from Individual Cases

*Karen A. Erickson, Deborah Hatton, Vicky Roy, DanaLee Fox,
Diane Renne (2007)*

Erickson et al. investigate how to encourage literacy development in infants and toddlers with visual impairments. Like Bishop, the authors note that children with low vision or total blindness have fewer opportunities to explore the world around them and learn incidentally through visual references in their environments. While Erickson et al. observe that children with visual impairments can show delayed progress in fine motor and object manipulation skills, they are more focused on improving concept and language comprehension. The authors also emphasize the importance of a family-centered approach to emergent literacy intervention in facilitating language and concept development. Interventionists and parents work together in natural environments (typically at home) to create literacy tools for children with visual impairments. One interventionist that Erickson et al. observe gives parents imagination kits, boxes containing scrap materials and art supplies. Parents then use these kits with their children to create tactile materials and games that support literacy comprehension.

Development of Tactile Strategies and Use of Tactile Resources in Emergent Literacy at Children with Visual Impairments

Andrea Hathazi, Mihaela Bujor (2013)

Hathazi and Bujor define emergent literacy as the developmental process during which children acquire the foundation for reading and writing. They argue that children with visual impairments must utilize different strategies to develop foundational language, listening, and motor skills. These include exploring tactile objects to understand their purposes; listening to adults read stories aloud to gain information; and interacting with responsive environments that encourage curiosity. First, however, children should be able to conceptualize themselves in relation to other people and objects. They can then begin to understand other spatial aspects of the world around them.

Based on existing research, Hathazi and Bujor explain which exploratory procedures (a pattern of manual exploration used to determine objects' properties) corresponds with which identification. Lateral motion gives information about texture; pressure indicates hardness; static contact reveals temperature; and enclosure indicates shape and volume. Children with visual impairments perform these procedures to understand and codify items they cannot investigate visually (Include Figure).

The authors also utilize a helpful rubric for tactile object exploration. Children with visual impairments should first search for an object (Stage 1), then make contact with that object (Stage 2), explore the object in detail to recognize what it is or build a new conception (Stage 3), and finally process the tactile information and imagine the object (Stage 4).

KEY THEMES:

Emergent literacy strategies

Tactile object exploration to understand meaning

KEY THEMES:

Difficulty understanding the Gestalt of an experience do to limited or no spatial references

Accessibility strategies for books

Creating and Using Tactile Experience Books for Young Children with Visual Impairments

Sandra Lewis, Joan Tolla (2003)

To facilitate early literacy experiences, Lewis and Tolla recommend that adults provide children with a print-rich environment and read aloud to them from a young age; children should also model the reading behavior they observe. Illustrations help bridge the gap between listening and these early reading behaviors by adding context to a story and providing clues to what is happening in the plot. They also introduce children to information they have not experienced in real-life. Children with visual impairments, however, have limited or no access to these helpful visual hints. The authors also explain that children with visual impairments frequently have difficulty understanding the Gestalt of an experience because their perception is constrained by what they can see in a narrow visual field or feel by hand.

Lewis and Tolla offer multiple solutions for this picture book accessibility problem. Raised line drawings give three dimensional objects representation on a two dimensional plane, although the authors observe that they can easily become too complex for readers with visual impairments to understand through touch. For example, a raised line drawing of a fish does not feel like a real fish; therefore, a school of fish swimming in the sea does not translate conceptually to this tactile format. Book bags provide a potentially less confusing alternative. They contain objects that are similar to characters, settings, or plot points in picture books, so that children with visual impairments can dramatize and conceptualize events as their parents read aloud to them. Tactile experience books are made especially for children with total blindness, who need to associate words with events or activities they have experienced in real-life. A parent and child would collect tactile artifacts from an experience. The parent then incorporates these items in a handmade book, with Braille text explaining the activity on the opposing page. The child can read the book either with the parent or independently.

TOPIC 4:

USER-CENTERED DESIGN

User-Sensitive Inclusive Design

*Alan Newell, Peter Gregor, Margaret E. Morgan,
Catriona Macaulay (2001)*

Newell et al. argue that researchers and designers should consider all potential user groups when creating systems, including people with disabilities whose expertise and input could impact the design's interface and functionality. At the University of Dundee, the authors frequently employ consultants with disabilities as prototype system testers and evaluators. As such, Newell et al. propose an extension of User Centered Design (where users are the heart of the design process) called User-Sensitive Inclusive Design. This methodology helps designers effectively include people with disabilities in the potential user group and overall design process.

KEY THEMES:

User-Sensitive Inclusive
Design

User-Sensitive Inclusive Design

A methodology where designers effectively include people with disabilities in the design process.

Convivial Toolbox: Generative Research for the Front End of Design

Elizabeth B. N. Sanders, Pieter Jan Stappers (2013)

Sanders and Stappers explain that all people bring creative contributions to the design process. Both experience and service design should create complex systems that offer value for users, rather than an artifact that only serves a functional purpose. As such, they advocate for a co-design process (collective creativity applied across the design process), where the individuals who will eventually use the refined solution plays a role in knowledge development, idea generation, and concept development as “experts of their experience.” The design researchers provide the experts with tools for expression and ideation.

KEY THEMES:

Co-Design Process

User-centered design

Users as experts of their
experience

Co-Design Process

Where the individuals who will eventually use a solution play a role in its knowledge development, idea generation, and concept development.

TOPIC 5:
REPRESENTATION

“The Power of Representation,” The Things that Make Us Smart: Defending Human Attributes in the Age of the Machine

Donald A. Norman (1993)

KEY THEMES:

Representations as a means to describe events and analyze actions

Norman observes that memory, thought, and reasoning are limited without external aids to enhance cognitive abilities. Humans have the capacity to represent perceptions and experiences through abstracted symbols and then use those symbols to do their reasoning. Representation helps people describe events and analyze actions, Norman explains. He identifies two essential components: the represented world (that which is represented) and the representing world (symbols that represent something in the represented world). Good representations should only include an event’s essential elements and not function as a replica of what they symbolize. Norman maintains that they should enhance an individual’s process of interpretation and ability to make judgments. Ideal representations are also customizable enough to match people’s specific thought processes.

Representational Fidelity

A representation that includes an event’s essential elements and improves an individual’s process of interpretation and ability to pass judgments.

The artifacts that support representations are most powerful when they are durable, portable and communicate their information over distances. Experiential artifacts allow users to experience and collect information from a real-world event when they are not present (a telescope or movie, for example); reflective artifacts create artificial representative worlds where users can explore alternative actions and develop new interpretations (fantasy or science fiction video games).

Picture This: How Pictures Work

Molly Bang (2000)

Using Little Red Riding Hood as a narrative basis, Bang discusses how color, shape, size, space, and their composition evoke emotions in viewers. Flat horizontal shapes provide a sense of calm, while vertical shapes are exciting and active because they defy gravity. Space implies time, but also isolation. Larger objects feel stronger than smaller ones. Triangles, she argues, represent stability because they have a flat, horizontal base. Bang uses a red triangle to symbolize Little Red Riding Hood, explaining that, like the character, the visual is alert, balanced, warm, and bold. For the wolf, she experiments with angularity and size, making it larger than Little Red Riding Hood and giving it aggressively sharp features.

KEY THEMES:

Imagery as a way to
communicate meaning.

PART 2:

MAKING THE METHODS

CONCEPTUAL FRAMEWORKS

After reviewing the problem space, I selected and adapted the following frameworks to assist my investigation.

ADAPTED THEORIES

Early Literacy Instruction Framework

Elena Bodrova, Deborah J. Leong, Diane E. Paynter, Dmitri Semenov (2000)

In their framework for early literacy instruction, Bodrova et al. identify literacy development standards and benchmarks. As outlined in the literature review, the benchmark most relevant to this investigation specifies that children should understand basic written language concepts. My reinterpretation applies these stages of knowledge to visual symbols rather than written symbols. I found this framework helpful in determining how a child interacts with visual symbolism and which methods could improve that child's understanding.

FIGURE 2.1:
(Below) Adapted Early Literacy Instruction Framework. Children should understand basic visual language concepts through supporting knowledge.

Early Literacy Benchmark 1.1

*Understands the basic concepts
of visual language*

Supporting Knowledge

Understands that a symbol is a representation of an object or event.

Knows that there are conventional symbols as well as made-up symbols that only have personal meaning.

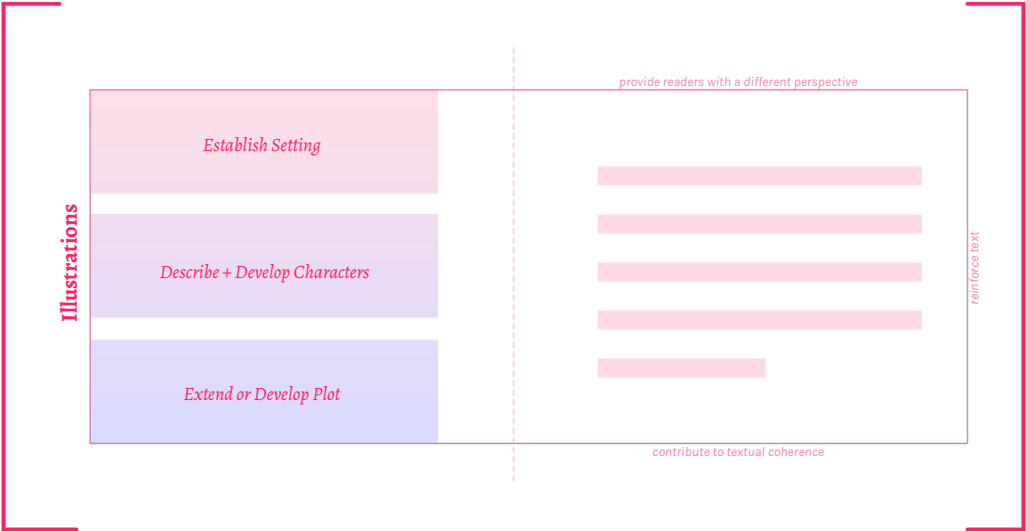
Uses conventional symbols and made-up symbols.

Picture Book Functionality Framework

Adapted from Zhihui Fang's *Illustration, Text, and the Child Reader: What are Pictures in Children's Storybooks For?* (1996)

Fang theorizes that illustrations establish setting, describe and develop characters, and extend or develop plot. Imagery relates directly to the text and encourages readers to investigate story details and guess plot points. I used this framework to break down picture books according to their main components and visualize how those components interact.

FIGURE 2.2:
(Below) Adapted Picture Book Functionality Framework. The diagram shows how the illustrations in picture books interact with the text.



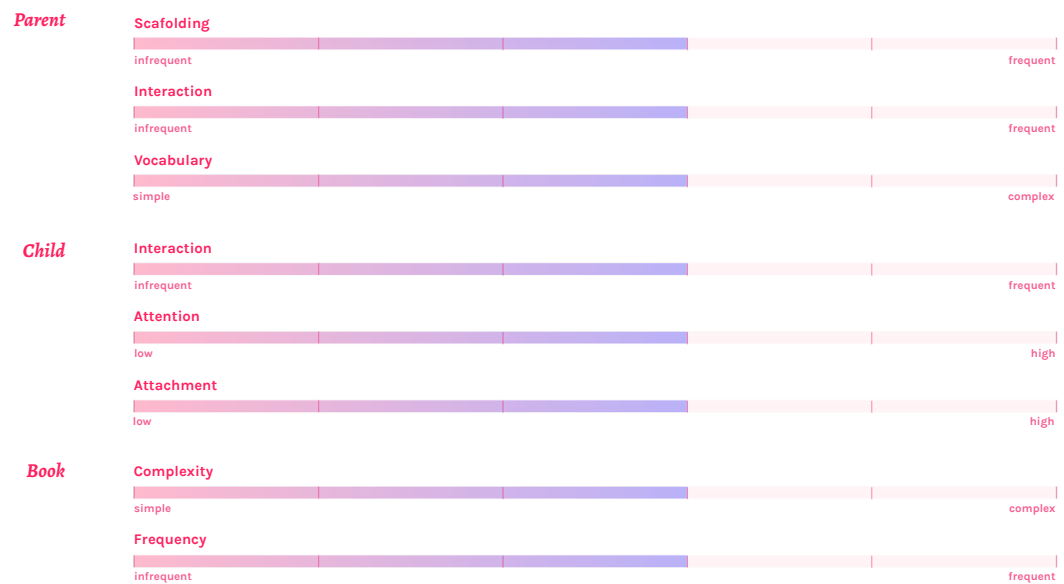
Quality of Picture Book Reading Framework

Kathryn L. Fletcher, Elaine Reese (2005)

As discussed in the literature review, Fletcher and Reese identify the components in story reading interaction and evaluate how those components affect attention levels, attachment, and the overall experience. My re-imagined version is a multi-scale system to measure participation with the picture book (Figure 2.1). This framework functions as a useful tool for evaluating parent and child engagement with the prototype during user testing.

FIGURE 2.3:

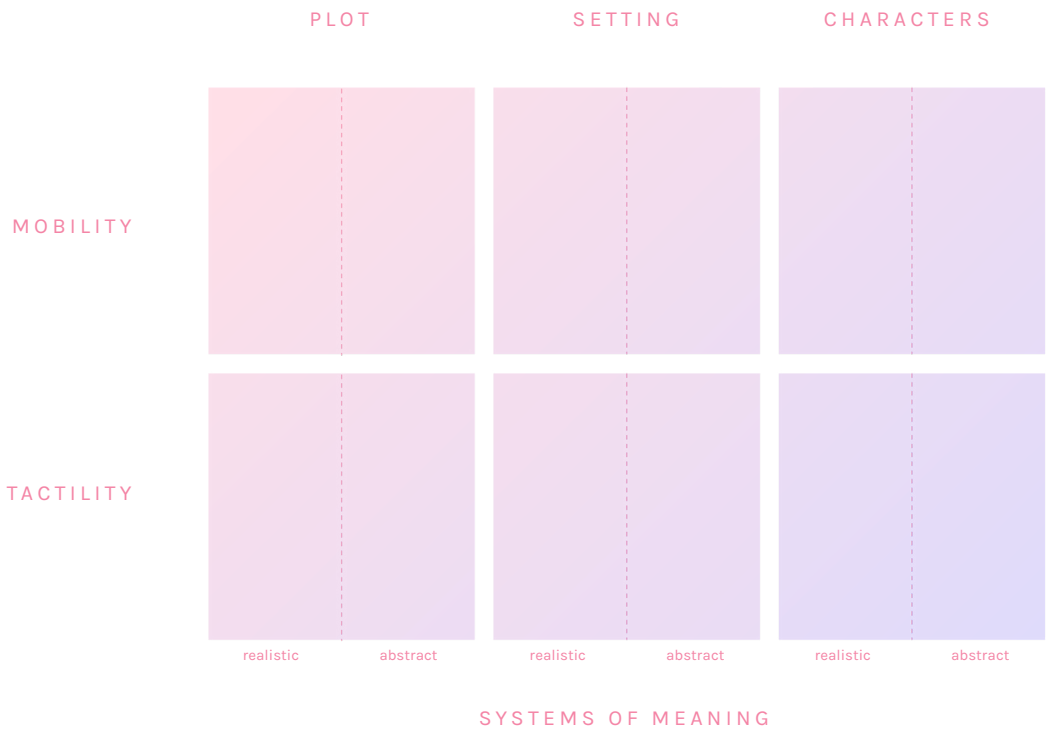
(Below) Adapted Quality of Picture Book Reading Framework. Each component interacts with the others to produce corresponding levels of attention, attachment, and overall experience quality.



CONCEPTUAL MATRIX

FIGURE 2.4:
(Below) Conceptual matrix.
This diagram structures
the investigation's
exploratory studies.

I designed this conceptual matrix to structure and guide my exploratory studies, combining Fang's illustration components with the accessibility factors identified in my subquestions with systems of meaning.



PRECEDENTS

To inform my initial making process, I studied existing accessible picture books and techniques. My objective was to evaluate their benefits and limitations, isolate trends, and find opportunities for design intervention and innovation. I grouped the results from this benchmarking investigation according to their accessibility methods.

METHOD 1:

RAISED ILLUSTRATIONS

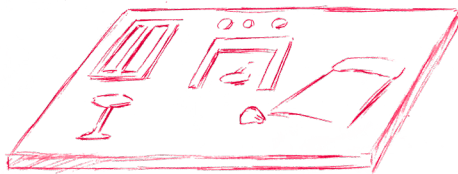


FIGURE 2.5:

(Left) Visualization of a raised illustration.

Raised illustrations are intended to give two dimensional drawings three dimensional representation on a flat plane.

Benefits

Raised illustrations are portable and keep some semblance of a book's illustration style.

Limitations

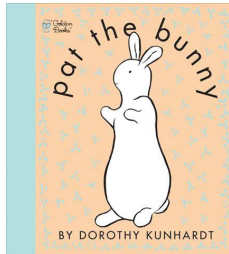
They potentially become confusing if an illustration is detailed, do not allow for object manipulation and motor development, and are not a scalable solution.

Pat the Bunny

Dorothy Kunhardt (1940)

FIGURE 2.6:

(Below) *Pat the Bunny*.



Pat the Bunny was written and “made” by Dorothy Kunhardt in 1940 (Kunhardt Jr., 1990). She developed the story as a “way to talk to children” with tactile pages, creating opportunities for interaction through minute tasks and explorations (Kunhardt, 1990). The book is still in print today and the first in a long line of “touch and feel” titles recommended for young children with visual impairments. It is important to note, however, that Pat the Bunny was not designed with accessibility in mind. Children with visual impairments often require concrete experiences to conceptualize spatial surroundings. The bunny in the story feels like a real bunny, but that is only one of its representative components. If unfamiliar with bunnies, the child reading the story would need to play with a rabbit or explore a representational rabbit object to fully conceptualize the character.

Fun with Spot, via Living Paintings

FIGURE 2.7:

(Below) *Fun with Spot*.



Living Paintings is a library service that creates tactile and audio books specifically for readers with visual impairments (Living Paintings, 2015). It offers a wide selection of picture books with raised, tactile illustrations. Children can listen to their parents read the story out loud while feeling the imagery with their hands. Living Paintings has earned rave reviews from teachers and parents, alike. Its selection for preschoolers includes Fun with Spot, a picture book with raised illustrations, braille, and accompanying audio narration. Children can feel Spot the dog's face and body in profile to get a sense of front and side perspective (Living Paintings, 2016). What Living Paintings does not address, however, is that children with vision impairments are often delayed in developing object manipulation skills (Ferrel et al, 1990, as cited in Erickson et al., 2007). Making raised illustrations into moveable pieces could help children improve their fine motor movements while interacting with tactile imagery.

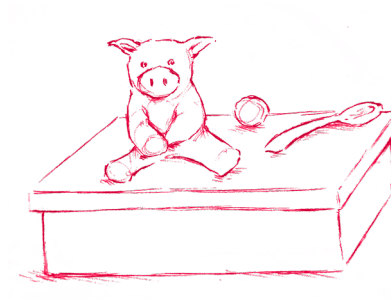
The Tactile Picture Books Project

The Tactile Picture Books Project utilizes raised imagery for picture book illustrations, but three-dimensionally prints the low-relief imagery so that it is attached to the page (Lupton & Lipps, 2018). Users are encouraged to help customize their own books using the team's digital 3D library. In this case, the "users" are the children's parents, who must send in a written request form before collaborating back and forth with the team (Tactile Picture Books, 2017). While the project offers potential for co-design, the web-based communication prevents children from being directly involved and offering input based on tactile explorations. Young children with vision impairments could help customize tactile picture book imagery by hand, a process that would strengthen their object manipulation skills and encourage interactive parent-child story reading (or story making, in this case).

METHOD 2:
STORY BOXES

FIGURE 2.8:

A visualization of a story box



Story boxes contain objects that represent characters, settings, and plot points in specific picture books, which children with visual impairments can use to conceptualize moments in the story. They are also called emerging literacy kits or book bags.

Benefits

Story boxes provide concrete representational experiences through tactile objects, facilitate motor movement development, combine reading and play time.

Limitations

They are time-consuming and expensive to make, not scalable solutions, and not easily portable.

Five Little Monkeys Emerging Literacy Kit

Original book by Eileen Christelow, literacy kit by Diane Brauner

Brauner crafted this kit for teachers to help students with visual impairments develop pre-Braille literacy skills. It includes a print copy of the original text with Braille added and tactile pictures; a monkey stuffed animal; a plastic crocodile; and two-dimensional representations of the characters that can move along a storyboard. Before reading, the student explores the stuffed monkey and identifies its body parts to better conceptualize the animal through tactility; the teacher adds to this experience by telling the student interesting facts about monkeys. They then repeat the process with the realistic plastic crocodile. After introducing the student to representational models, they can read using tactile illustrations or by acting out plot points on the storyboard with two-dimensional characters.

FIGURE 2.9:

(Below) *Five Little Monkeys* emerging literacy kit.



Story Box for *If You Give a Mouse a Cookie*

Original book by Laura Numeroff, story box by Teresa Thomas

This story box helps students contextualize information through three-dimensional imagery (Thomas, 2017). Thomas recommends using a life-sized model for the main mouse character, noting that students with visual impairments likely have little to no experience with actual mice and, therefore, need to explore an accurate representation. She also includes important props to help illustrate the story, specifically a glass with a straw and a fake mustache. In the book, the mouse drinks some milk and sees that he has a milk mustache; after reading this plot point, the child can try on the mustache to help cement the concept. While Thomas lists only a few representational suggestions, book boxes like these can become complex with many items that require multiple interactions to understand. Additionally, their contents are so specific that children can only apply them to one picture book, making them an expensive and potentially bulky solution if parents have to create a box for each book they read.

FIGURE 2.10:

(Below) Story box component for *If You Give a Mouse a Cookie*.



METHOD 3:

TACTILE EXPERIENCE BOOKS

FIGURE 2.11:

(Right) Visualization of a tactile experience book.



Tactile experience books are handmade books that children with visual impairments and their guardians co-create using tactile artifacts from a real-life activity or event.

Benefits

Tactile experience books allow children with visual impairments to construct their own systems of meaning through the objects they have gathered, make readers co-creators of that experience, and reinforce experiences through representational tactile objects.

Limitations

They are only applicable to existing picture stories if the child has experienced events similar to the plot, time-consuming to construct, and not easily portable.

Mackenzie's Birthday Party*Samantha Neukomm (2017)*

Mackenzie is turning 6-years-old and taking an active interest in her birthday party. She was born blind and has delayed language, writing, and social behavior development. To build her confidence, commemorate the party, and facilitate her language and writing skills, Mackenzie's parents help her create an experience book. The book follows her princess theme and documents the planning process and eventual celebration, incorporating physical artifacts from the party. One page displays the invitation Mackenzie made on a Velcro strip. Another includes a photo of Mackenzie and her party guests with a description of the picture printed on a Braille label. Experience books help readers like Mackenzie scaffold an experience (in this case, a party) and apply its meaning to other contexts.

FIGURE 2.12:

(Below) Components for Mackenzie's birthday party experience book



RESEARCH METHODS

Case Studies

I made taxonomies of picture books to evaluate how they create an interactive, visual narrative I researched existing accessible picture books to determine how they function, what they do well and which elements could use improvement.

Interviews

I conducted semi-structured interviews with early literacy experts and teachers of the visually impaired to understand how students currently read picture books with their parents. I also watched and studied interviews of parents and students with visual impairments reflecting on their eye conditions and experiences.

Personas

Using the information gleaned from interviews, I developed two personas to reflect the interviewees' respective visual conditions and corresponding needs. I also created two parent personas with their own sets of concerns regarding their respective child's reading experiences.

User Journey Maps

To better understand users' interactions, emotions, and perceptions, I mapped out how my two sets of parent and child personas currently engage in interactive story reading.

Research Through Design

Pulling from the frameworks, precedents, and literature I reviewed, I conducted a wide range of material and functionality explorations to generate components for my proposed toolkit.

Prototyping

Based on my explorations and the feedback I received, I chose which elements to include in an initial toolkit. The versions I made, while rough, gave me a sense of how to package the kit for users and make the components function in a real-world scenario.

Usability Testing

I conducted preliminary user tests with simulation goggles to evaluate the design toolkit's general functionality and ability to facilitate literacy comprehension and interactive story reading.

INITIAL STUDIES

In the early stages of my design explorations, I challenged myself to build out traditional fairy tales using tactile and moveable materials to generate systems of meaning. I selected Little Red Riding Hood and The Princess and the Pea as source texts because of their recognizable visual symbolism (Red Riding Hood's cloak and the pea under the mattress).

FIGURES 2.13-15:

(Top row) Little Red Riding Hood systems of meaning.

FIGURES 2.16-18:

(Bottom row) The Princess and the Pea systems of meaning.



PART 2: MAKING THE METHODS

Initial making focused on creating a play-oriented, performative reading experience. The characters were moveable pieces on a board that children could customize using attachable accessories included in the kit. While their parents read aloud, they would use the figures to act out scenes and interactions happening in the story. I made set pieces for particular scenes in the stories — abstracted trees for the forest in *Little Red*, stackable foam mattresses for *Princess* — but my original concept was to have children generate these elements themselves before and during story reading. Every time the scene changes in the book, children and parents would work together to create and assemble the new setting.

FIGURE 2.19:
(Below) Characters as customizable pieces with attachable accessories.





These initial studies allowed me to play with materiality and consider which objects make strong representational forms. Upon reflection, they led to the following discoveries:

FIGURE 2.20:
(Above) The materials included in the initial toolkit.

- 01 Requiring children and parents to build characters and settings from raw materials takes the emphasis away from story reading. **This toolkit should not need so much assembly.**
- 02 Setting a new scene for each spread takes time and could become confusing for children, particularly if some spreads requires a new setting, characters, and systems of meaning.
- 03 Tactile and mobile systems of meaning **should help children conceptualize existing picture books and enhance the reading experience, rather than become tools for children to create their own stories.**

INTERVIEWS

To better understand how children with visual impairments read and experience picture books, I spoke with early literacy experts and interventionists. Orientation & Mobility Specialist and Teacher of the Visually Impaired Diane Brauner shared her expertise in accessible approaches to picture books, including how she uses tactile objects and interaction to help children conceptualize characters and settings. Associate Professor Angela Wiseman explained which early literacy techniques had viability as tactile and mobile forms. I also sought to learn more about specific visual impairments and how they impact sight. Through the Glaucoma Research Foundation, I watched interviews of students with glaucoma reflecting on their experience with the eye condition, particularly how it progressed and which treatments they received. The Blind Children's Learning Center provided me with a variety of video resources ranging from conversations with parents about their children's visual impairments to recordings of teachers guiding students through customized intervention methods.

Conducting and watching these interviews helped me identify user pain points and potential areas for improvement in the story-reading experience. I found these insights most useful moving forward with the investigation:

Building Concepts

Reading to a child involves building concepts about print, letters, and vocabulary. Illustrations help parents and teachers with that process creating cognitive connections between words and visual representation. Books bags function in a similar way for children with visual impairments, providing them with three dimensional props that give meaning to vocabulary.

Realistic Representation

Children with early onset visual impairments can develop vocabulary without representation. For example, they can describe which features a duck possesses. When given a three-dimensional representation of the animal, however, they cannot tell that it is a duck. They need to experience a duck or duck-like object to completely conceptualize its attributes.

Realistic to Symbolic

Parents reading to children with visual impairments should first introduce them to realistic concepts. If a spoon is mentioned in the story, the parent should give the child a real spoon to feel. After exploring the spoon, the child conceptualizes its structure and function. The next time the spoon makes an appearance in the story, the parent can use a symbolic item, like a stick or a pen, to represent the utensil.

Three-Dimensional to Two-Dimensional

Applying three-dimensional moveable objects to a two-dimensional book allows children with visual impairments to reenact what is happening in the plot. Children should begin with three-dimensional objects to conceptualize the story. Once they have a grasp on the representational objects, they can then use two-dimensional versions in a similar fashion.

Limitations

While tactile images and book bags are viable tools for making picture books accessible when crafted well, they are time-consuming and complex to make. Tactile image books, especially, require many components that need to be assembled in book form with careful consideration. Typically, teachers create these resources and can only build one copy at a time.

PERSONAS

I created two sets of personas based on the information gathered from conducted and watched interviews. Each set includes a child with visual impairments and a parent.

CHILD

JUANITA "NITA"

age 4

Likes

Nita is a curious child and enjoys exploring the backyard with her parents and family dog, Maggie. She likes all animals and she wants to be a veterinarian when she grows up.

Vision

Nita has congenital glaucoma, a condition that increases the eye's intraocular pressure, potentially causing damage to the retina through pressure on retinal tissue and the optic nerve (Bishop, 1991). She has had eight surgeries from the time she was born until she turned 3, at which point she lost most of the vision in her last sighted eye. Nita can perceive the presence and absence of light, but has no spatial references, which means she requires concrete experiences to help construct her understanding of the external world (Bishop, 1991). To conceptualize a duck beyond its descriptive components (that it has webbed feet, feathers, a bill, etc.), Nita must feel an actual duck, or duck-like representational object (from interview with Diane). She also has difficulty understanding the Gestalt of an experience because her perception is restrained to what



FIGURE 2.21:

(Above) Juanita persona illustration.

she can feel by hand. Doctors diagnosed her glaucoma early, so her parents have ensured she receives the necessary early education interventions to help her cognitive and language development.

Wants

Nita also loves listening to her mom read books aloud to her older sister, Teresa, and wishes that she could experience the pretty pictures, too. **She wants a story reading time just like Teresa's, sitting on the floor in their shared bedroom, cuddled up against her mom.**



FIGURE 2.22:

(Above) Maria persona illustration.

PARENT
MARIA
age 35

Occupation

Maria is 35-years-old and works part time as a dental hygienist. When she is not in the office, she stays at home with her children Teresa, 7, and Juanita, 4.

Wants

Nita was born with glaucoma and Maria and her husband have made sure that she meets with specialists regularly to help her with her eye condition. She wants Nita to enjoy reading as much as her other daughter, Teresa, and develop literacy and language skills, so she spends a lot of time playing sensory games with her. Maria frequently worries that Teresa is not getting enough of her attention, so she reads to her older daughter after school or before bed. Recently, however, Nita has been asking Maria for a story time experience just like Teresa's, in the same room, with the same picture books. Typically, Maria checks out picture books from the library with raised illustrations for Nita, but Teresa's books do not have accessible versions readily available. Maria has agreed to read these books with Nita, but is concerned that her daughter will not be able to follow along with the illustrations because they are not tactile. **She wants Nita to have a story reading experience where she is engaged and has fun.**

CHILD

MACKENZIE

age 5

Likes

Mackenzie currently attends preschool and loves to tell stories to herself during playtime. Sometimes, she gets her friends to act out parts, but is just as happy playing alone. When she is at home, she spends hours watching her older brothers play video games and sometimes they will let her join them. Her favorite is *Zelda: Ocarina of Time* because she likes *Zelda's* character and the plot.

Vision

Mackenzie has Marshall Syndrome. Her left eye is prosthetic and the vision in her right is limited. Her functioning eye is highly myopic and has glaucoma. She is also at high risk for retinal detachment, so her parents have told her to avoid sports and other physical games. She does not have very effective peripheral vision and what she does see is clouded by cataracts.

Wants

Mackenzie enjoys story time in the evening when her mom comes home from work. She likes to predict what is going to happen in the book, but has difficulty viewing details in the illustrations that indicate future plot points. She has an easier time seeing cartoon-y or block-like characters with clearly defined lines and large features, but associates that drawing style with picture books for babies. Mackenzie wants to be able to find clues in the illustrations to figure out what happens next in the story.

**FIGURE 2.23:**

(Above) Mackenzie persona illustration.



FIGURE 2.24:

(Above) Susan persona illustration.

PARENT

SUSAN

age 37

Occupation

Susan is a 37-year-old real estate agent. She works every week day from 10 to 5 and spends the weekends with her children and husband. She has twin sons, Zach and Sammy, and a daughter, Mackenzie, who is 8 years younger. Susan relies on either her husband or the twins to watch Mackenzie after preschool while she is at work. After dinner, Susan and Mackenzie have story time together and they can read up to three books each night.

Wants

The family is planning to go on a vacation in two weeks and Susan wants to continue reading to Mackenzie while they are away. She has limited room in her luggage for tactile picture books and book bags, however, and has considered just taking a kindle with a collection of stories downloaded. Still, Susan knows that Mackenzie will want to follow along through the imagery and guess what happens next in the plot. She wants a compact set of tactile objects that Mackenzie can apply to multiple existing books to help her conceptualize plot developments before they happen.

USER JOURNEY MAPS

To help identify specific opportunities for design intervention, I plotted out how these personas would currently read picture books together. In her article for online literacy development resource, “Paths to Literacy,” Cheryl Kamei Hannan breaks accessible story reading into four stages: preparation, where a parent selects a book and practices its pacing; before telling the story, where the parent lets the child explore tactile representational objects from the story and make predictions; during the storytelling, where the child listens as the parent reads the book aloud; and after storytelling, where the child asks questions and retells the plot (2018). I used Kamei Hannan’s first three stages to structure my journey maps. I wanted to directly compare how my sets of personas interacted with each other and the book and how those interactions helped or hindered the overall reading experience.

These were the three main user pain points I identified:

- 01 Exploring contextualizing picture clues
- 02 Using visual references to follow the story
- 03 Understanding the Gestalt of the story

PART 2: MAKING THE METHODS

PREPARATION			BEFORE STORY READING			
Parent Maria	Picks a book that she usually reads to Teresa. Believes that Nita will like it because it's about a dog.	She practices exaggerating her reading voices so that Nita can differentiate between characters.	Brings there family dog, Maggie, into the room on a leash to help Nita understand the main character in the story.	Gives Nita a brief descriptio of the book and that it's about a talking dog.	Has Nita pet Maggie to understand what Martha feels and looks like.	Lets Nita get comfortable before story time begins.
Mood	Tired	Anxious	Nervous	Excited	Determined	Content
Child Juanita				Listens.	Pets Maggie.	Snuggles against her mother and pats Maggie's head.
Mood				Excited	Content	Happy
STORY READING						
Parent Maria	Begins reading. Explains that alphabet soup goes up to Martha's brain instead of down to her stomach, which makes her speak.	Has Nita trace her hand from Maggie's throat down to her stomach.	Introduces Mom, Dad, and Helen characters. Tries to use different voices for each.	Explains that Martha has a sister, like Nita. Counts off the family members by lighting squeezing Nita's arm three times.	Reads that Martha has won her family a vacation, but Martha can't go because she is a dog.	Tells Nita she will have to wait and find out.
Mood	Enthusiastic	Prepared	Uneasy	Resourceful	Apprehensive	Concerned
Child Juanita	Asks why.	Says she understands.	Is confused by who is speaking when her mom reads the speech bubbles in the illustrations.	Listens and says okay when she feels the squeezes.	Asks if Martha will be able to go on the trip.	Says she'll wait, but is disappointed that she can't predict what happens like Teresa does when she reads.
Mood	Curious	Content	Confused	Satisfied	Worried	Disappointed
STORY READING						
Parent Maria	Reads that Martha leaps in the air to catch a frisbee using different voices to show the characters' reactions.	Reads that the family leaves Martha alone in the hotel room because there are no dogs allowed.	Reads that the maid at the hotel assumes Martha has eaten Grandma, even though Martha is pretending to be Grandma.	Is worried that Nita won't be able to understand what happens without pictures.	Reads that Martha explains the situation and is asked to help run a hotel for dogs.	
Mood	Apprehensive	Tired	Amused	Concerned	Exhausted	
Child Juanita	Has difficulty understanding who is talking.	Is concerned that something will happen to Martha and pets Maggie.	Asks her mom to skip to the end of the book to find out what happens, like she does with Teresa.	Is frustrated that she can't do the same reading activity as her sister.	Wants to read another story before bed that's less complicated.	
Mood	Frustrated	Upset	Aggitated	Irritated	Eager	

USER JOURNEY MAPS

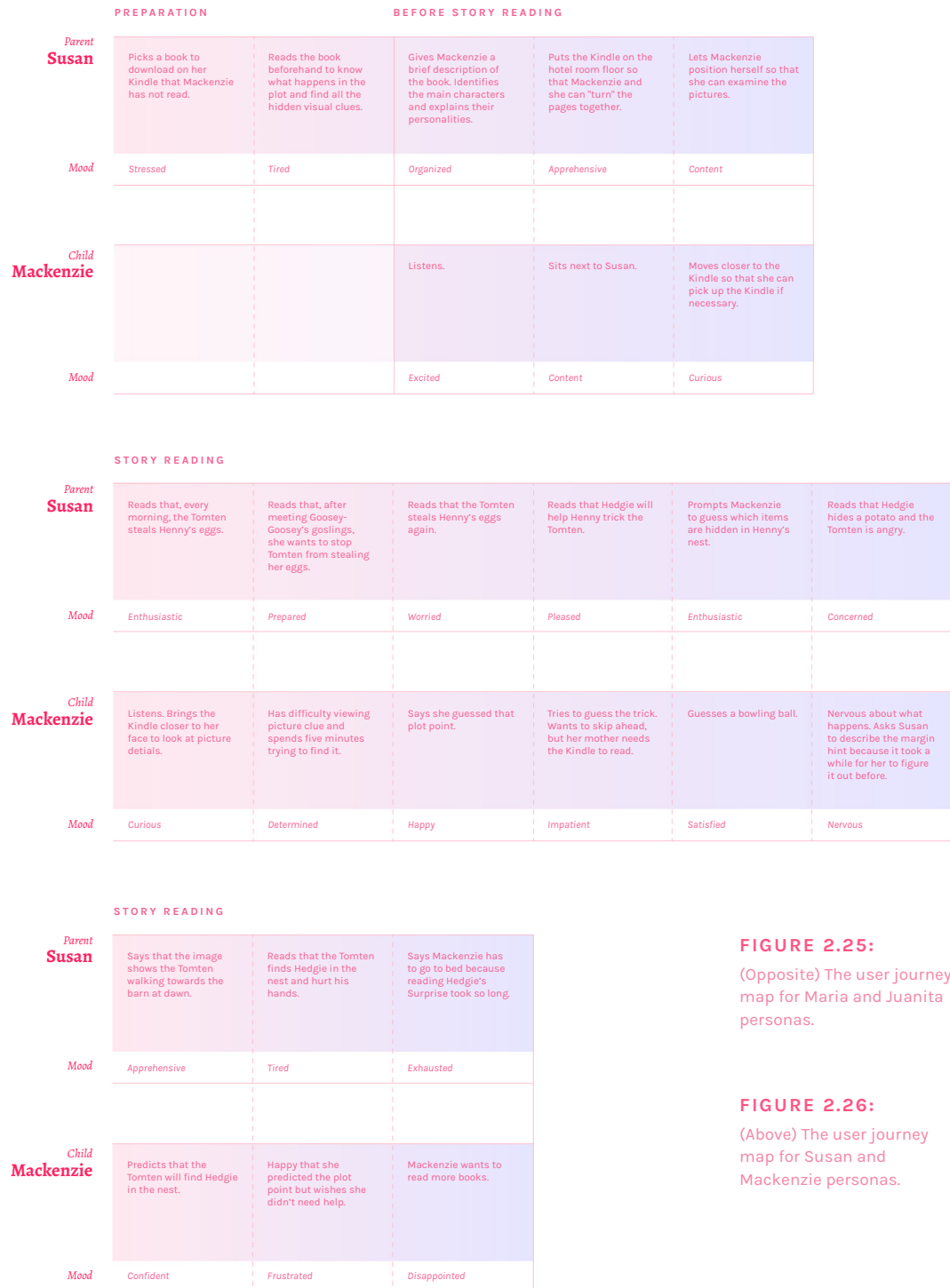


FIGURE 2.25:

(Opposite) The user journey map for Maria and Juanita personas.

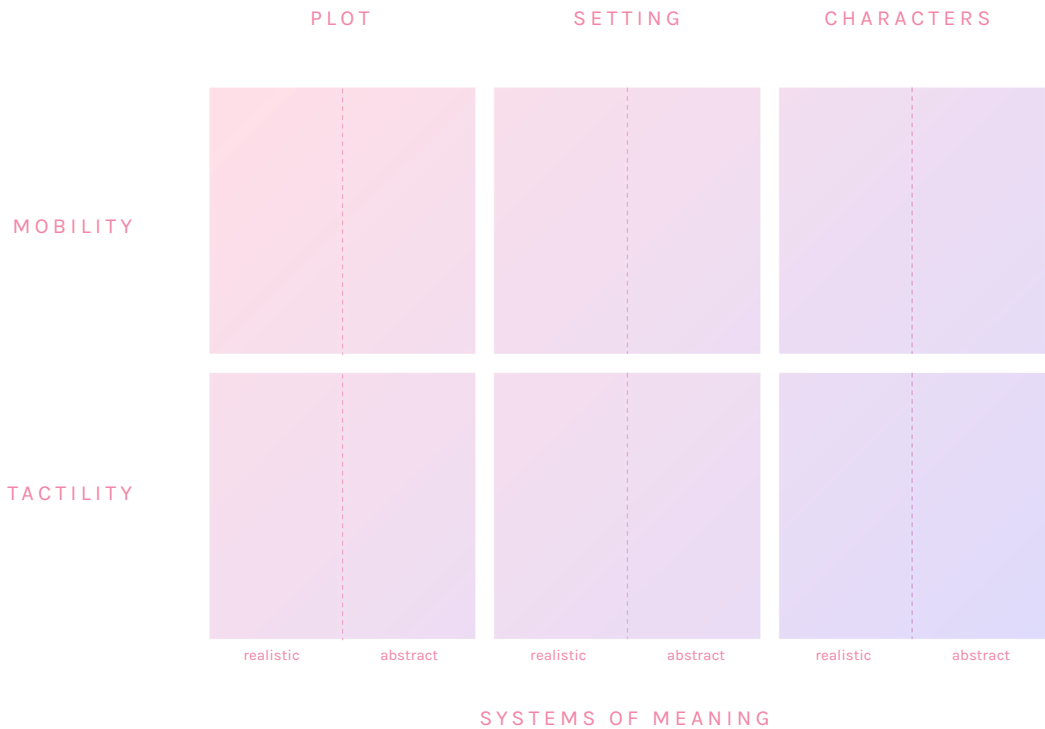
FIGURE 2.26:

(Above) The user journey map for Susan and Mackenzie personas.

EXPLORATIONS

To generate accessible toolkit solutions, I completed my conceptual matrix, pairing **plot**, **setting**, and **characters** (*Axis 1*), with **mobility** and **tactility** (*Axis 2*), and **systems of meaning** (*Axis 3*). In addition to the identified pain points, I wanted my explorations to address:

- 01 Mobility as an opportunity to help children with visual impairments develop fine motor movement skills (Ferrell et al., 1990, as cited in Erickson et al., 2007).
- 02 Tactility as a means for children with visual impairments to identify and differentiate between specific forms and functions (Hathazi and Bujor, 2013).



PLOT

I focused on illustrations functioning as plot development (Fang, 1996). If illustrations dictate a story's progression, then page turning controls its pacing. I considered how the subsections on *Axis 2* could represent the act of page turning.



Exploration 1

First, I created blank booklets with turnable pages. Children can flip through the booklet to simulate the same action in picture books and control pacing. I tested different material textures: Smooth paper, rough cardstock, and foam.



Exploration 2

Moving to more abstract forms, I developed a tactile abacus that helps readers track plot progression. Each time their parents turn a page, children can slide a pom-pom down the string.



Exploration 3

Continuing with the concept of linear progression, I constructed a segmented container with adjustable dividers that correspond to page spreads. Children can move the pom-pom from one segment to another to represent a page turn.



Exploration 4

I bent the pipe cleaner to symbolize plot developments, both positive and negative. As their parents read aloud, children follow the story by moving the sponge along the line.



Exploration 5

Similarly to **Exploration 4**, I bent the wire to follow positive and negative developments. Children trace the wire to understand where they are in the plot.



Exploration 6

I also looked to more familiar objects for inspiration, like a timer. The dial I made has scored indents that reference page numbers. Children feel the ridges on the curve and turn the dial to align with the scores.



Exploration 7

I expanded on the bent wire exploration with a more rigid approach. Each segment represents a picture book spread. Parents and children can adjust the segments to indicate positive and negative plot developments. They can also move character pieces along the path segments created.



Exploration 8

I played with the idea of page turning as completion when building this prototype. Every time their parents turn a page, children drop a pom-pom into the container until it is filled.

SETTINGS

Settings in picture books can range from quaint barns (*Hedgie's Surprise*) to fantastical castles (*Many Moons*). I considered which forms (natural, man-made, etc.) might recur across multiple stories but also how to represent locations in more abstracted contexts, like “inside” and “outside.” Scenes can also change with a page turn; the process is quick and, therefore, should be quick in conceptualization to mimic the reading experience. I explored how toolkit components might indicate scene shifts without requiring children and parents to assemble and arrange those new settings themselves.



Exploration 9

Foliage was a recurring setting piece that I observed in multiple picture books. Forests, in particular, and the way an artist renders them, can change an illustration's atmosphere from stable to scary (Bang, 2000). I twisted a pipe cleaner into the shape of a tree, to represent the outdoors in both form and texture. One tree was not enough to make a forest, however, and I began to consider how many replicas I should include in the kit and what would happen if a child decided the form was not a tree but something else entirely.



Exploration 10

I then moved in a more abstract direction and made rough tactile spheres. Children can pick a representational object (a tree or a rock, for example) based its described texture. I anticipated that creating less realistic forms would help children establish their own systems of meanings that they could then use for multiple picture books with similar settings.

CHARACTERS

Creating character representations posed similar challenges to crafting settings. After my mini-studies, I veered away from designing a toolkit where children and parents build story components together, but I still wanted explore customizable characters. I also began to conceptualize not how children could (or should) accurately represent a character through multiple components but rather how they could assign representational meaning to existing objects.



Exploration 11

I created a customizable, realistic paper person. The hair and outfit are detachable. I wanted children to have the opportunity to create accurate representations of picture book characters through tactile components.



Exploration 12

Similarly to **Exploration 11**, I considered using existing toys as character representations with attachable accessories and body parts. I also tried connecting this particular toy to the wire from **Exploration 5** so that children could move a character along the plot. I gradually realized, however, that this customization process would be time-consuming and emphasize character creation rather than picture book reading. Children might spend hours picking clothes and hair for one human character based on tactile properties. Additionally, developing a kit with a range of realistic customization options could quickly become an overly complicated design challenge and still not guarantee that a child would identify a human form as a human form.



Exploration 13

I then played with assigning meaning to different textures rather than relying on representational objects to convey concepts. In the early stages of this investigation, I read through a wide range of picture books geared toward preschool children to identify recurring themes, settings, plot points, and character roles. I observed that characters were typically either animals or humans (*Hedgie's Surprise*, *Martha Calling*, *Many Moons*, *The Princess and the Pea*, *The Teacher from the Black Lagoon*). In this exploration, I decided that all fur-like materials would represent animals and then curated a diverse assortment of fluffy, spherical objects.



Exploration 14

I continued with the system in **Exploration 13** and decided that hard, smooth objects would represent human characters to contrast with the animal representations. I picked a range of sizes so that children could choose a bigger shape to represent a major character or a character who is large. Abstract forms would give children more opportunities to create their own systems of meaning rather than relying on exact replicas.

REFLECTION

I evaluated how well my explorations addressed the identified pain points, their scalability across multiple picture books, and how they might function as a system to facilitate literacy comprehension and parent-child interactive story reading. I then selected the most successful plot, setting, and character explorations to include in my initial toolkit prototype.

Note: *Most of the studies fell between tactility and mobility on Axis 2 of the matrix; thus, all my selected toolkit components have both characteristics.*

FIGURE 2.41:
(Below) The completed conceptual matrix.





The Wire (Exploration 5)

Pain Points Addressed: 1 and 3. This exploration can effectively convey the Gestalt of a picture book through tactility (the bent story wire) and movement (tracing the bends to understand plot progression).

Scalability: Because the wire is flexible, children and parents can easily bend it up or down to indicate plot points in a specific picture book. They can then rebend the wire according to another story's narrative progression, making it a truly scalable solution.

As a System: I decided where to implement the wire in my journey maps. Children can trace the wire before story reading to get an overview of the plot and make predictions. During story time, they can reference the wire to preview what will happen next in the story. After reading, they practice information retention by tracing the wire again while retelling the story to their parents.



Abstract Spherical Objects (Explorations 10, 13, and 14)

Pain Points Addressed: 1 and 2. Children select which objects represent which settings and characters in the story, thus creating their own textural references. They then use those references to conceptualize and act out the plot.



Scalability: Because the character and setting representations are abstract, children and their parents can reuse the same forms for different stories, creating new systems of meaning.



As a System: Before story reading, parents give their children a brief description and help their children select which object represents which character or setting piece. Children then use the objects to act out the plot or trace the wire during story time.

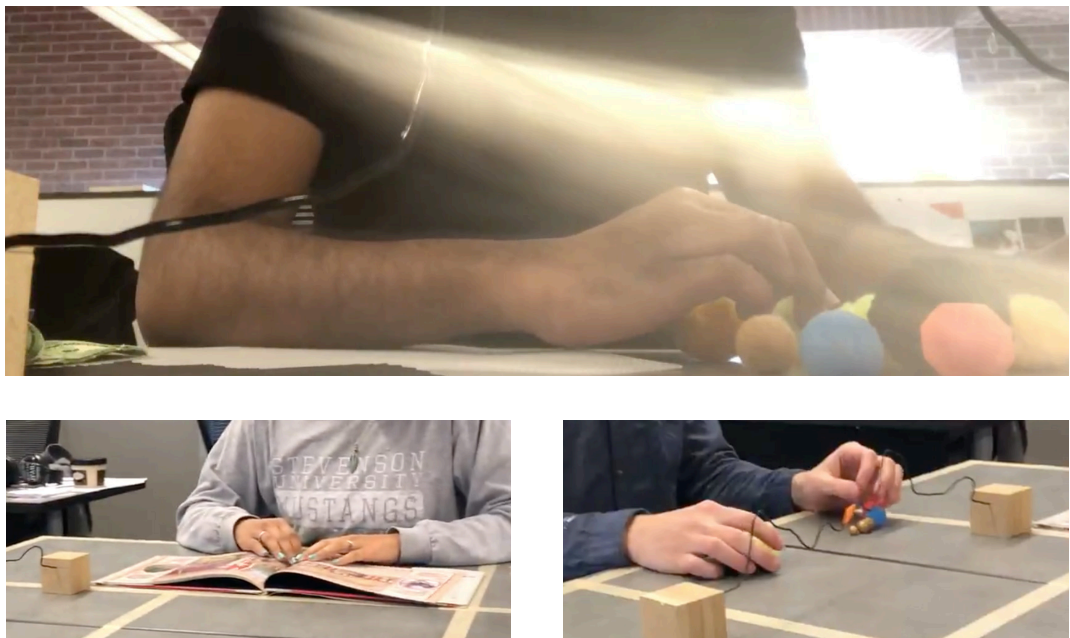
PART 3:

TESTING THE TOOLKIT

INITIAL USABILITY TESTING

I usability tested my initial toolkit to determine which components were successful in facilitating literacy comprehension and parent-child interactive story reading, which were not, and why. These tests gave me invaluable insight into the system's functionality. Through users' feedback, I was able to make necessary improvements and additions to the prototype and create a more effective and accessible solution.

FIGURE 3.1:
(Below) Pictures of initial users testing the toolkit prototype.



Sighted participants wore Marshall Syndrome simulation goggles and listened to either *Hedgie's Surprise* or *Martha Calling*. They had no access to the toolkit materials until they were wearing the goggles. I took notes during the tests, paying attention to which characters and setting pieces they selected, how they interacted with the wire, both before and during story reading, and whether or not they were able to follow along with the narrative. After story time, I asked participants about their experiences to understand what they found helpful or detracting. These comments were the most constructive to my investigation:

- 01 Tracing the wire during story reading was confusing. Several participants had difficulty identifying where they were in the picture book according to the wire bends; they also did not know how fast or slow to trace the narrative. **Most preferred to act out the story using just the character objects rather than moving the characters along the wire or using it to predict plot outcomes.** One participant suggested tracing the story wire before and after reading time begins, rather than during.
- 02 Another participant explained that he moved the characters to different areas on the table depending on where they went in the story. One direction was the barn and another was the field. **He wanted additional materials to represent different locations,** like sections on a gameboard.
- 03 Several participants mentioned that they had trouble keeping track of where they had placed representational objects, especially when the story featured many characters. **Even on flat surfaces, the character pieces would roll away.**

Literacy Education Professors Jill Grifenhagen and Angela Wiseman also reviewed the toolkit. They evaluated its viability as a system of early literacy instruction tools for preschoolers. Both agreed that the bends in the story wire were too complex for young children to understand and better suited for elementary and middle school students. They recommended that **the wire represent a story's beginning, middle, and end**, as those are those are easier concepts for preschool children to learn.

REFINED TOOLKIT

Based on the feedback I receive from usability testers, literacy education specialists, and my committee members, I modified the toolkit to include suggested elements. I added a range of material swatches to represent picture book locations; simplified the wire bends to only indicate a story's beginning, middle, and end; and rearranged the order in which children and their parents use the materials. I also designed and built a new box to hold all the toolkit components and functions as a flat play area during story reading time.

TOOLKIT COMPONENTS AND STORAGE



FIGURE 3.2:

(Left) Character objects in ranging sizes and textures stored in the toolkit box.

Character Objects

Children choose character representations from a selection of differently textured spheres organized by size from small, to medium, to large. The objects are abstract enough for children to create their own systems of meaning, but texturely diverse enough to ensure that children can quickly identify them during story time.

FIGURE 3.3:

(Right) Location swatches in a variety of textures.



Location Swatches

To set the scene, children select textured fabric swatches that they think best represent different locations in a specific picture book. The flat material squares give an area for character pieces to interact.

FIGURE 3.4:

(Right) Instruction manual telling children and parents how to use the toolkit.



Instruction Manual

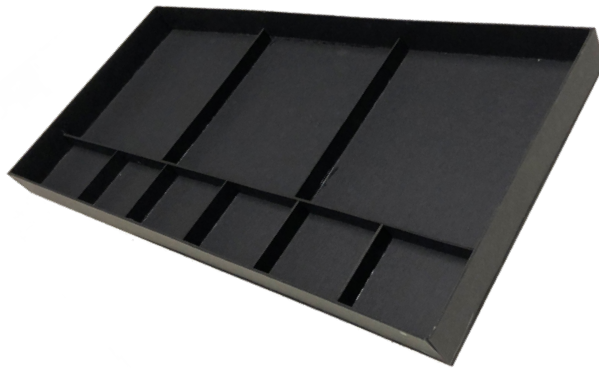
The instruction manual provides parents with a step-by-step guide on how to use the toolkit. It has a list of the materials and their respective functions and walks parents through the preparation process, including assembling the wire and helping their children select characters and locations. The instructions also contain helpful hints for parents during story time and explain how to use the story wire to reflect on the book when they have finished reading. The pages have a plastic Braille overlay for readers with visual impairments.

**FIGURE 3.5:**

(Left) Story wire that children trace to conceptualize a story's beginning, middle, and end.

Story Wire

The story wire has two notches to help children conceptualize a picture book's beginning, middle, and end. It fits between two wooden blocks, suspended with the bends faced upwards so that children can easily trace from the first wooden block to the first notch (beginning), the first notch to the second notch (middle), and the second notch to the last block (end).

**FIGURE 3.6:**

(Left) Box that stores all the toolkit components.

Toolkit Box

A specially designed box stores all the toolkit components. The bottom container divides into thirds to hold and organize the differently-sized character spheres, the wooden block bases, and the instruction manual. A fourth compartment houses the story wire. The box lid also divides into thirds, but has six smaller sections on the opposing side. Children place location swatches in the three square segments and use the six smaller sections to keep characters secured where they can find them. During story time, the lid functions as a flat play area where children move the character objects to different location swatches to act out a story's plot.

SCENARIO

Susan and her family are on vacation for the next week. She has promised her daughter, Mackenzie, that they will continue reading picture books together at night, but Susan does not have much space in her luggage for tactile picture books and book bags. She knows that Mackenzie will want to follow along with the story and predict what happens next in the plot, so she packs the toolkit, two picture books, and a Kindle with additional stories downloaded in case they finish the print books.

See the full scenario at: <https://www.jessye.org/final-project>

FIGURE 3.7:

(Below) Parent opens the toolkit.



PART 3: TESTING THE TOOLKIT



FIGURE 3.8:
(Above) Parent assembles
the story wire.

After they have settled into their Airbnb and eaten dinner, Susan and Mackenzie go to Mackenzie's room to read. Susan has already picked a book that she thinks her daughter will enjoy. While Mackenzie gets comfortable on the bed with her stuffed animals, Susan opens the toolkit and takes out the story wire from the bottom container. She attaches it to the two wooden blocks with its bends pointed upwards.

Susan sits next to Mackenzie and hands her the box lid play area which Mackenzie balances on her lap. She also places the bottom container near her daughter so that Mackenzie can access the rest of the toolkit materials. Susan then gives Mackenzie a brief overview of *Hedgie's Surprise*, the book they will be reading together.

FIGURE 3.9:

(Below) Child balances box lid play area before story time.



PART 3: TESTING THE TOOLKIT

Susan helps Mackenzie select tactile objects to represent the story's characters. She describes Henny, the hen, noting that she is the main character and small, feathery, and soft. Mackenzie reaches into the bottom container and feels the character forms. She picks large styrofoam sphere and puts the character in a smaller section of the play area. Susan asks Mackenzie to explain why she chose this particular form for Henny so that she can practice articulating her conceptualization process.

FIGURE 3.10:

(Below) Child selects an object to represent a character in the picture book.

Susan repeats these steps with Mackenzie until she has picked representations for all of the primary characters in Hedge's Surprise.





To help Mackenzie situate the characters, Susan tells Mackenzie about the settings in the book. She explains that Henny lives in a barn that is dry and made of wood and straw, although she sometimes goes outside to visit her friends Hedgie and Goosey Goosey. Mackenzie picks two material swatches to symbolize these locations and puts them in the play area.

FIGURE 3.11:
(Above) Child picks material swatches to symbolize locations in the picture book.

PART 3: TESTING THE TOOLKIT



FIGURE 3.12:
(Left) Child familiarizes
herself with
representational objects
before story reading.

Once Mackenzie has established her own system of meaning for this picture book, Susan suggests that Mackenzie interact with the selected objects and characters to familiarize herself with their respective sizes and textures.

Right before reading, Susan has Mackenzie trace the story wire to understand plot progression. As she traces from the starting wood block to the first notch, Susan asks her to predict what will happen in the beginning of the story. From the first to the second ridge, she asks what will happen in the middle of the story. From the second ridge to the last wood block, she asks what will happen at the end of the story. Mackenzie makes all her predictions and is excited to know if they are correct.

FIGURE 3.13:

(Below) Child makes plot predictions while traces the story wire.

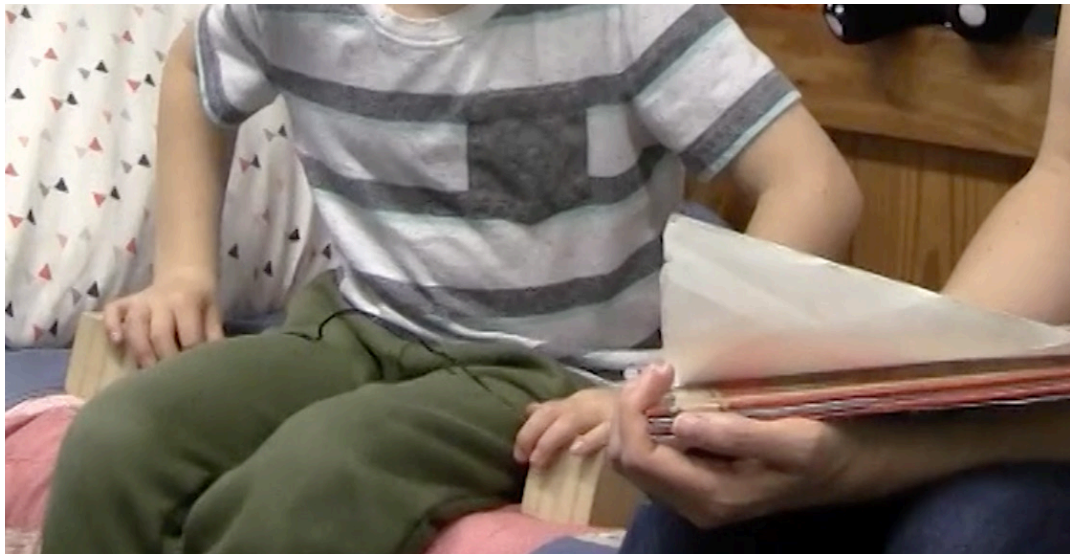


FIGURE 3.14:

(Below) Child uses character pieces to act out what is happening in the story on the location swatches.

Susan begins to read Hedgie's Surprise. While she reads, Mackenzie uses her character pieces to act out what is happening in the story on the location swatches. When Henny or Hedgie go to different settings in the illustrations, but the book's text does not specify that they have moved, Susan tells Mackenzie so that she can put them in the right location.





When Susan reads that Hedgie plans to trick another character by hiding an object in Henny's nest, Mackenzie uses her character pieces to conceptualize the potential outcome rather than closely examining picture clues. She is pleased when she accurately predicts what Hedgie has hidden.

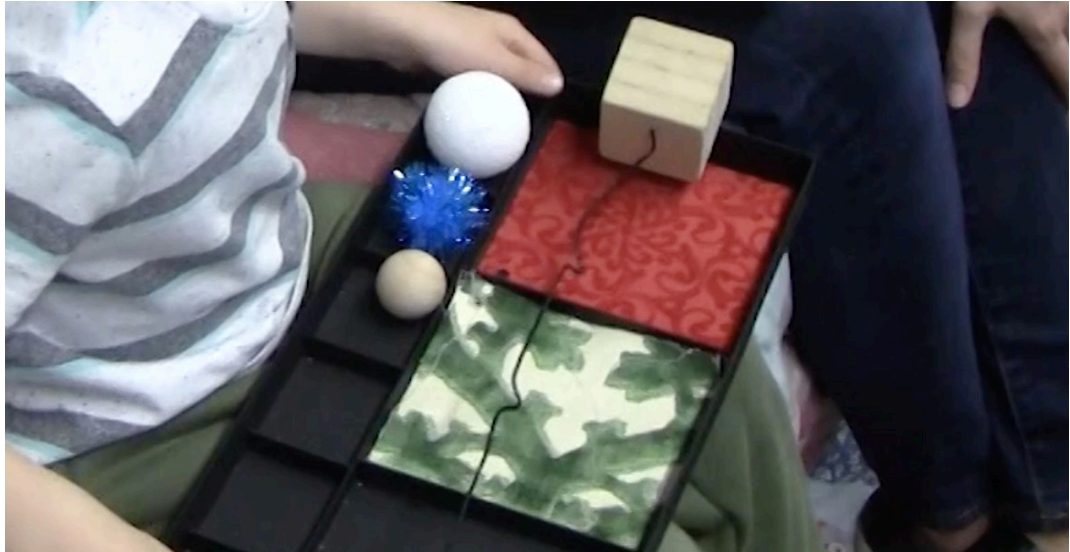
FIGURE 3.15:
(Above) Child uses character objects to predict what will happen next in the picture books.

FIGURE 3.16:

(Below) After story time, child retraces wire to retell the plot.

After Susan finishes reading the book, she asks Mackenzie to trace the wire again while retelling the story from the beginning, to the middle, to the end. Mackenzie repeats all the major plot points in the right order, demonstrating that she comprehends the literature.





Susan is tired from traveling all day. Even though they have time to read another book, she encourages Mackenzie to continue playing with these character objects and location swatches to create her own adventures. Mackenzie is happy to keep using the toolkit.

FIGURE 3.17:

(Above) Child continues to play with character objects and location swatches to create her own adventures.

PART 4:

DISCUSSION

CONCLUSIONS

Over the course of this investigation, I developed a set of scalable tools that children with visual impairments and their parents can apply to existing picture books to make them accessible. Substantial research and exploration led me to the following conclusions, all of which I believe could help other accessibility designers:

The Toolkit is a Functional System

Producing toolkit components as separate entities (like plot, settings, and characters) can be helpful when iterating on similar concepts, but designers must ensure that those components work together to help children and parents conceptualize picture books in real-world scenarios.

The toolkit should be a functional system rather than an assortment of individually functional parts.

Simplicity is Often Key

While children and parents can co-create their reading experience, they should not have to customize their own character and setting representations. Doing so takes emphasis away from story time and places it on character design. Additionally, creating a wide range of customization options for a specific representational form is time-consuming and impractical, especially when the designer has no guarantee that a child will interpret that specific form as intended. A person might be a person; it might also be a rock. **Simple, abstract forms (like spheres and fabric swatches) can represent a much wider range of picture book characters and settings.**

Representational Fidelity does not Mean Realism

While children with visual impairments first need to experience an object to understand its properties, they can then conceptualize that object as a more abstract form. For example, children who have met a dog might use its texture or size to justify choosing a particular representational object. **As long as children can draw a connection between an object and a character or setting, that object holds representational fidelity.**

Always Maintain Spatial Awareness

Designers should consider where children with visual impairments will use certain materials. Spherical objects easily roll away, even on a flat surface. If a child is holding multiple character forms and puts one down, she can lose track of its location and disrupt story time to search for it. **Giving children a designated, contained area to place specific objects helps them take characters in and out of scenes, conceptualize locations and their proximity to each other, and stay involved in the reading experience.**

Some Elements Might be Changed in Translation

Designers should note that they are developing new methods for facilitating a picture book's benefits; this does not mean developing accessible illustrations. Some picture book elements and functionalities will change and that is not a failure of translation. For example, artists bring their own styles to picture book imagery, variations that are difficult for readers with visual impairments to conceptualize. Thus, this investigation does not attempt to directly translate stylistic differences. Similarly, picture book illustrations remain the same, while the scenes children build with this toolkit are different each time they read a story. **This toolkit should enhance children with visual impairments' reading experiences, not recreate sighted children's experiences for them.**

FUTURE WORK

This investigation is by no means complete. My research questions explore a specific context in a complex problem space full of opportunities for continued exploration and design intervention.

Continued Usability Testing

While the initial user tests I conducted helped me refine the prototype and improve its overall functionality, having children with visual impairments test this toolkit is an absolutely necessary next step. Designers can often overlook people with disabilities in the creative process, assuming that we accurately empathize with their respective needs. This is not human-centered or inclusive design. As a sighted designer, I cannot assume anything about my users' experiences; I need their insights and expertise to know what is a viable solution and how best to address accessibility issues. Ideally, usability tests would involve children with visual impairments and their parents reading multiple picture books together to further gauge which components function and which do not, whether they can easily apply the kit to multiple picture books, and how well it facilitates literacy comprehension.

Expanded Demographic

I designed the toolkit components for preschool children with visual impairments to address their respective pain points and literacy development stages. The story wire, for example, represents an important early literacy construct — a story's progression from beginning to end. Still, teachers, accessibility experts and designers, alike, could adapt the materials for elementary and middle school children with low vision. Instead of conceptualizing illustrations, for example, students might break down key narrative elements using tactile and mobile representations for more advanced literary devices (like personification, similes, foreshadowing, symbolism, and metaphors). The wire is also a viable tool for older children, with or without disabilities. To understand a story's structure and progression, teachers often require students to map out plot progression. Bending the wire to indicate positive and negative narrative developments could help students grasp this concept through tactile manipulation.

Digital Component

My precedents' research led me to some excellent resources for parents of children with visual impairments. Sites, like Paths to Literacy, offer an online space for parents to share accessibility solutions and learn literacy techniques. Currently, this toolkit allows children to establish their own systems of meaning and then apply them to a range of picture books. Moving forward, a digital platform would help parents share the useful systems their children create with other families. They could upload pictures of the play area during story time or explain which forms their children tend to favor and why. Exchanging ideas might eventually inspire children to modify how they conceptualize picture books and use other representational forms or methods of object interaction. An online community would also help parents new to the toolkit familiarize themselves with its materials and discuss story reading strategies with experienced users.

Adding Accessibility Factors

My studies only focused on mobility and tactility as accessibility factors. Future explorations might consider how haptics or sound could enhance the toolkit's functionality. Perhaps the characters vibrate when they tap the play area or the locations swatches beep as children place them into their respective sections. Audible picture books also raise a series of possibilities, including how representational sounds factor into children's systems of meaning and whether or not they must correlate with the object that makes that noise in real life.

Creating for accessibility encourages designers to explore beyond the scope of existing solutions, to work with end-users as they bring their expertise to the design process. My research, explorations, and conclusions have only placed the partial groundwork for continued investigation. Moving forward, designers and accessibility experts can, and should, build upon these observations. I view picture book accessibility for those with visual impairments as a problem space with the potential and need for interdisciplinary involvement. By teaming with users and designers with visual impairments; accessibility experts and instructors; and industrial and graphic designers, this toolkit could become a viable solution.

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APPENDICES

DEFINITION OF TERMS

Co-Design Process: Where the individuals who will eventually use a solution play a role in its knowledge development, idea generation, and concept development (Sanders & Stappers, 2013).

Design toolkits: A curated collection of materials that end-users utilize to generate ideas and potential solutions for a design problem (Sanders & Stappers, 2013).

Literacy comprehension: The ability to process a book's contents and recall those contents (Fang, 1996; Strouse et al., 2018).

Mobility: The ability to move easily. In this context, the ease with which an individual can move or manipulate an object.

Parent-child interactive story reading: A means of supporting children's literary comprehension. When parents direct their children's attention and understanding during read aloud sessions by interacting with the story (Greenhoot et al., 2014; Strouse et al., 2018).

Picture books: Books where illustrations tell the reader the story rather than provide supplementary support to written words (Shulevitz, 1985).

Representational Fidelity: A representation that includes an event's essential elements and improves an individual's process of interpretation and ability to pass judgments (Norman, 1993).

Scalability: A system's ability to adapt and manage an increased range or volume of tasks.

Tactility: Responsiveness to the sensation of touch. In this context, how an individual gains meaning through touch.

APPENDICES

User-Sensitive Inclusive Design: A methodology where designers effectively include people with disabilities in the design process (Newell & Gregor, 2001).

Visual impairments: A range of vision functionality where an individual's eyesight cannot be modified through glasses, prescription lenses, or medical treatment (Bishop, 1991; Duffy, 2018).

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