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TACTILE TEXTS:

A MULTISENSORY STORYBOOK GAME FOR REIMAGINING READING THROUGH MATERIAL AND COLLABORATIVE PLAY

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Abstract

This paper describes *Shadow Castle*, a two-player interactive storybook game that blends digital projection with tactile materials to engage players in narrative exploration. Developed as an arts-based intervention, the game supports aliterate learners – those who *can* read but don't *want* to – by reimagining reading as a self-driven yet collaborative process rooted in play and imagination.

In the game, two players progress through a fairytale-inspired world using a collaged fabric book constructed with conductive materials, as well as a companion tablet. Touch-based interactions reminiscent of touch-and-feel storybooks activate hidden story elements, trigger animations from an overhead projector, and reveal additional pieces of narrative. This multisensory structure reframes reading as an active, process-based social experience, concepts that align with the core principles of intrinsic motivation.

The development of *Shadow Castle* was shaped by co-design sessions with university students, who explored their emotional and symbolic associations to fabric through playful activities. These sessions investigated how physical materials shape understanding, offering valuable insight into how learners might connect more deeply with story when multiple senses are involved. Insights from these sessions directly informed the book's material design.

This paper outlines the game's design process, technical implementation, and early playtest feedback, while also reflecting on how its creation shaped the author's evolving artistic practice. By merging craft, technology, and storytelling, *Shadow Castle* explores how multimodal, participatory design can open new pathways into reading, particularly for those who have felt excluded or disinterested in traditional text-based approaches.

Keywords: Aliteracy, reading motivation, narrative games, interactive storybook, literacy engagement, textile arts, playful reading

Introduction

Many of us have experienced a time when we were told to read a book but couldn't bring ourselves to open the page. For some, this disinterest is temporary; for others, it is a pervasive issue that continually prevents them from engaging with text. This reluctance is known as aliteracy, which is the technical ability to read but the lack of motivation to do so. This lack of intrinsic engagement is crucial; students who *want* to pick up books tend do so more often with deeper internalization, resulting in higher literacy scores, academic performance, and vocational outcomes (Park, 2011; Merga, 2016). In turn, feeling competent builds positive self-perception and well-being, resulting in higher engagement and value in reading (Vaknin-Nusbaum & Tuckwiller, 2023).

Despite the importance of wanting to read, a growing number of students, including young adults, are spending less time reading for pleasure (De Naeghel, 2016; Chong, 2016). This concern has intensified due to COVID-19 disruptions and the rise of scripted, rigid educational models that are described as 'mind-numbingly boring' (Parsons & Erickson, 2024). Arts-based literacy practices offer promising alternatives to how we define and structure reading, moving away from skill-based measures to techniques that invite agency, physical embodiment, and multiple modes beyond written words. These approaches are particularly relevant today, as the rise of digital interfaces reshape how readers access, process, and build knowledge in non-linear, multi-sensory ways (Mills et al., 2023).

Educational games can likewise foster personal engagement by offering structured yet flexible environments where learners can explore identity, develop skills, experiment and receive feedback, and form social connections (Cruz et al., 2017; Rapp, 2017). These motivational affordances not only improve comprehension, but shift learning away from rigid measures of 'right' or 'wrong', prioritizing self-generated knowledge that emerges as players think critically and creatively to explore and solve problems (Mills et al., 2023). These qualities make games a compelling platform for rethinking what it means to read and engage with stories.

However, few studies explore the intersection of game design and aliteracy, and even fewer examine how arts-based practices might deepen these connections. In an OpenAlex database search, there were 4,504 articles published in 2024 on the topic of educational games and gamification. Of these, only 3% include the keyword 'reading' or 'literacy' in the title or abstract (not including 'digital literacy'), and only 8 also included the keyword 'art'. This paper addresses that gap by examining how games and arts-based strategies can combine to make reading more active, expressive, and socially connected. The result of this inquiry is *Shadow Castle*, a two-player hybrid game that takes the form of a fabric storybook embedded with conductive, interactive materials alongside a companion tablet. Rooted in multimodal semiotics, the game combines tactile exploration, cooperative play, and embodied interactions to spark curiosity in narrative. The design of *Shadow Castle* also investigates how fabric can shape the emotional and cognitive dimensions reading and play.

Background

Aliteracy and motivation

Unlike *il*literacy, which is based in skill, *a*literacy is rooted in affective, perceptual, and motivational barriers. These challenges have intensified in the wake of COVID-19-era educational disruptions, shifts to remote instruction, and rising rates of screen-based leisure activities (Ludewig et al., 2022). These conditions have made it harder for students to sustain their attention and move beyond shallow processing, especially when reading on digital devices where scrolling, multitasking, and jumping between informational sources are habitual (Liao et al., 2024).

At the same time, educational policy has increasingly emphasized mandates centered in the science of reading. Though this body of knowledge is essential, its implementation often neglects the critical role of motivation, resulting in scripted, skill-centric curricula that prioritizes linear, print-centric texts (Parsons & Erickson, 2024). When reading is framed as passive, irrelevant, and full of judgement, learners feel bored and limited in their ability to express themselves (McGlynn-Stewart et al., 2017). These concerns extend into higher education, where undergraduates report feeling dissociated from reading due to the volume and nature of required texts, often reading the bare minimum to meet expectations (Chong, 2016).

Self-Determination Theory (SDT) offers a helpful lens for these dynamics. According to SDT, intrinsic motivation emerges when learning environments support autonomy, competence, and social relatedness (Ryan & Deci, 2000). Readers who select texts that align with their interests, develop positive self-beliefs, and use literacies to express themselves to their peers experience higher skill growth and an increased desire to continue reading (Toste & Didion, 2020; Erickson, 2019). In this way, motivation and reading achievement reinforce each other; as engagement rises, so do well-being and enjoyment (Howard et al., 2021). Studies with college students reflect this same reciprocal relationship between motivation and reading outcomes (Cartwright et al., 2020). These insights frame aliteracy as an issue of agency, affect, and identity rather than lack of technical skill.

Analog and digital arts-based literacy practices in the reading classroom

Arts-based literacy approaches challenge narrow definitions of reading by offering multimodal, active, and social pathways into narrative. One example is dialogic storytime, in which students ask questions, offer interpretations, and imagine new parts of the story as they listen (Albright et al., 2009). This parallel dynamic increases participation, supports content processing, and fosters a deeper sense of belonging as learners feel their contributions are appreciated (Yousefi & Mirkhezri, 2019; Diamant-Cohen, 2007; Koulouris & Dimaraki, 2014). These benefits persist across in-person and digital formats, even with virtual agents, as long as conversational turn-taking and modeling still occur (Xu et al., 2021).

Collage is another promising tool for literacy engagement. Its low-stakes, open-ended nature removes fear of artistic judgement and self-criticism, creating a therapeutic space for learners to freely explore meaning and metaphor (Raffaelli & Harzell, 2016). This results in a heightened sense of affect, self-efficacy, creative agency, and mental and emotional health (Kaimal et al., 2017; Williams, 2002). In classroom

contexts, collage helps disengaged readers strengthen their ability to visualize, recall, and relate to narrative elements, while also validating their creative interpretations as legitimate forms of literacy (Wilhelm, 1995).

Digital composition platforms extend these principles by enabling readers to create multimodal narratives through images, text, sound, gesture, and spatial design (Axelrod & Kahn, 2023). Development projects such as visual novels, animation, and comic books allow students to draw on familiar technologies – including mobile apps, social media platforms, and creative software – as they create and interpret narrative in personally meaningful ways. These creative environments reflect how contemporary readers make sense of non-linear, multimodal, multisensory, interconnected texts (Kells et al., 2023).

Semiotic meaning-making and our relationship to material

Collage naturally bridges arts-based practice and semiotic theory, which examines how meaning emerges from multimodal signs, cues, and socially shared systems (Siegel, 2006). As an artform that relies on found materials, collage requires makers to move through a complex process of association and abstraction as they arrange images, textures, and symbols to communicate ideas (Chilton & Scotti, 2014). Material Engagement Theory (MET) extends this perspective by arguing that materials are not merely carriers of meaning but active participants. According to MET, meaning emerges *through* the act of engaging with objects (Malafouris, 2013). Related research demonstrates how thinking-through-material generates a conversational relationship between body and form, stimulating agency, memory, and imagination in ways that are not possible through mental abstraction alone (O'Brien et al., 2025).

Fabric offers an interesting example of this embodied form of meaning-making. Due to the tactile, aesthetic, and symbolic richness of fabric, it invites unique forms of subjective exploration through texture, weight, temperature, movement, and other sensory properties (Atkinson et al., 2017). In works such as *Fabric with Feeling* (Subramaniam, 2023), the physical interface of the story doesn't just contain narrative, it becomes the narrative through its materiality. The fabric storybook's folds, stitches, textures, weight, and sheen shape the construction of the story and how it is experienced. Fabric, in this view, provides opportunities for narrative construction that linear text cannot, making it a compelling medium for interactive storytelling that is felt as much as read.

Games and interactivity as literacy tools

Game-based learning leverages many of the same motivational strengths underlying arts-based literacy, situating them within interactive systems that further support intrinsic motivation. Well-designed games mirror effective teaching practices, encouraging exploratory learning, scaffolding skill growth, and empowering players to express their evolving identities with others (Rapp, 2017; Simões et al., 2013). When learners are placed in these playful experiences, they are more likely to become invested in the experience and internalize its value. However, concerns about digital reading complicate this potential. Digital texts are often perceived as entertainment, causing readers to skim for the 'gist' with less attention, effort, and self-regulation (Liao et al., 2024).

Additionally, cognitive load can increase when too many sensory features compete for attention, or when incongruent effects and interactions fragment story coherence and attention (Schugar et al., 2013).

Despite these cautions, games and interactive features can strengthen reading when integrated intentionally. Interactions that align with and reinforce narrative and comprehension goals enhance learning (Barzillai et al., 2018). Similarly, high-level interactions that dynamically respond to user behavior can improve motivation, comprehension, content knowledge, and internalization of the story (Kao et al., 2016). When combined with insights from MET and embodied learning, these findings suggest that digital environments that incorporate meaningful gesture, responsive interaction, and/or tactile materiality can counter shallow processing by anchoring attention and meaning in haptic and sensory engagement.

Methodology & Design Process

This project explores how arts-based strategies, such as dialogic reading, collage, digital interactions, and material exploration can be combined with the motivational affordances of games to help hesitant readers rediscover joy in stories. Central to this inquiry is *Shadow Castle*, a two-player interactive storybook game designed and refined through practice-led research, iterative playtesting, and co-design activities.

Research approach

This study is grounded in practice-based research and research through design, methodologies well suited for exploring 'wicked problems' that are too complex to be solved through linear approaches (Buchanan, 1992). These design methods argue against a singular, final solution, instead prioritizing the generative insights that emerge through the iterative process of creative experimentation and making (Skains, 2018). As such, *Shadow Castle* isn't a solution to aliteracy, it is a mode of inquiry to examine how form, play, and interactivity influence narrative engagement.

This study also integrates co-design, a participatory methodology in which end users are actively involved throughout the design process. Co-design recognizes that designers alone cannot fully anticipate the values, experiences, or emotional responses of users. Instead, it invites participants to collaborate and provide personal insight through generative activities (Sanders & Stappers, 2008). In this project, co-design sessions revealed how college-age participants interpreted different fabrics through emotional and semiotic associations, insights that directly informed the material language of the book.

Design Process

Concept development

Initial stages of design explored how physical books might operate as interactive interfaces that support multimodal, embodied forms of literacy in ways not possible with traditional paper. Prior work on touch-and-feel storybooks (Simon and Shuster, n.d.), sensory books for visually impaired readers (Edirisinghe et al., 2022; Kim & Yeh, 2015), and hybrid physical-digital systems (Posch, 2021; Stark et al., 2023) demonstrated how books can function as controllers and

sensory interfaces that invite exploratory interaction. They also illustrate how tactile materiality can be integrated into a storybook's construction to help readers build comprehension through multisensory engagement.

Demographic

The game was designed for college-age students, as research indicates that aliteracy remains a significant issue in higher education. Designing for this age group allowed the project to focus on the motivational, affective, and semiotic dimensions of narrative engagement rather than foundational reading skills. College students were also well-positioned to participate in the project's co-design sessions due to their ability to articulate their sensory and symbolic association with fabric. Practically, their accessibility within the researcher's academic environment enabled multiple rounds of iterative testing.

Narrative & design

Development began with narrative structure to ensure that interactive elements meaningfully supported story progression. The novella *Shadow Castle* (Cockrell, 1945) was chosen as inspiration due to its fantastical plot and all-ages appeal. The opening chapters of the story – leaving home, beginning an adventure with a new friend, and facing the fear of the unknown together – were adapted into storyboards that translated the narrative into actions for two players. This process helped identity opportunities for meaningful interaction and digital effects that propelled the story forward rather than detracting from its narrative arc.

Early prototypes and playtesting

Iterative playtesting occurred throughout the design process. Early prototypes made from paper and cardboard were tested with individual volunteers to assess clarity of instructions, balance between player roles, and cognitive and physical demands. These sessions were informal and qualitative, using observation and conversational debriefs to determine how players interpreted the story, navigated multimodal cues, and collaborated across different interfaces. Each cycle of feedback informed revisions to the narrative structure, page layout, interaction design, and instructions. As the game's physical and technical complexity increased, additional playtests examined the feasibility of conductive materials and sensors.

Co-design activity

To gain insight into how material can shape narrative perception, the next phase involved a co-design activity designed to investigate the semiotic associations players bring to fabric and texture, allowing the author to use those shared associations to guide the selection of materials for the finalized version of storybook.

The co-design sessions involved approximately 40 students enrolled in interdisciplinary arts and technology courses at a midwestern U.S. university, including undergraduates learning about physical controllers and graduates exploring how to combine digital sensors with traditional craft. Participants ranged from sophomore undergraduates to second-year master's students; 57% identified as male. This population

aligned with the intended audience for *Shadow Castle* and possessed basic, introductory experience with material and interactive technologies.

Each class participated in one 75-minute session in their regular classroom, which were decorated with a large range of fabric swatches selected for their diverse properties. With consent, audio recorders captured natural and guided conversation and photographs documented material choices and group interactions. The sections below briefly describe the generative activities.

Memory sharing and mystery object warmups

The co-design sessions began with a series of small activities to ease students into exploring tactile association and sensory perception. First, participants were divided into pairs and asked to share specific memories related to fabric, which they were then invited to share with the class. Next, one partner held a small, mystery object in their hand that they analyzed through touch and described for their partner to draw. Many participants described their objects through analogies, such as comparing plastic fringe to a pine tree or a rough ribbon to birthday balloons. The partners then switched roles.

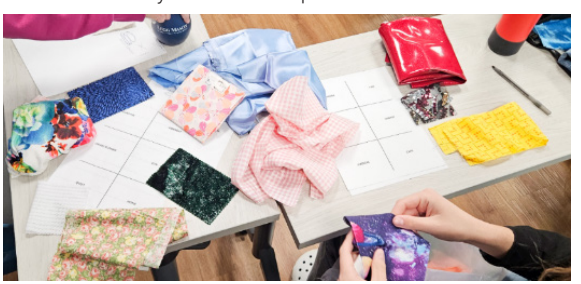

Figure 1 Students collecting fabric swatches based on scavenger hunt list

When they were finished, participants were allowed to view their objects, triggering enjoyable surprise. Though these activities were documented, they were intended as warm-ups and did not inform the project's design.

Solo scavenger hunt

Participants received worksheets listing six words related to an emotion, setting, or sensation – such as 'nature,' 'curiosity', or 'other-worldly' – that correlated with the thematic elements of the storybook game. Their task was to collect swatches from around the room that best related to each word (Figure 1). After students completed their scavenger hunt, they were divided into two groups to discuss. At this stage, it was revealed that multiple students had identical worksheets.

Students used a range of senses to explain their fabric selections, including texture, weight, flexibility, color, and pattern, as well as personal associations. As they talked, they chose to display their swatches or pass them around for others to play with and experience. Duplicate lists added a social dynamic that heightened engagement and reflection. Upon learning they had the same words, students naturally wanted to go back and forth between their selections, finding enjoyment in the act of comparison. Some students vocalized that they wished they had challenged themselves to think more deeply when their conclusions were too easy or obvious compared to their partner's.

Selected fabrics were later analyzed to document their properties and audio recordings of the groups' conversations were transcribed and examined to identify key descriptors and associations (Table 1).

Word	**Measures**	**Session 1 partner 1**	**Session 1 partner 2**	**Session 1 partner 3**	**Session 2 partner 1**	**Session 2 partner 2**	**Session 2 partner 3**	**Session 2 partner 4**
Home	Observed: Material Color Print Weight Texture Transcribed: Associations	Cotton / pastel pink / floral / medium / soft matte Kitchen table, timeless	*Denim / medium blue / distressed / lightweight / soft matte Dad's jean jacket	Cotton / green, pink, yellow / floral / medium / soft matte Color scheme of house, homemade	*Cotton / white and silver / metallic floral / heavy / embossed -	Satin / red / jacquard / medium / embossed	Faux wood / tan / solid / lightweight / smooth matte Material of house	*Faux fur / pink, blue, yellow / abstract ovals / heavy / smooth hair Warm, petting a cat
Comfort		Silk / Dusty pink / Floral Lightweight / Low gloss Cutscene in a game, soothing	Cotton / brown and tan / abstract strokes / medium / low gloss Grandma's couch, sleep	*Denim / medium blue / distressed / lightweight / soft matte Regular clothing	Satin / pink and white / checkered / lightweight / low gloss Picnic table, generic, fresh air, family and friends	Flannel / brown and tan / checkered / heavy / fuzzy Blanket, cardigan	Silk / medium blue / floral / lightweight / low gloss Grandma scarves	*Cotton / Tan, orange, black, white / Circular abstract / Medium weight / embroidered Nice stitching, old lady scarf
Magical		Tulle / Sheer white / Metallic stars / Lightweight / Crisp; stiff Texture/ color of fairy dust	*Cotton / white and silver / metallic floral / heavy / embossed Wizard's cloak, absurdly shiny	*Mesh / Baby pink / Solid Lightweight / Iridescent Glitter, princess costume, costume fairy wings	*Cotton / blue and purple / solar system / medium / smooth matte Mermaid purse	*Faux fur / pink, blue, yellow / abstract ovals / heavy / smooth hair Fantastical creature	*Cotton / blue and purple / solar system / medium / smooth matte -	Netting / white / solid / lightweight / flimsy with holes Magical spell, broken glyphs
Fire		Paper / Tan / Metallic orange speckle / Lightweight / Stiff; rough Ember, matchbox	Gauze / brown and black / abstract splotches / lightweight / rough Burned wood, ash	Faux fur / brown and black / cheetah / heavy / smooth hair Ash	Vinyl / cherry red / metallic sparkle / heavy / high gloss Expensive, bold	Velvet / deep red / solid / heavy / low gloss Vibrant, color of fire	Satin / burnt orange / solid / lightweight / low gloss Fashion, bold	Cotton / medium red / jacquard / medium / embossed Sound of crackling fire
Uneasy		*Cotton / Tan, orange, black, white / Circular abstract / Medium weight / embroidered Murky, cursed, dirty	Mesh / gold / metallic / lightweight / rough and flimsy Repulsive, trypophobia	Upholstery / tan / metallic lines / heavy / embossed Inconsistent stitches, off-putting	Mesh / black, red, gold / abstract / lightweight / embroidered sequins Wearing would cut skin, lack of durability	-	Mesh / metallic gold / solid / lightweight / rough Confusing texture, curtain, worn down rug	Lace / black / floral / lightweight / scratchy Stressful, dragon, uncomfortable
Cute		*Mesh / Baby pink / Solid Lightweight / Iridescent Pink is the color of cute	*Faux fur / pink, blue, yellow / abstract ovals / heavy / smooth hair Fluffy, petting a dog, pet safe dye	Chiffon / baby pink / floral / lightweight / embossed and rough Cute dresses, fancy desserts	Cotton / yellow and orange / domino dots / medium / smooth matte Silly, playful	Cotton / white and brown / metallic floral / medium / smooth -	Cotton / white, yellow, green / floral / medium / smooth matte -	Canvas / baby pink / floral / medium / smooth matte Flower garden

Table 1 Material choices of participants with the same worksheet during the solo scavenger hunt. Fabrics that appear in multiple selections are marked with an *.

For each word on the worksheets, properties and descriptors were compared to identify overlapping similarities between student selections. When multiple participants selected fabrics with similar qualities or rationales, this was interpreted as an indication of shared semiotic association. The degree of overlap served as evidence of how consistently certain material features were linked to particular concepts. Although insights from the group scavenger hunt played a primary role in shaping the project's design, patterns that emerged from this stage served as secondary guidance in determining compositional elements of the storybook.

Group scavenger hunt

Participants then self-organized into four teams based on which prompt they wanted to explore: playful and curious, fantasy and wonder, hidden and danger, or peaceful and calm. These prompts related to the narrative theme of each storybook page. Teams collected 5-10 swatches that reflected the emotion of their scene and presented their collection to the class (Figure 2).

Figure 2 Students presenting their fabric collection for the 'playful and curious' prompt

The group structure gave students the opportunity to discuss their thinking as they worked through material choices, allowing them to share, debate, and influence their associations amongst themselves before explaining their reasoning to the class. Fabric selections and presentations were documented

Figure 3 Co-design fabrics that portray 'playful and curious.' Left: co-design 1 students chose bright colors with watercolor-like qualities that reminded them of children's coloring books, swatches with surprising sensations, and fur because cats are curious and wild. Right: co-design 2 students also chose bright colors for child-like qualities, plus space, stars, and iridescent fabrics because children play/dream of these things. The bubble wrap invites touch.

Figure 4 Scene 1 environment, composed of bright colors with painterly strokes and a variety of textures that are fun to touch. Starry sky is revealed through interaction (see Figure 14)

and labeled in the same manner as the individual scavenger hunt. Interestingly, there was a significant degree of overlap between groups with the same prompt. These similarities most directly influenced the final design of the storybook's material language. Figures 3-6 summarize the results of two co-design prompts and how they informed their corresponding collage scene.

Figure 5 Co-design fabrics that portray 'fantasy and wonder.' Students in both sessions chose similar associations and duplicate fabric. Iridescent swatches reminded them of magical things like unicorn horns, fairy wings, and spells. Purple hues were attributed to royal princesses and silver metallics to brave nights. Green represented either an enchanted forest or the emerald city.

Figure 6 Scene 3 environment, composed of an emerald green forest and royal purples. Waterfall includes layers of glossy and iridescent fabric. Hidden magic and fairies are revealed through interaction (see Figure 16).

Project Description

Shadow Castle is a hybrid storybook game that combines interactive materials, digital projection, and cooperative gameplay to create a shared, exploratory reading experience for two players. Loosely inspired by a children's fairytale of the same name, the book is constructed from collaged paper and fabric and embedded with hidden conductive sensors. As the first player explores the physical pages, their touch activates digital responses and animations from an overhead projector. Meanwhile, the second player leverages unique abilities via a companion tablet. This dual-interface structure is designed to encourage verbal collaboration and joint problem-solving. The book's visual and tactile design acts as a critical element of the narrative, inviting players to make meaning through sensory and symbolic association.

The following sections describe the overall setup, form, and technology of *Shadow Castle* before diving deeper into gameplay.

Setup

Gameplay begins with two players choosing a role: control physical interactions via the book (Figures 7-8), or control digital ones via the tablet (Figure 9). Both interfaces are placed on lecterns facing each other. Each player is given a particular role based on their chosen interface and a unique set of accompanying skills. Player 1 acts as an omniscient guide for the main character Lucy, manipulating tactile elements and uncovering hidden elements to progress through the story.

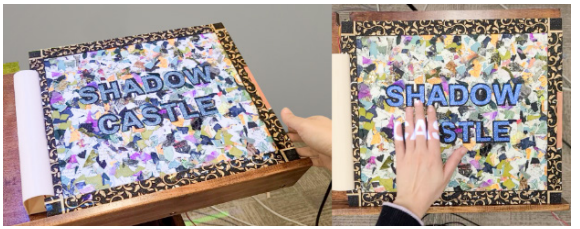

Figure 7 Front cover of storybook interface, with projected title. Early prototype from first beta playtest.

Figure 8 Player 1 interacting with tutorial level, with projected instructions. Early prototype from first beta playtest

Figure 9 Tutorial page of Player 2 tablet interface

Player 2 controls a lost shadow companion who helps Lucy overcome challenges through magic. This character can absorb keywords from text and turn them into actions, such as using the word 'light' to ignite torches in a dark cave. Players are introduced to their roles and abilities in a tutorial scene.

Despite their separate displays, the two players control the same game, moving through the story together. Physical and digital choices trigger shared animations and states that are displayed on the tablet and projected onto the storybook from overhead. This asymmetrical structure is meant to foster open dialogue, interpretation, and joint decision-making.

Form and material

Each two-page spread is dedicated to a particular scene and structured according to Figure 10. The tablet version shows one page of the spread at a time. When the pair is ready to progress, Player 1 simply turns the page, movement that is automatically detected by the system. Alternatively, Player 2 can 'turn the page' on the tablet.

Insights from the co-design sessions shaped the game's visual and material design. Participants' fabric associations were used to select the materials for each scene, organized around four moods: curiosity, fantasy, danger, and peace. These materials were arranged as a side-scroller environment, similar to platformer games, with layered foreground, backgrounds, and walking paths. Techniques found in touch-and-feel storybooks, such as pull tabs, sliders, and spinning wheels, were used to add interactive zones. Figures 3-6 in the Methodology show student-selected fabrics, their associations, and how these insights inform the final design of the page.

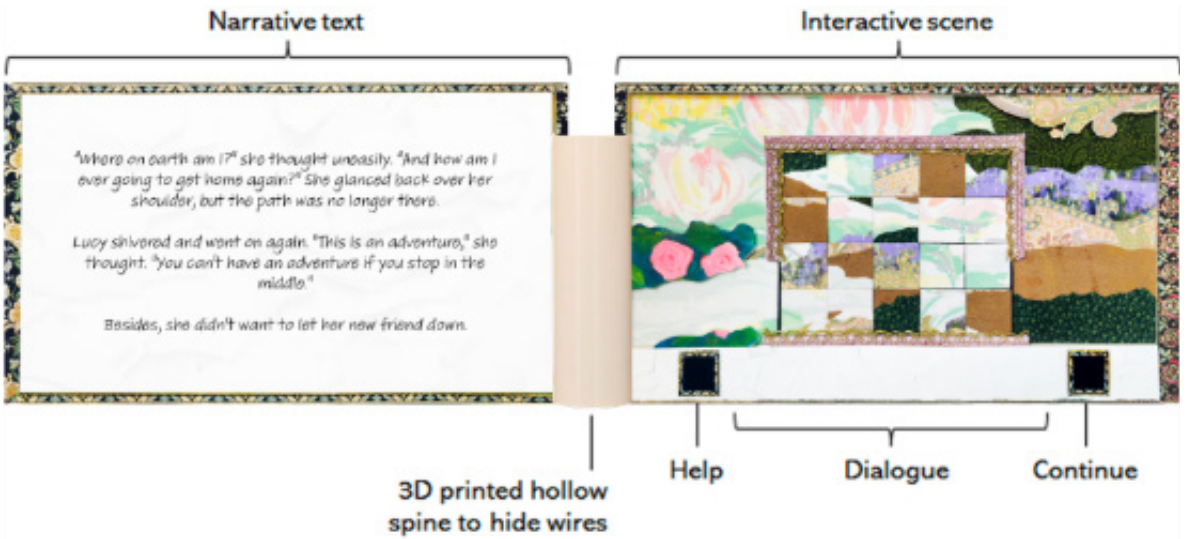

Figure 10 Page structure, with second narrative scene as reference. Digital mockup for clarity

Technology

Interaction is enabled through a Makey Makey microcontroller, which detects when conductive materials are pressed and maps each input to a designated keystroke (Figure 11). In other words, when you touch a conductive material, the Makey Makey interprets this as a particular button press, such as A, and sends this information to a computer via USB. The game running in Unity then responds to this input.

To support the use of the Makey Makey, conductive copper fabric and thread were embedded beneath moving elements and fused to thin wires nestled between the layers of the canvas and upholstery backing (Figure 12). These wires run through the hollow spine of the book and are then connected to the Makey Makey hidden behind the podium (Figure 13). Because these conductive elements are hidden behind surfaces, the player doesn't touch them directly. Instead, players move disconnected pathways together to create a complete, closed circuit that the Makey Makey interprets as a button press. This concealed circuitry enhances surprise by making interactions feel organic to the material page rather than technological in origin. It also supports embodied cognition by aligning physical gesture with narrative progression.

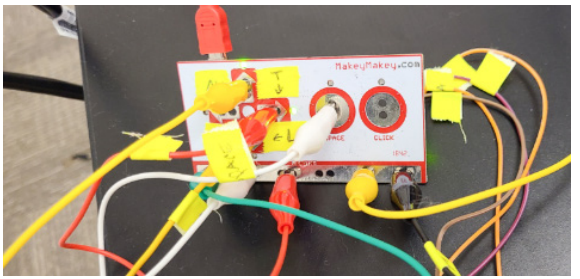

Figure 11 The front view of a Makey-Makey, with tape marking new keystroke mappings

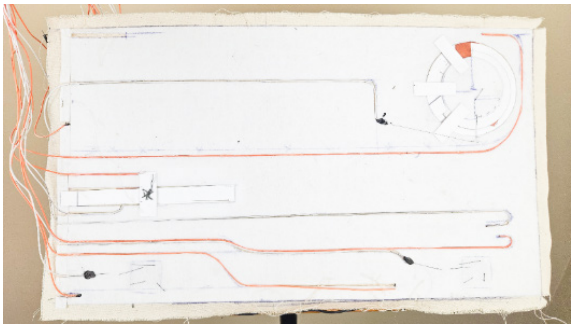

Figure 12 Backside of scene 1 with Makey Makey wires and conductive materials. Process picture.

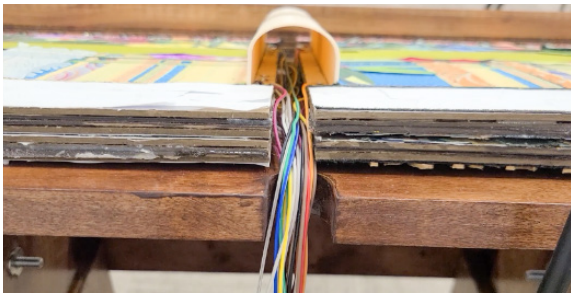

Figure 13 Makey Makey wires running to the edge of the page, into the hollow spine, and behind the podium. Early prototype from first beta playtest.

Gameplay

Gameplay unfolds across six chapters, each represented by a two-page spread. Each chapter begins with an animated scene to settle players into the world, describe the main story, and give players their tasks to help Lucy and her shadow friend. The way to fulfill these goals is not outlined. Instead, players must explore and experiment, discovering the answers through trial, error, and surprise – though there is a help button just in case. Though both players have unique inputs and interactions, meaningful progression requires them to work together.

Scene 1

Lucy wanders too far from her grandmother's house, looking for adventure. While exploring, she meets a strange, flying creature who looks like a small black ball. Shadow – a fitting nickname – asks for help finding its way home.

Task: Find the magic tunnel that leads toward home beneath a strange pile of bushes.

Player 1 actions (Figure 14): pull a flower to reveal story text, unfold origami butterflies to reveal an illustration of Lucy and story text, lift a bush to find a herd of cows, rotate a bird to reveal a starry night sky.

Figure 14 Detailed view of Player 1 interactions in scene 1 (full scene shown in Figure 4)

Player 2 actions: absorb the word 'find' to scan the area for clues and story text; locate hidden branch pieces in the cow pasture, night sky, and behind a tree.

Scene 2

Things look a little strange and confusing on the other side of the tunnel, making it difficult for Lucy and Shadow to find the right path.

Task: Solve a 20-piece tile puzzle to set the scene straight

Player 1 actions: reposition magnetic tiles in the correct position

Player 2 actions (Figure 15): absorb the word 'settle' to dampen the uneasy, wave-like visual effects distracting the other player.

Figure 15 Detailed view of Player 2 interactions in scene 2 (full scene shown in Figure 10)

Scene 3

The pair follow the path and enter a fairytale forest full of surprise – including a raging waterfall with a broken bridge.

Task: Clear the rubble and repair the broken bridge.

Player 1 actions (Figure 16): push boulders to the side, slide wood pieces into place, pull flowers to reveal story text, lift a

Figure 16 Detailed view of Player 1 interactions in scene 3 (full scene shown in Figure 6)

spiderweb to find dancing fairies, pull a bee's wings to turn to a fairy.

Player 2 actions: equip the word 'find' to spot odd creatures holding story text, equip the word 'settle' to slow the raging current for safe crossing.

Scene 4

The forest begins to darken as the pair approach a foreboding cave.

Task: None; players can proceed when they are ready

Player 1 actions: turn signs around to reveal hidden warnings, lift rocks to discover large paw prints, part branches to reveal watching eyes.

Figure 17 Detailed view of Player 2 interactions in scene 4

Player 2 actions (Figure 17): equip the word 'find' to gather tufts of a creature's fur, equip the word 'settle' to calm the raging breeze coming from the cave, absorb the word 'light' to see into the cave's entrance.

Scene 5

The pair enters the dark and spooky cave. Though they can hardly see their own footsteps, they sense a dangerous presence coming closer.

Task: Illuminate the cave to allow escape and stop the monster's pursuit.

Player 1 actions (Figure 18): fold back layers of sheer fabric covering the scene, pull and secure stalactites to block the monster's way, lift dark spiderwebs to find remains of unfortunate travelers.

Player 2 actions: equip the word 'find' to locate hidden torches, equip the word 'settle' to help Lucy find the confidence to jump over stalagmites, equip the word 'light' to ignite the torches.

Scene 6

The pair narrowly escape the cave in time, finding themselves in a dreamy landscape full of rolling hills. Shadow remembers this place; they're home! But there's something missing …

Figure 18 Detailed view of Player 1 interactions in scene 5

Task: Cast a spell to reveal the magical Shadow Castle.

Player 1 actions: lift flowers and bushes to find ingredients for the spell.

Player 2 actions (Figure 19): equip the word 'find' to locate additional spell ingredients, equip the word 'light' to brew ingredients together.

Game Complete.

As Lucy stared through the clear, unearthly light in a kind of dreamy wonder, she saw – a castle!

Playtest Results & Discussion

The following insights are drawn from informal playtests conducted with approximately 16 college students and adults during two public game events. These sessions were not designed as formal user studies. Feedback emerged through direct observation, casual post-game conversations, and brief follow-up interviews with interested participants. The first session used an earlier beta version of the storybook (Figures 7-8) that led to meaningful revisions in the current prototype. Most participants played with a friend or peer, though the author stepped in as the second player when needed.

Collaboration and shared play

Players consistently responded positively to the cooperative structure of *Shadow Castle*. In the initial prototype, both players shared a singular storybook interface, though one still controlled physical interactions while the other controlled the shadow companion projected onto the page. Though the intention was to foster simultaneous play, players took turns instead, pausing to watch each other's discoveries. When asked about this, players stated that they didn't want to miss

what the other player was doing, a sign of curiosity, but one that didn't support the intended pacing.

To address this, the interface was separated into a storybook and a separate tablet with its own set of abilities. This resulted in a noticeable increase in communication and gave players a sense of permission to engage in the game at the same time. After playing, participants described feeling a bond with their partner and said they enjoyed the collaborative nature of the game. Many pairs switched sides after completing the game to better understand the other's interface. This curiosity and desire to understand their partner's experience suggests a strong sense of shared authorship.

These findings align with Self-Determination Theory's emphasis on relatedness, as well as suggest that hybrid interfaces can support collaborative meaning-making by encouraging players to articulate choices, negotiate interpretations, and rely on one another's strengths. This social configuration appeared to increase and sustain engagement.

Curiosity in form and reading

Shadow Castle's hybrid form enabled unique interactions that wouldn't be possible in purely digital or physical formats. The book's tactility and technology created an interface that was *part* of the story instead of just a shell to contain it. This unique physical-digital experience resulted in high levels of surprise in terms of how the game appeared in the room, how it physically felt, what could be moved and manipulated, and how it responded to touch. Because participants didn't know what to expect, even small discoveries like turning the page to trigger the next scene elicited joy. This curiosity increased their focus and engagement in the game.

The game's flexibility also supported different play styles, allowing players to engage in ways that matched their preferences, levels of comfort, and personal strengths. No two pairs played the game the same way. Some read all the text aloud, some read in silence, and others took turns. Some prioritized solving puzzles first while others preferred the process of discovering new narrative details. Some let their partner operate independently while others sought insight and suggestions. This agency allowed pairs to play on their own terms in ways that felt comfortable and meaningful for them.

Notably, players showed increased interest in narrative embedded within the fabric environment compared to longer expository text. In the first playtest, narrative passages appeared across the top of the page, paired with animations and dialogue in the same space, at the same time. Players felt this text was too boring compared to everything else and wanted to move past it to get to the 'fun' parts. In contrast, these players were highly interested in text hidden within the pages, stating that these elements felt more integrated with the narrative and more rewarding.

These observations are consistent with literature that emphasizes the importance of meaningful, related interactions that focus attention and integrate activity within the story. This feedback informed the redesign of the spatial elements of the scene, resulting in a clearer separation of exposition and action, as well as a better balance of multisensory elements.

Material meaning and co-design influence for players and artists

One of the most compelling takeaways from the co-design sessions was how readily participants connected to fabric through playful activities. Other studies in this space ask participants to rely only on touch as they assess fabric and assign data-driven descriptors (Atkinson et al., 2017; Xue et al., 2023). This study, however, welcomed visual senses and asked participants to assign material to given adjectives. This reverse approach resulted in a wider range of interpretations that allowed participants to think beyond surface traits. These sessions demonstrate core principles of semiotic meaning making and Material Engagement Theory, demonstrating how participants communicate with material to shape their interpretations and emotional responses.

A noteworthy outcome occurred among players who had also participated in the co-design activities. These students immediately recognized which page correlated to their scavenger hunt mood, and they could directly pinpoint how the book's fabric, color, and texture related to their choices. Seeing their ideas materialized this way elicited pride, excitement, and personal connection. Though their contributions had been interpreted through the lens of the designer, players still felt a deep sense of authorship with the book.

For the designer, this process of co-creation provided helpful, creative constraints. Rather than sorting through an overwhelming amount of creative materials, artistic decisions were limited to those that honored the participants' fabric associations. Individual aesthetic instinct was no longer the only consideration; instead, collaging required constant regard for participants, material, and future players. This collaboration shifted the maker's role from solitary artist to co-creative interpreter, requiring constant reflection on how tactile choices could convey meaning, story, and emotion. The iterative process of arranging and testing materials became a feedback loop between theory, design, and reflection, yielding insight that would not have emerged through conceptual thinking alone.

One unexpected challenge was the fact that players in the first playtest were hesitant to touch the book. They perceived it as too fragile or precious, fearing they might damage the handcrafted elements. According to player feedback, their hesitance was a reaction to the artistic quality of the book and wanting to protect the designer's work. Players suggested adjusting the tutorial instructions to more explicitly encourage playful touch.

Technology

Initially, players wore copper wrist and ankle bands connected to the Makey Makey to allow them to touch conductive materials directly. This proved cumbersome; wristbands got in the way visually and ankle bands led to frequent tripping hazards. In the updated version, the ground wires were embedded into the book itself. This redesign improved usability and contributed to players' sense of surprise and discovery.

The use of the Makey Makey introduced limitations that required rethinking definitions of autonomy. Because the system only registers on/off inputs on specific touchpoints, this prevented the system from responding to player input anywhere on the page. Game design literature often defines

autonomy as a sense of self-driven choice. However, in arts-based contexts, autonomy can also mean being guided by one's own curiosity and sense of wonder. Designing for this alternative definition meant privileging surprise and exploration over unbridled freedom of choice.

Summary

Player responses to *Shadow Castle* suggest that interactive, multimodal experiences can transform reading from something passive to something active and personally engaging. Participants described feeling pulled into the story due to the unexpected influence of their actions, encouraging them to consider narrative meaning in surprising ways alongside their peer. These dynamics suggest that reading experiences embedded in collaborative, sensory-rich play can support intrinsic motivation by creating space for curiosity, personal choice, and meaningful interaction with others. Rather than separating text from play, the game intertwines them, making narrative engagement feel spontaneous and meaningful. This approach offers an alternative way to engage hesitant readers by emphasizing enjoyment, participation, and a more expansive understanding of what it means to read. It also highlights how alternative physical interfaces can support deeper emotional engagement by centering sensory discovery and response.

Relationship to other works

Though *Shadow Castle* builds on prior work in tactile picture books (Edirisinghe et al., 2022; Kim & Yeh, 2015; Subramaniam, 2023), it differs from these projects due to its integration of gameplay, translating story elements into a procedural, playful experience informed by game design processes and principles. It also frames reading as a shared, two-player experience. The cooperative structure that requires partners to coordinate actions, interpret sensory cues together, and negotiate meaning introduces a relational dimension that is largely absent from related work and is particularly well-aligned with motivational theories emphasizing social connection.

The project also advances material-based storytelling by treating the entire page as a tactile and semiotic environment. Instead of framing a singular, isolated subject as the main point of interaction, *Shadow Castle* presents opportunities for tactile engagement across every element. It also fosters feelings and curiosity, discovery, and surprise due to its inclusion of hidden elements and implicit interactions, sensations that are not prominent in related tactile picture books. These features, which are in line with MET, encourage longer engagement and self-driven exploration.

Perhaps the most prominent distinction lies in the project's co-design methodology. Rather than selecting materials solely for aesthetic or functional reasons, the book's tactile language was shaped through participants' emotional and symbolic associations with fabric. Few interactive book studies incorporate this kind of collaborative meaning-making into their design process. As a result, *Shadow Castle* reflects not only theoretical principles of multimodality and semiotics but also the lived sensory interpretations of its participants – strengthening its contribution to research in literacy and materiality.

Limitations and Future Steps

While *Shadow Castle* produced promising insights, its evaluation was limited in scope. Although small-scale, informal playtests

offered valuable feedback that shaped the game's design, no formal assessment protocol was used to reach definitive conclusions about the game's educational impact or its effectiveness in supporting aliterate learners. Future evaluations should include survey instruments to better assess how the game effects players' attitudes toward reading, their emotional engagement, and their sense of agency. Tracking changes in self-perception and motivation before and after gameplay would allow for clearer analysis of the game's pedagogical potential.

The co-design process was conducted with university students who represent the game's intended audience, but findings from children's reading research were also used to frame the problem space. Additionally, this study did not specifically recruit individuals who identify as aliterate or reluctant readers. Future iterations could include additional age groups and specific reading profiles to examine how diverse learners interpret and benefit from material engagement.

Additional considerations include accessibility, cultural responsiveness, and sensory variation. While the co-design process helped mitigate some designer-imposed assumptions, a fuller scope of lived experiences would reveal more knowledge around diverse material relationships, reading practices, and sensory needs. S*hadow Castle* is also not an experience that can be delivered and accessed at-scale, though insights generated from its creation and testing can be used to inform future projects intended for distribution.

Conclusion

This project began with a central question: how can we reframe reading for those who *can* read but *choose* not to? Specifically, how might story become more active, expressive, and emotionally rewarding for learners who have been underserved by traditional, text-centric instruction? *Shadow Castle* was developed as a response to this challenge. Drawing from arts-based literacy practices, game design, and theories around material engagement, the multimodal storybook demonstrates how hybrid systems can help hesitant learners re-kindle the spark of reading and re-discover their narrative imagination. For students navigating post-pandemic shifts in attention, motivation, and digital reading habits, such experiences may offer alternative entry points into narrative, ones that foreground curiosity, sensory engagement, and shared interpretation.

The project also illustrates how participatory and materially situated design methods can reshape creative practice. By centering the tactile associations and symbolic reasoning of co-design participants, the process generated a dialogic form of collage-making that blurred boundaries between maker and reader. Working in this manner demonstrated how collage – often an isolating practice – can become responsive and socially grounded. In this way, *Shadow Castle* reflects on the kinds of questions arts-based approaches are uniquely equipped to explore: How do materials carry meaning? How might aesthetic choices shape motivation, perception, and emotion? How can making serve as both expression and exploration, as method and message?

Ultimately, the project contributes to ongoing conversations about how literacy tools might evolve to meet the needs of contemporary learners. *Shadow Castle* gives a glimpse into what's possible when reading is approached as an arts-based, participatory, and materially situated, playful practice.

It challenges narrow definitions of literacy and highlights the potential of tactile, collaborative, and open-ended experiences to build new pathways for learners who may have felt disconnected from traditional literacy practices. For makers, it affirms that interventions informed by participatory and process-led design practices can become promising tools for reimagining education, connection, and play.

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