Jabberstamp: Embedding sound and voice in traditional drawings

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ABSTRACT

We introduce *Jabberstamp*, the first tool that allows children to synthesize their drawings and voices. To use Jabberstamp, children create drawings, collages or paintings on normal paper. They press a special rubber stamp onto the page to record sounds into their drawings. When children touch the marks of the stamp with a small trumpet, they can hear the sounds playback, retelling the stories they created.

We describe our design process and analyze the mechanism between the act of drawing and the one of telling, defining interdependencies between the two activities. In a series of studies, children ages 4-8 use Jabberstamp to convey meaning in their drawings. The system allows collaboration among peers at different developmental levels. Jabberstamp compositions reveal children's narrative styles and their planning strategies. In guided activities, children develop stories by situating sound recording in their drawing, which suggests future opportunities for hybrid voice–visual tools to support children's emergent literacy.

Author Keywords

Toy, Learning, Children, Drawing, Storytelling, Literacy, Tangible Interface.

ACM Classification Keywords

K.3.1: Computers and Education: Computer Uses in Education. H.5.2: Information Interfaces and Presentation: User Interfaces.

INTRODUCTION

Children in our culture are accustomed to creating people and things and places—with implied context—in their drawings. Since the first days they draw, parents will ask "who is that? Where are they? What are they doing?" From early on, children have learned through drawing to provide the information necessary for an audience to understand the story that is going on in their drawing. Conversely, learning how to contextualize an oral or written story in the absence of images is a much slower learning process for children, and children's ability to use language to communicate when and where their story takes place is considered a milestone in literacy development [15].

Figure 1. Children use Jabberstamp to create drawings with embedded audio recordings. Children use a special rubber stamp+microphone to record sound and a trumpet for playback. Paper and traditional art materials are used to create drawings.

Children's scribbles begin as a reflection of action, progress to iconic stereotypes of objects and support the development of skills for written language [2, 11, 12]. Children often express their ideas and theories about their words by creating representative drawings, sometimes accompanied by oral explanations. But while the drawings can be shared with others later, the stories and ideas that inspired the drawings disappear after they are spoken. Through our work, we hope to offer the possibility to recall these stories.

Literacy education encompasses reading and writing, but most tools for literacy development address children's reading skills [10]. Tangibles have been argued to support children's creative expression, and we are inspired to develop new technologies that leverage children's creativity and existing knowledge to make story creation, comprehension, and communication part of a child's ongoing intellectual life [4, 16]. Our research builds on a history of interactive systems to support children's literacy through storytelling and drawing.

RELATED WORK

Jabberstamp invites children to contextualize stories by combining graphic representations and symbolic forms (drawing) to create stories. Educators developed various approaches to support literacy development, ranging from skills-based, e.g. phonics, to whole language, e.g. projects that build on students' experience [5, 16]. Our work is situated in a whole language approach to literacy education.

Language acquisition

We propose that our work is at an intermediate level between pretend play activities [14] and traditional written activities. Because no interface has ever combined the use of stories and the use of drawing, we refer to pioneer work done on computer-related storytelling and drawing for children. We are influenced by literature describing the specifics of oral stories for later written literacy, e.g. contextualization, quoted speech, spatial and temporal expressions, and the drawing development of children [15, 16].

Tangibles to support literacy

Researchers in HCI have developed systems to support children's literacy, some of which combine audio recording and playback with conventional media.

TellTale specifically invites children to connect story segments through play with a tangible, modular caterpillar toy [1]. StoryMat reflects spatial organization of characters to help children create understandable contexts for their stories [3]. Dolltalk records and transforms children's stories into narrator, direct and quoted speech using pitch modulation [20].

Digital Narrative

Kidpad also allows children to draw digitally by hyperlinking their drawing to their writing [7]. Interactive Pencil Drawings is a concept prototype to allow a child to computationally associate parts of a story with discreet elements of a pencil drawing [8]. I/O Brush is a digital paintbrush that children use to paint with image patterns and sounds collected from the environment. In "history of the ink" mode, children captured oral stories in their painting [13].

Talking books

The Audio Notebook concurrently records audio and drawing marks. This is useful when audio and writing are temporally related, because users can touch written marks to hear the audio recorded while the marks were made [17]. This approach could support our objectives, and would be similar to imagining the stamp as a pen that is continuously recording. We suspect that such continuous, synchronous audio and pen recording would lead to a more magical (albeit less flexible) system. However, Jabberstamp's explicit, individual tools for all system operations (record, playback) makes functionality extremely clear. Separating drawing and recording also gives children time to develop their stories independently from their drawings. Children rehearse, develop or negotiate oral ideas independently of the drawing activity, and later embed them for their audience.

A number of talking books entered the commercial toy market in the past eight years, coupling paper books with interactive recorded sound, e.g. LeapPad [10]. Some aim to teach reading skills like phonics. Only one (very recent) product provides for children to create original content [19], and one can regard Jabberstamp as a contribution to our culture's transition from tools for consumption (TV) to tools for authorship (the www). We continue many years of research in creating digital media that prompt children's learning through self-motivated creative activities, following pioneering efforts such as those of Alan Kay [9].

JABBERSTAMP SYSTEM

Jabberstamp (fig. 1) is a system children can use to embed their voices and ambient sounds in their drawings, paintings and collages. With Jabberstamp children can record the meanings of their drawings and create narrative compositions before they have mastered writing. Jabberstamp is also a communication tool: children mark the page with illustrations which have meaning that is not obvious to their teachers, peers or other adults. With Jabberstamp, children record these meanings directly into their drawings, supporting children to share their ideas.

Interaction Design

Jabberstamp works with regular paper and is designed to create the illusion that children's sounds exist within the paper page. All interactions are executed by touching the stamp and trumpet tools on to the page. Our intention is for children to seamlessly incorporate the user interface into their existing practices with traditional artistic media (paper, pens, paint, stickers). We aim to keep the values of traditional objects and maintain their languages. We hope to add value by expanding their expressive capabilities with the illusion of embedded digital technology.

To use Jabberstamp, a child first places a piece of paper on a special plastic tablet, and identifies the page by pressing the numbers 1, 2, 3, pre-printed in the left column of the page. The child can draw, paint, or create collages on the page with traditional art media. To record a sound, she grabs the "Jabberstamp"—a self-inking rubber stamp integrated with a microphone—and presses the rubber stamp to the page. The microphone glows red while the systems records the child's story. When the child removes the stamp, a red star is printed on the page. The child touches the red star with a small trumpet to hear her recording play back. If multiple recordings are triggered, their audio playback is mixed together.

Although we only tested the Jabberstamp single-page mode, the system also supports a "book" mode. Jabberstamp recalls old pages at command and stores all audio recordings on a computer, so a child's many drawings can be returned to the system and played long after they have been composed. If the child wants a suggestion of what to do next, she presses a question mark printed on the page that guides her through interactions, e.g. "now press the number two".

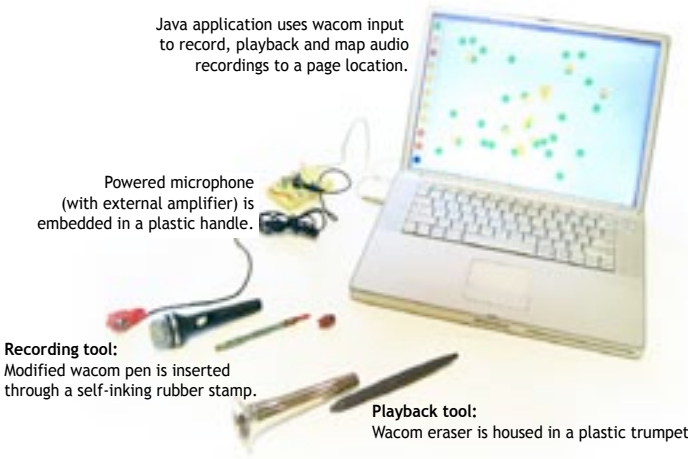

Figure 2. Jabberstamp technology. A Wacom tablet, used for location and event sensing, is not shown.

Technology

Jabberstamp includes a Wacom tablet, two modified Wacom pens, pre-printed paper templates, speakers and microphone, and custom software running on a computer (fig. 2). Paper templates are affixed to the Wacom tablet. Wacom pens, located in the stamp and trumpet, are read by a custom Java application which creates audio recordings and associates them with locations on the page. Children can revise their recordings because stamps made in similar locations reference the same (most current) audio file.

Audio operations are structured to allow multiple audio streams to playback simultaneously. Children can create echoes (by pressing the same clip many times in a row) or harmonies (by recording several individual notes and playing them back in quick succession). The application is robust: children's work is not lost even in the event of a system failure.

Tech. Problem	Design Change	Result
Children are unsure when recording is happening.	LED is embedded in microphone and lights during recording.	Success: children understand when the system is recording.
Recordings are hard to hear.	Embedded microphone in the stamp, and speaker in the trumpet.	Failure: microphone was harder to use with a tether, and trumpet was heavier, with decreased sound fidelity.
Recordings are hard to hear.	Added higher quality external microphone and speaker system	Success: recordings were audible.
Original table-top system was tilted and allowed only landscape orientations.	Presented flat tablet with a choice between landscape and portrait	Failure: Sensor errors because children stored multiple tools on the tablet at the same time.
Tablet senses both the trumpet and stamp at the same time, causing sensor errors.	Tablet is tilted (not flat)	Success: children cannot rest tools on the tablet. System does not detect multiple tools simutaneously.
Children moved the stamp during recording, causing inaccurate sensing.	Added spring-loaded locator ring that required children to press the stamp firmly and flatly onto the page.	Success: Children recorded more accurately.

Table 1. Technical Refinements

Design Changes prompted by user interactions

Our evaluations prompted a number of design changes (Table 1). For instance, an early prototype was introduced to Mary, age four. A researcher showed Mary how she could draw and then record a sound in the drawing with the stamp and playback the sound with a trumpet. Mary immediately set herself to drawing a train, characters and other objects (fig. 1). First, she experimented with simple recordings on the page, not associated with her drawings. Then she proceeded to make recordings near or on top of her drawings, naming what she had drawn. "Dog. Train. Cloud," often doing several recordings until she was satisfied with the playback. Mary easily incorporated the system into her drawing process, but sometimes she had some difficulty holding the stamp firmly to the page during the recording, which caused only a small portion of her words to be recorded. This informed us to pursue a design refinement: we added a red "recording" light to the microphone to provide user feedback.

Children's interpretation of Jabberstamp

Children had to be explicitly shown that they could use the stamp to record and the trumpet to later playback a recording. The form of the tools did not automatically imply their use to the children. Once children were shown the system they found the tool designs to be natural representations of their functions. For instance, sometimes children put the trumpet up to their ears to hear sounds louder.

Experimenters offered pre-printed templates to children with scenes from well-known children's books, to provide existing context to prompt users. However, children always chose a blank piece of paper. But when the experimenter introduced ideas to use sound effects and direct speech to complement a story, kids immediately adopted the ideas and chose musical instruments and their own voices to create a variety of sounds and characters. In future designs, we would like the device and materials themselves to suggest contextual possibilities to children. We have tried several approaches so far (Table 2).

Design Limitation	Design Change	Result
Children couldn't revise their recordings.	New recording replaces old one.	Success: allows for refinement, but used mostly by older children.
Children do not know conventions to tell a story wtih a single page.	Present a series of drawing templates, with comic style frames.	Failure: children prefer to start with blank page.
Children do not know conventions to tell a story wtih a single page.	Decorated tablet frame with example comic strip.	Children did not mimic the decoration, but invented their own conventions.
Desire to prompt children to situate sounds into rich drawings.	Present a series of templates with images from children's books	Failure: children prefer blank pages to imagine their own scenes.
Wanted to provide inspirational media.	Provided stickers as well as pens.	Only young children used the stickers

Table 2. Evolution of interaction design

Evidence that children incorporated musical instruments, found toys and miscellaneous materials like tape and stickers to compose both visual and oral content shows that Jabberstamp is an intuitive extension to children's familiar knowledge and environment. Children's use of paper, tape and other physical media demonstrates that our decision to provide paper media for composition, rather than a purely digital approach such as a tablet-PC, allowed the system to become an intuitive extension to children's familiar knowledge about visual composition.

GALLERY INSTALLATION

We observed people's usage patterns with Jabberstamp during a two–week gallery installation of interactive art and new technologies. Approximately 150 people played with the system, of which one third were children ages 5-15. A researcher observed and interviewed a number of users, and all drawings were collected for analysis.

Jabberstamp was presented on a simple table with markers and blank templates for people to draw on. A short description of the stamp and trumpet tools was written next to the drawing tablet. The computer, microphone and speaker were hidden from the users.

After reading the description, people tried to record different sounds, or investigated sounds and drawings that had been left by other visitors. Jabberstamp was inviting and easy to use, suggesting that we investigate the extent to which Jabberstamp can be used for free playing in the absence of guided activities. Visitors enjoyed bringing friends to the system to demonstrate stories they had discovered or created. This shows that the system afforded people's creation of meaningful compositions.

Analysis

Jabberstamp was introduced to ten users in two different ways. In one scenario, Jabberstamp was introduced first as a sound recording tool that can also be supported by drawing. In the second scenario, Jabberstamp was described as a drawing tool with which users can illustrate their drawings with recorded sounds. The two methods resulted in dramatically different uses of the system.

Introducing Sound First

When sound was introduced first, users produced compositions that included a multitude of recordings not necessarily related to drawings. Often, compositions consisted of sounds alone with little visual indication for readers to navigate the composition. This kind of scenario may be useful to encourage quiet children to share their oral stories with others. However, resulting compositions may not convey an immediate message to support communication.

Introducing Drawing First

When drawing was introduced first, users usually carefully composed drawings before recording sounds. They only recorded sounds when they referred accurately to the drawing. The final compositions were much more accessible for other users to quickly understand.

Introducing drawing first seems to lead to more seamless relationships between visual and oral composition. Jabberstamp supports integrating sound and image, a skill necessary to support multi–media literacy.

EVALUATION WITH CHILDREN

Methodology

Our objective was to evaluate the system's ability to support children's narrative. We conducted qualitative evaluations with ten groups of 1-4 children, ages 4-8. The children were video taped, and their drawings and related videos were later transcribed and analyzed.

We set up the system at a child's table and prepared a variety of materials for the children to use. Markers, stickers, blank pages and pre-printed images from familiar children's books were available. Researchers presented the system and showed children how to record and playback a sound.

Environment

As a first user test, Jabberstamp was introduced to three kindergartners at a local Montessori school as part of their free play morning exercises [11]. Several children individually worked with the system to explore drawing and recording. All children successfully recorded and played back sounds, although one child did not incorporate sound in her compositions. Our observations of usage and technical problems informed our design of a user study that focused on children's free play with a robust and reliable system.

Figure 3. Individual kindergartners used Jabberstamp in their school library.

In our following study, seven children, boys and girls ages 4–8, played with Jabberstamp in a familiar home environment, where children could be inspired to incorporate their own toys in their stories. We conducted two play sessions over the course of two weeks, each 2-3 hours long. We paired children to encourage them to vocalize their ideas through planning and negotiation, and to observe the different approaches of children. Children were invited to play as long as they wanted. We observed several styles of work.

How children use Jabberstamp — Results

Discovering the machine

Initially, children copy the minimal examples of record and playback provided by the experimenter, such as naming the color of a mark. Children then spend a half hour recording sounds on the page, using the system as a voice recorder. Their creation of over fifty individual recordings suggests that voice recording alone is a salient learning exercise that is developmentally appropriate for the children [11].

Creating through play

Since educational tools, in the absence of a formal structure, must engage children through their design, we identify play as one approach to capture children's attention and creativity. With Jabberstamp children's play is motivating and informs children's creative work. For example, two girls alternately laugh, dance, and sing while they record sounds into their drawings. Their intentions are as much about playing and entertaining each other as they are about creating interesting compositions.

Figure 4. Ashlie and Anika use Jabberstamp to create an interactive game.

Collaboration

Jabberstamp allows children at different ages and developmental levels to create compositions that build on their personal skills and interests. It seems to be a successful medium for mixed-age groups to collaborate.

There is no turn-taking among Ashlie (age 8) and Anika (age 4). When they prepare a drawing (and have not begun recording yet) the girls are both drawing and sharing ideas about their stories (fig. 5). However, during the compositions of the oral stories themselves, the older child tells the stories, and the younger one observes and suggests. Despite the younger girl's multiple requests to use the stamp to record her own voice, the older girl seems to have a long list of recordings she is eager to make before giving up the tool.

Following Vygotsky's analysis of collaboration between peers with different abilities [21], we observe the younger to be a more passive observer, and making regular comments that show she is reflecting on the older one's activities, while the older one is coaching and directing the creation. The older peer helps the younger one create compositions that may have been too complex for the younger one to create on her own.

Naming

Two girls age 8 and 4 go through a process of naming and drawing. First, they record a name, and then create a drawing that represents that name. Ashlie says the word "heart" and then draws a heart. After drawing, she records the word "heart" on top of her drawing of the heart. Ashlie also makes a "crazy star," "cow," "x" and "grass." An experimenter asks the girls to create sound effects to go with the names, such as recording the sounds of a wolf or dog. Emily records these sounds and then the children return to descriptive naming of the drawings.

Step by step, children begin to integrate different drawings with their words. An experimenter introduces thematic stickers to the children, and it immediately inspired the contexts of their stories.

Invented symbolic language

Ashlie organizes a drawing and story: she chooses a blank piece of paper and soon creates a large box in the upper right corner of the page. In this box, she records a sequence of descriptions in a narrator's voice that tell the story of Mary and her lamb. She numbers her six sequential recordings to help a reader know when to press each, and labels the last stamp "The end." The rest of the page includes drawings of the characters in the story, and each of them includes its own quoted speech, recorded with a stamp that is located near or on top of the drawing itself.

Ashlie writes numbers next to the characters' voices that corresponded to the narration segments at the top of the page. She intends for a reader to press the narration #1 "Once there was a little lamb" and then press the characters' speech #1, Lamb saying "hey bird." When Ashlie or Anika creates a recording she doesn't like, she crosses the stamp with a pen or covers it with a pink dot to remember that it is not good (fig 5).

A possible story structure that communicates from the writer to the reader develops an ongoing narrative that is spatially and temporally presented. It requires coherent connectors between different parts of the story. If the story contains characters, then some character description is necessary [16]. We find evidence that children develop these different elements using various symbolic languages. In one example, two characters are drawn with iconic drawings (character description and spatial context), their dialogue is recorded (using direct speech), and the evolution of narrative over time (a temporal progression) is indicated by numbering the recordings with a marker.

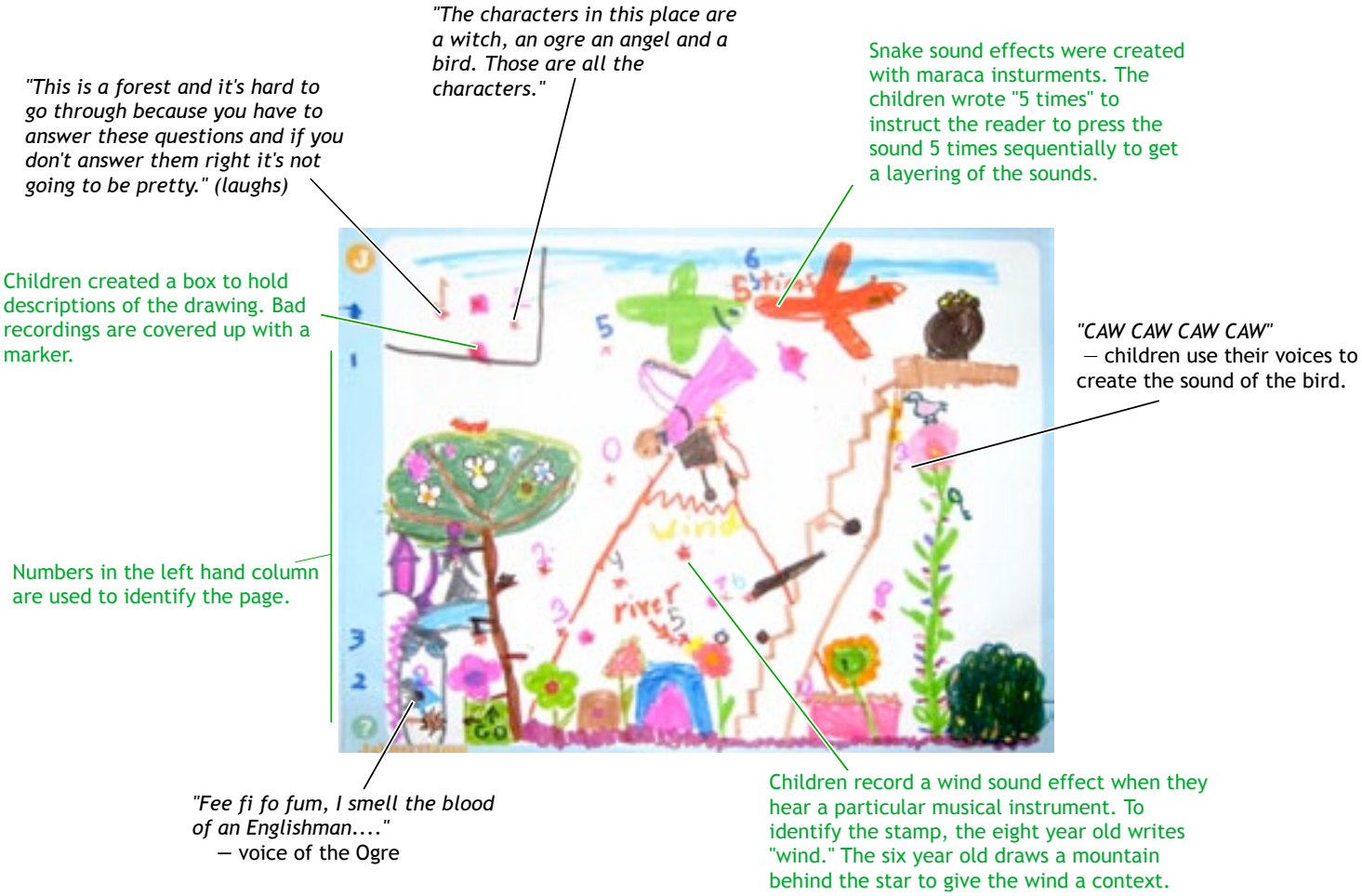

Figure 5. Ashlie (age 8) and Anika (age 6) created an interactive game for their Mother to play.

Evolving narrative complexity

Children engage with the system for over one hour, adding more and more complexities to their stories as they become more familiar with the system. The complexities are demonstrated by the evolution of story characters over time, and by the careful choice of direct speech vs. narrator voice according to the context. Over time, children assume shared context with their audience and use drawing to contextualize their stories, instead of providing context with a narrator voice alone.

Children use direct speech (dialog spoken in the voice of the character) and voicing (change in voice pitch), to represent characters' intentions in their stories. Drawings often provide context for the reader to understand where/when the action takes place. Another strategy to introduce context in a story could have been to use quoted speech, i.e. *he said*, or a narrator voice (who usually introduces the characters in a story).

Planning a story-game

In the Kidpad system, when children shared stories they tended to create game scenarios [7]. In our system we observe that children who share stories together also develop a game, which is initiated by the oldest.

Ashlie (age 8) and Anika (age 4) draw for 45 minutes with no recording. However, they continually negotiate an oral story, and describe the meaning of their drawings to each other. The two girls draw at the same time on the same piece of paper and explain their drawings to each other, building on each others' work. They explain how their drawings provide action, thinking of interactivity such as the order in which a reader will trigger sound elements.

Their drawing embodies procedural thinking, because it structures a visual scenario of choices for a reader to make. For instance, next to a green patch of grass they draw two arrows, one pointing up to a witch, and another pointing sideways to an Ogre in a cave. The girls invent the story by explaining to each other, "There are 2 ways you can go. There's the Ogre, which is the bad way, and there is the Witch, which is the good way. If you go with the Ogre you will die..." Later, the girls record this message in the drawing (fig. 5). Ashlie and Anika have invented branching paths for a reader to follow.

Ashlie practices her lines before recording them, and the playback gives her direct feedback, allowing her to evaluate her message from a reader's perspective.

Ashlie and Anika have created an interactive game for a reader unfamiliar with the composition. The reader can follow a sequence of narrative clips and embedded stories, character voices and sound effects to navigate through a fantasy world. The goal of their game is clear: the reader

must choose a path that avoids evil and leads him to a pot of gold. But only if the reader remembers to leave all his belongings behind can he actually reach the gold. It is a game about choosing right over wrong, and they assume readers will play the game honestly.

DISCUSSION

Contextualization

Children using Jabberstamp may have been inspired by the structure of their drawings to structure oral or written stories. In one example, when a child said "up to the tree," she was orally referring to a tree she had drawn. While we don't know if children's drawings triggered stories or vice-versa, the final product demonstrates an ability to create a variety of locations that would lead the audience to understand where and when actions take place.

We are interested to see if children's use of Jabberstamp is helping children develop ideas about how to balance context and plot, ideas that can transfer to their writing. For example, Anika, 4, heard the sound of a musical instrument and decided it sounded like wind. Anika asked her friend Nick (age 5) to create the sound, and used the stamp to capture it in her drawing. She made the stamp in the middle of the page, and to give it context she drew a mountain behind it. Her older collaborator Ashlie wrote "wind" next to the stamp to communicate the meaning in a more explicit way—with writing.

Communication tools

Several professional educators remarked that Jabberstamp has potential to become a unique communication tool, especially in a classroom environment. Children can use drawings and sound/voice to record messages, stories, and games that are much more complex than they can record with conventional media such as pencil and paper. Teachers could apply the technology to various lessons, where children could develop strategies to present their ideas about various subject matter. The system could complement conventional literacy skills because it would facilitate children's communication about complex ideas before they have mastered the ability to write complex narratives.

Emergent narrative styles

Teachers have developed a number of strategies to help children understand what literacy is about. Sometimes teachers use existing drawings to inspire children to create stories that teachers will later translate into writing. In anther approach, a teacher transcribes an oral story of a younger student, to help that child learn how speech is translated into writing [5]. In such settings, Jabberstamp could become a useful tool for formal literacy education. It can synthesize both of these kinds of approaches: children can create drawings to define an environment and context for stories, and children's own ideas (recorded with the stamp) can help engage them in the writing process because their words are familiar, personal and readily accessible for children to revisit and reflect upon.

With Jabberstamp, children relate to their imagery using different strategies (table 3). All children, from 4-8 could name their iconic drawings. Children ages 5 to 8 work to evolve stories over time by integrating character voice, (direct speech) presenting them in the stories (quoted speech), and providing some contextual information (using a narrator voice). This shows that Jabberstamp supports different layers of complexity regarding children's narrative skills.

Type of narration	Type of drawing associated with narration	Age of child
Naming, e.g. "crazy star, heart, grass"	Identifying visual elements, e.g stickers, stamps, iconic drawings.	4-8
Sound effects, e.g. a wind	Written word, e.g. "wind" in context with drawing of a mountain	4-5
Interaction scenario, e.g. "5 times" is written next to a recording, so that users will press the recording five times in a row.	The word "5 times" next to a drawing and its associated recording.	4-5
Direct Speech, expressive sounds, e.g. "CAW CAW CAW"	With drawing of character, e.g. bird.	5-8
Direct speech, e.g. "fee fi fo fum, I smell the blood of an Englishman."	Wtih drawing of character, e.g. Ogre.	8
Sequential numbering of narrator voice	Numbers	8
Game scenarios, e.g. "You have to answer these questions..."	Numbers and stamps	8
Narrator voice and quoted speech, e.g. "The characters in this place are a witch, an ogre..." and "The witch said"	Character drawings, numbers	8
Indicating the passage of time by creating multiple direct speeches, e.g. "(1) hey bird (2) hey lamb (3) come in (4) no I can't."	Either with one drawing and multiple recordings, or with a sequence of numbers.	8

Table 3. Narrative samples.

FUTURE WORK

Based on our evaluation, we envision Jabberstamp becoming a tool to support children's emergent literacy, which is "the reading and writing behaviors that proceed and develop into conventional literacy" [18]. Our observation that our initial users were (1) extremely absorbed in their work and (2) exhibiting increasingly complex compositional structures in successive sessions suggests that there is potential to conduct a longitudinal study to see how a variety of children progress with the tool. This study should include a detailed analysis of narrative patterns that are exclusively device specific. We are particularly interested in how Jabberstamp can support children who have trouble developing literacy skills with traditional materials (e.g. dyslexic children).

Our evaluations encourage us to include means to replace experimenters' prompting with design materials. Embedded voice-over prompting and printed instructional examples could scaffold children's contextualization of character and narrative. Formats besides single pages, like books or layered animations could promote additional narrative conventions.

We intend to evaluate new materials with a quantitative and qualitative analysis of new tools to enhance children's literacy development. We will focus on children's abilities to address more specific tasks, with one focus being on Jabberstamp's applicability to formal education.

CONCLUSIONS

We presented Jabberstamp, a system children use to embed their voices and ambient sounds in their conventional drawings and collages. Through our evaluations, we observed that children ages 4-8, who are at multiple developmental levels, combined a variety of visual and narrative techniques to create increasingly complex compositions as they became more experienced with the system.

ACKNOWLEDGMENTS

Many thanks to the children, parents and professional educators who contributed to this work. Thanks also to Mitchel Resnick, members of the Tangible Media Group, the MIT Media Lab community, and the Things That Think consortium.

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