Make a Riddle and TeleStory: Designing Children's Applications for the Siftables Platform

Seth Hunter
MIT Media Laboratory
75 Amherst St,
Cambridge Ma 02139
hunters@media.mit.edu

Jeevan Kalanithi, David Merrill
Sifteo Inc
2325 3rd St., Suite 223
San Francisco, CA 94107
{jeevan, dave}@sifteo.com

ABSTRACT

We present the design of *Make a Riddle* and *TeleStory*, educational applications developed on the Siftables platform for children aged 4-7 years. Siftables are hybrid tangible-graphical user interface devices with motion and neighbor sensing, graphical display, and wireless communication. Siftables provide a unique opportunity to give children responsive feedback about the movement and arrangement of a distributed set of objects. We contrast the use case that includes an external display to their use as a standalone application platform. We outline design strategies for communicating information about the affordances of the Siftables and methods of providing dynamic feedback to encourage manipulation and to increase engagement during application use for hybrid tangible-graphical user interfaces.

Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation (e.g., HCI)]: User Interfaces – haptic i/o, theory and methods, user-centered design. K.3.0 [Computers and Education]: General.

General Terms

Design, Experimentation, Human Factors

Keywords

Siftables, tangible user interface (TUI), digital manipulatives, ubiquitous computing, augmented reality, sensor network, embodied media user interface, TeleStory, Make a Riddle.

INTRODUCTION AND BACKGROUND

Tangible user interfaces [4] have been designed to enhance children's engagement with digital content by merging physical and digital representations in interactive environments [2,3]. Like others, we were inspired by the potential of tangibles to utilize a child's ready ability to manipulate physical objects for applications with computational logic and graphical feedback [5,9]. The majority of existing applications use external sensing such as fiducial markers [1] or RFID tags to provide information about the position and orientation of the objects. Siftables are in a class of hybrid tangible-graphical manipulatives that allow visual content to be displayed directly on the objects [10], introducing new opportunities for direct forms of learning and teaching [8], and new interaction challenges for designers.

Figure 1: The four Siftables in Make a Riddle. The top tile displays an image when the other three form a descriptive sentence.

The primary purpose of this paper is to provide guidelines and observations based on our work that may aid designers when designing applications for children on hybrid TUI/ GUI platforms. Using Siftables [6] and starting from the interaction gestural language guidelines articulated during early development of the Siftables platform, we developed and tested four gestural actions in our applications: tilting, in-hand selection, shaking, and adjacency.

For each application we designed a unique set of narrative-based animations to encourage children to interact with the tiles. We expanded on guidelines from sequential art [7]: displaying a simple iconic image on each Siftable to give it a unique identity, making it a character within a larger story, and using episodic narrative techniques that return the interaction to a waiting state when the user is not active.

IDC 2010, June 9–12, 2010, Barcelona, Spain.

Both applications are designed to encourage open-ended experimentation. Mistakes are opportunities for humor and surprise, just as playing with language can produce unexpected and creative results, and comedic interactions were used to increase engagement.

By affording direct arrangement of physical manipulatives, Siftables engage children more actively in language learning processes. *Make a Riddle* provides a word-to-block mapping that allows sentence formation. *TeleStory* enables children to participate in the creation of an animated scene on a television, a typically passive content-consumption scenario.

APPLICATION DESCRIPTION: MAKE A RIDDLE

Make a Riddle is a language-learning application developed in collaboration with a first grade teacher in the Boston Public School System. It is targeted at children aged 4-7, and is loosely based on the children's book *Hop on Pop*.

The focus of the application is to teach children spatial concepts and basic sentence-construction skills through creative play. We wanted to explore a manipulative-only application design that did not require an external display. All user interaction and visual feedback are on the Siftables exclusively. Children can build three-word riddles by arranging Siftables displaying words into a sentence, which updates an image on the fourth Siftable (Figure 1). Of the six possible sequences in each round, two produce an image (Figure 2), encouraging the development of language skills by arranging words in multiple ways motivated by humorous outcomes.

Figure 2. Sentences from left to right: house on mouse, mouse on house, ice on mice, mice on ice, king on ring, ring on king, box in fox, fox in box.

It aims to demonstrate phonemic awareness (through rhyme endings with different spellings), semantic sentence structures (what image does the sentence produce?), creativity (experimenting with different arrangements), vocabulary and fluency (through image/word association, grapheme awareness, and word families), and basic punctuation (when blocks are switched the capital letters and periods are switched). To assist children with the interaction, self-describing instructional animations were shown on manipulatives if activity lagged for 8 seconds. These animations were approximately 2 seconds and in black and white format.

Figure 3. Images from the brief sort and shake animated help sequences shown on the Siftables screens.

(Figure 3) They present a visual means of demonstrating how to proceed that supplements audio feedback.

APPLICATION DESCRIPTION: TELESTORY

TeleStory is a language-learning application, developed for pre-school children. It is designed to teach vocabulary and reading to children by enabling them to influence a story about a cat and dog in a whimsical land.

Figure 4. In TeleStory, six Siftables are used on a surface in front of a large-screen Television.

TeleStory is comprised of interactive characters and objects represented both on a Siftable and in parallel on an HD television as part of an animated scene (Figure 4). The large display allowed for a richer graphical presentation, but introduced challenges related to visual attention management. The Siftables become active in pairs, starting with the sun and moon, then with menus of props, and finally introducing two main characters, a cat and dog. In this way the child is slowly introduced to an unfolding narrative, where they have some ownership in bringing the story to life. Children introduce items and characters to the scene by picking up a Siftable, adding to a cast as they handle each one.

For example, if a child picks up the Siftable showing the sun, the scene on the large display becomes daytime. If they select the moon, it transitions to nighttime (Figure 5). Props include man-made objects (a tractor, a fence, a house, a magic hat) and organic objects (an oak tree, a sunflower, a potion). There are 22 episodes in *TeleStory*. Each episode is triggered by placing a Siftable to the left or right of the cat or dog, introducing the prop displayed on

the Siftable to the character and changing the relationship between them.

Figure 5. Raising the siftable displaying the moon, to transition to nighttime in the TeleStory application.

For example, if a child places the tree Siftable next to the cat Siftable, the cat in the large scene will run up the tree and the dog will run around the tree barking.

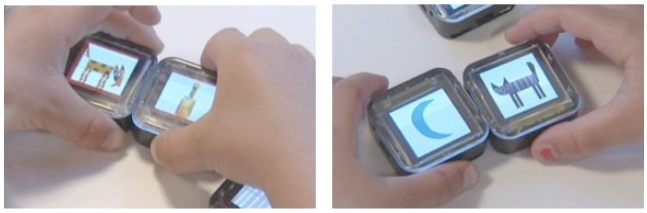

Figure 6. Placing siftables to the left and right of each other.

A narrated voice says "Cats can climb trees!" and "Dogs cannot climb trees." The narration also appears in text at the bottom of the screen. (Figure 7) A triggered episode plays for 4 to 20 seconds, then the application returns to a waiting state.

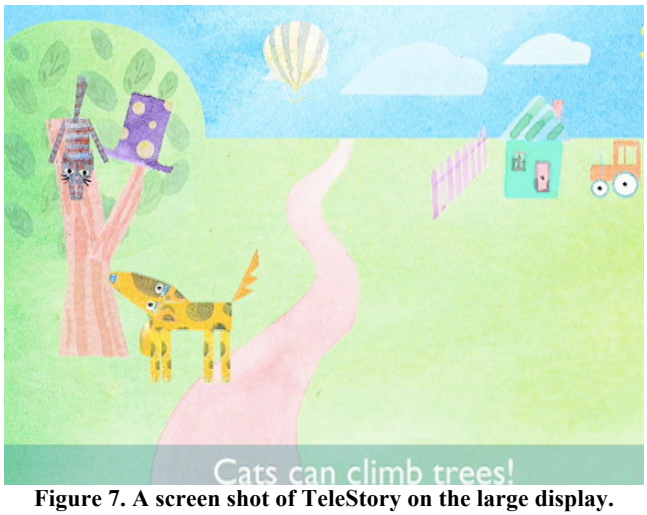

Figure 7. A screen shot of TeleStory on the large display.

Stateful transitions between episodes, such as left and right entrance animations for the cat and dog to vary their position, and a variety of randomly selected "waiting" animations, such as tapping the foot, or scratching, or wagging the dogs tail to keep the scene active when the user is not interacting with the Siftables.

Figure 8. The tilt-based selection menu. Tilting towards a corner for 2 seconds selects the corner item.

We experimented with an interactive tilt-based menu (Figure 8) for *TeleStory* to allow a child to select props. The menu divides the screen of the Siftable into four quadrants, and shows a thumbnail image of the prop in each quadrant. One of the four quadrants starts out in full color, while the other three are faded. Tilting the Siftable toward a corner causes the thumbnail in that corner to become the selected item and shown in full color, while the others become faded. If a given prop remains selected for two seconds, the selected item fills the entire display of the Siftable and the item enters the scene on the large screen.

OBSERVATIONS AND DISCUSSION

We conducted a pilot study with nine children aged 4 to 7 interacting with *TeleStory* and *Make a Riddle* and observed that they all easily understood the connection between the manipulated Siftables with graphical content representation and the corresponding characters and scenes shown on the large display or the non-manipulated Siftable. Direct imitation gestures, such as raising the Siftable displaying the sun to make the sun rise on the large screen, or shaking the dog to make the on-screen dog shake, were the easiest to learn and most engaging.

In the *TeleStory* application there was some conflict of visual attention between the displays on the Siftables and the large screen. Children would glance at the Siftables to orient and grasp, then try various puppet-like gestures like shaking the cat, or raising and lowering the moon.

Adjacency was a primary mode of interaction in both applications. Each Siftable embodied a character or word and was mapped in a direct one-to-one relationship to the content, making adjacency-based arrangements meaningful. For example, if a child placed the cat next to the flower, the cat on the large display would approach the flower, sniff it, then sneeze. Children found discovering these relationships very pleasing and some triggered favorite episodes more than 10 times consecutively.

Less direct manipulations like the tilting menu in *TeleStory* for prop selection and shaking a Siftable to advance the round in *Make a Riddle* were more problematic. The on-Siftable demonstration animations (Figure 3) worked better with older children (6+), and only 40% of the younger

children understood the animations on the Siftable as cues to imitate. A simple demonstration by a teacher was needed to teach the concept of “shake to continue" in these cases. Additionally, when the large screen was showing action, some children did not notice updates on the Siftable, leading to confusion. A possible solution to this would be to place a selection menu on the large screen and allow the child to select by moving the Siftable in the desired direction, like a wireless mouse.

CONCLUSIONS AND FUTURE WORK

Children reported liking the *TeleStory* application more than *Make a Riddle*, however the relative simplicity of *Make a Riddle* reduced the amount of time to understand how to interact with the Siftables, and was more directly focused on teaching language skills. Children recalled more of the sentences from *Make a Riddle* than from *TeleStory*.

The use of episodic narratives in both applications was effective at keeping the attention of the child, with greater enthusiasm and experimentation in response to the character development of the cat and dog in *TeleStory*.

Self-describing / self-referential interfaces such as our help screens in the *Make a Riddle* application are a relatively unexplored subject in tangible interaction. Our pilot study indicates that augmenting objects with images or animations of themselves can provide additional contextual guidance, but the age of the child impacts the understandability of these graphical aids. We found that younger children (under 6) had some difficulty with this approach and require more direct guidance.

Assigning a fixed identity to the blocks that is represented graphically on the display is important in clarifying their role in the narrative. Selection by grasping/moving and adjacency are the easiest gestural modalities for children to understand. Tilting and shaking are less obvious and require more assistance. Children often learned one gesture and would intuit new gestures we had not predicted. For example, in both applications children tried to stack the Siftables on top of each other, and with *TeleStory* they would show the Siftable to the screen, apparently expecting that the screen would be able to see the Siftable and react. This observation can provide guidance for other applications that utilize manipulatives in conjunction with an external display, namely that systems should detect when the user orients a manipulative’s screen toward the large display and holds it up. It may also be useful to allow manipulatives to detect stacking.

Designing an application like *TeleStory* where the Siftables are controls for an external scene allows for more dynamic and immersive content than a standalone application like Make a Riddle, but adding an external screen adds additional complexity that will require further study for disambiguation. We found that children primarily wanted to use the Siftables to puppet content on the larger screen. Depending on learning objectives, future applications using TUI/GUI hybrid interfaces should avoid splitting the attention of the user between on-screen and on-Siftable interactions. We recommend that applications either (a) present content entirely on the Siftables, focusing on how to develop deeper and richer narratives on small displays, or (b) incorporate an external screen by keeping the dynamic visual feedback on the Siftables minimal, using them primarily as digital handles to trigger and puppet the richer content on the larger screen.

ACKNOWLEDGEMENTS

Thanks to Jordan Weymer for his educational input on *Make a Riddle*, to Katya Popova for her wonderful artwork for *TeleStory*, to Pattie Maes for her oversight and feedback, and to Woohyoung Lee and Samsung for their interest and support.

REFERENCES

1. Costanza, E., Shelley, S. B., Robinson, J. d-touch: a Consumer-Grade Tangible Interface Module and Musical Applications. In the *Proceedings of the Conference on Human-Computer Interaction.* (2003) Bath, UK.

2. Fontijn, W, and Mendels, P. StoryToy the Interactive Storytelling Toy. In the Proceedings of the 2nd International Workshop on Gaming Applications in Pervasive Computing Environments. (2005).

3. Horn, M.S., Solovey, E.T., Crouser, R.J., and Jacob, R.K.J. Comparing the Use of Tangible and Graphical Programming Languages for Informal Science Education. In the proceedings of the *ACM CHI 2009*

4. Ishii, H. and Ullmer, B. 1997. Tangible bits: towards seamless interfaces between people, bits and atoms. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.* (1997) ACM Press.

5. Marshall, P., Rogers, Y. and Scaife, M. PUPPET: a virtual environment for children to act and direct interactive narratives. In the *2nd International Workshop on Narrative and Interactive Learning Environments*. (2002) Edinburgh.

6. Merrill, D., Kalanithi, J., and Maes, P. Siftables: towards sensor network user interfaces. In *Proceedings of the 1st international Conference on Tangible and Embedded interaction.* (2007)

7. McCloud, S. Understanding Comics. (1994) Haper Paperbacks.

8. Resnick, M., Martin, F., Berg, R., Borovoy, R., Colella, V., Kramer, K., and Silverman, B. Digital manipulatives: new toys to think with, Proceedings of the *SIGCHI conference on Human factors in computing systems*. (1998)

9. Xie, L., Antle, A. N., and Motamedi, N. Are tangibles more fun?: comparing children's enjoyment and engagement using physical, graphical and tangible user interfaces. In *Proceedings of the 2nd international Conference on Tangible and Embedded interaction.* (2008) ACM Press.

10. Zuckerman, O., Grotzer, T., Leahy, K. Flow blocks as a conceptual bridge between understanding the structure and behavior of a complex causal system. In the *Proceedings of the 7th international conference on Learning sciences*. (2006)