Shadow Box: an interactive learning toy for children

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Abstract

The Shadow Box is a tangible computing project that exploits visual association and auditory clues to teach children the representational relationship between words and their meanings. The Shadow Box contains three major components: the main box, picture blocks and word blocks. The Shadow Box activates when a block or a matching pair of blocks is placed inside. The box prompts children to find matching blocks and combine them together. When children successfully combine the right word and picture, the box rewards them with an animated video as if they had made the objects come alive. An informal study shows that children responded positively to the concept of the box. They played with it for a length of time and engaged in a collaborative learning process with other children.

1. Introduction

Learning is effective when children build new understandings based on active reconstruction of existing knowledge and preconceptions. During the development of literacy skills at an early age, children may experience difficulties learning to read and write if they don't have a preconception of language's representational nature. The National Research Council (1999) suggests that young children should learn representational systems during their early literacy development [2]. Children acquire many of the skills necessary to attain literacy prior to the stage of reading-readiness which are also known as pre-reading skills. The acquisition of these skills provides the conceptual framework necessary to achieve higher level skills such as onset recognition fluency (beginning sounds), letter recognition fluency, phonemic segmentation, and ultimately, phonemic awareness, which links directly to reading mastery [5]. The acquisition of such skills is hierarchical, with children generally mastering word-level skills before they master syllable-level skills, syllable-level skills before onset-rime skills, and onset-rime-level skills before phoneme-level skills. This project focuses on helping preschool aged children attain word-level skills. We propose a tangible toy for early literacy development called the "Shadow Box". The Shadow Box aims to teach the representational nature of written language to three to four year-old children while they are playing with tangible word and object blocks. The Shadow Box consists of three primary components: the shadow box equipped with an RFID reader, as well as picture blocks and word blocks with embedded RFID tags. In order to activate the Shadow Box, a single block or a matching pair of blocks must be placed inside. If the child inserts a word block, the box pronounces and spells the word and prompts the child to look for its matching picture by projecting a static shadow image of the object. A similar sequence is initiated when the child inserts a picture object and is prompted to find the matching word block. When the child successfully matches a picture block with its corresponding word block and places the pair inside the Shadow Box, they are rewarded with an animated movie clip.

Figure 1. Shadow Box and word and picture blocks (left). Placement of a word block into the box (right)

2. Related Works

Even though computers permit the creation of dynamic content and the development of sophisticated interactive systems, it is still difficult to engage children in realistic settings using screen-based computational media [1]. Conventional computers do not support concurrent interaction and physical exploratory experience which is most familiar to preschool children.

To overcome this limitation, many researchers are interested in how tangible technology can help the learning experience of young children. Terrenghi et. al. developed Learning Cube, which is a digitally augmented learning platform that children can hold and play with [3]. The system is a standalone implementation that uses a microcontroller with acceleration sensors and 6 displays. Their research with 7 – 12 year old children showed that the physical form and affordances of tangible user interfaces promote a greater initial engagement with learning activities. They report that children do not consider the appliance as a traditional learning tool or as a computer, but rather as a toy.

Another example of a tangible interface designed for childhood education is "Ely the Explorer" from Africano et al. [4]. Researchers on this project developed a multi-user collaborative environment for 6-12 year old school children. In their study, they found that conveying realistic experiences for children required a high level of detail in the implementation of the content, hardware, and user interface. Without these elements children were not able to understand necessary operations or mentally complete missing steps in the interaction.

These prior studies demonstrate that tangible toys can afford highly engaging learning experiences by incorporating dynamic and interactive computational activities. To ensure that our project was appropriate for preschool age children, we were careful to implement a sufficiently high level of detail for the content, hardware and user interface.

3. Shadow Box: how it works

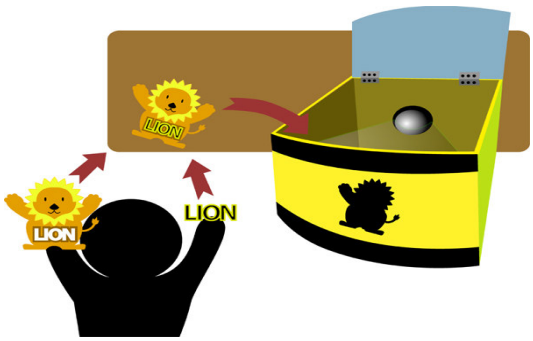

Figure 2. Initial concept for the Shadow Box

The Shadow Box consists of three key components: wooden picture blocks and word blocks with embedded RFID tags, and a box containing an RFID reader. The picture pieces are wooden blocks cut to resemble objects children are familiar with. These include a lion, a frog, a bell, a duck and a car. The word objects are blocks cut into the shape of words corresponding to the images depicted on the picture blocks. The word and corresponding picture blocks interlock to form a single word/picture block, much like a puzzle. Figure 2 shows a diagram of the Shadow Box.

Children interact with the Shadow Box by placing a block or set of blocks inside the top of the box and closing the lid. There are three possible positive outcomes that can result from this. The first scenario is that a child puts a single picture block into the box. The system provides audio feedback and prompts the child to find the associated word block by visually displaying the word on the front of the box. The second scenario is that a child puts a single word block into the box. The then box displays the picture and sounds out the word. In both scenarios, the box prompts the child to find the other matching piece to combine the word and picture together. For instance, if a child puts a lion picture block into the shadow box, she/he will hear the sound of a lion roaring and see the word "LION" displayed on the front of the box. An audio message then asks the child to find the word block that matches the image. Audio messages are recorded in a child's voice rather than an adult's, since this sets a more playful and less commanding tone for the interaction. The full scenario is as follows:

{a child puts lion picture block}{close the box}{lion roar} I'm a lion. This is how you spell my name. L-I-O-N. {display spelling on screen} If you match my shape and my name I'll put on a show for you.{continuous loop until the child opens the lid}

In the final scenario, a child successfully matches the word and picture blocks together and places the combined block into the box. This demonstrates that the child has understood the inter-connection between the word "Lion" and the picture representing the lion. The Shadow Box thus rewards them by showing an exciting shadow animation of a lion, as if the child has brought the object to life.

The Shadow Box also triggers contextual error messages when a child does not combine the right word and shape, or when they place two or more picture and words blocks into the box. For instance, when they put two words into the box, it prompts them with an error message saying: "Oops…you put two words in the box. Try to match my word with my shape."

By playing with the Shadow Box, children are engaging with an interactive tool that foregrounds the basic concept of the representational relation between written words and their corresponding objects. The Shadow Box can thus serve as a stepping stone to help children build a frame of reference for basic semantics.

4. Informal study: how children responded

Before deploying this project to a formal user study, we decided to get children's reactions to it in an informal context in order to determine if our concept was valid. We set up the Shadow Box at an Interactive System Show Case held at Georgia Tech on May 3, 2006. During the four hours of demonstration, six children stopped by whose ages ranged from two to nine. From this brief interaction with children, we gained three main insights. The first insight is that the learning curve is a lot faster than we expected, and therefore the word and picture set needs to expand if we want to do an empirical study for a greater length of time. The second insight is that children continue to play with the same objects if they get attached to them. It would be desirable to have more sets of animations per object instead of playing the same animation repeatedly to keep the children's interest. The third and most intriguing insight is that children quickly and spontaneously developed a collaborative approach to playing with the Shadow Box. For example, if child A selected a picture object, child B would start looking for the matching word by trying different word blocks on the picture block.

The overall reaction from children was very positive. One boy who was three became so engaged with the Shadow Box that he played with it for half an hour until his parents had to lure him away to go home. Another girl who was also three became immersed with the 3D animation and moving on-screen objects. Upon the display of the animation, she screamed and reached her hand out to grab the object.

Figure 3. Children's collaborative learning and play

5. Conclusion & future work

The Shadow Box provides children with a fun and engaging learning experience aimed at the acquisition of pre-reading skills. By teaching children to understand the concept of the word as a distinct unit of representation, we give them the conceptual foundation necessary to more easily acquire advanced skills such as phonemic awareness.

The Shadow Box is an initial investigation into the use of Tangibles to encourage the independent exploration of written language by preschool aged children. By mapping common tasks used in the development of pre-reading skills into a physical, interactive and computational environment, we hope to decrease the acquisition time of these skills while providing a fun and fulfilling experience for children.

We plan to conduct tests to ascertain how well it functions in a real world environment. We are interested in collecting data for two purposes: first to determine acceptance levels among children; second, to elicit feedback from teachers on the effectiveness of the system. By setting up the project at various preschools and conducting short term observations and interviews, we will be able to meet both these goals.

Along with testing of the current system, we would like to expand the functionality of the Shadow Box to enable it to work for children at a variety of reading levels. The ultimate goal would be to assist children in the development of pre-reading skills leading towards phonemic awareness. Since phonemic awareness has been directly linked to the development of good reading skills, augmenting the Shadow Box to allow children to explore the relation of letters to sound would make it an even more robust and useful educational tool.

6. References

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