Vision 3D: Digital Discovery for the Deaf

Becky Sue Parton, Ph.D.
Southeastern Louisiana University
becky.parton@selu.edu

Robert Hancock, Ph.D.
Southeastern Louisiana University
robert.hancock@selu.edu

Abstract

Since many Deaf children are not exposed to fluent ASL during their early years, they must be presented with language acquisition opportunities in a direct way upon entering pre-school (Ardis, 2006). Additionally, the National Agenda directs deaf education to make emergent technologies integral to the learning process (Stifter, 2005). Because young children need concrete experiences, there ideally needs to be a direct link between digital representations and the real world (Chipman, 2006). A technique that has been successful in connecting physical and virtual environments is radio frequency identification (RFID). With the Vision 3D project, common objects such as an apple are tagged and placed in classrooms. Children explore, select items, and simply move them over the RFID reader. A multimedia presentation is automatically launched containing the ASL sign, supplemental video, and the English word for print exposure purposes. This article describes a pilot study conducted at the Louisiana School for the Deaf along with a review of the literature.

Keywords
[RFID, Deaf, Educational Technology, Tangible Interaction, Exploratory Learning]

Introduction and Background

Several terms such as ‘tangible interfacing’ and ‘physical browsing’ have been coined to address the concept, dating back to 1993, of creating a direct link between computer-based activities and real-world objects and events (Price, 2008; Valkkynen, Niemela, & Tuomisto, 2006). Although the field is still in its infancy, especially in regards to special needs populations, there has been increased momentum behind related research projects as evidenced in part by the creation of the International Conference on Tangible and Embedded Interaction (TEI) in 2007. In fact, Girouard, Solovey, Hirshfield, Ecott, Shaer, Jacob assert, “Tangible computing combines the best of the digital and physical worlds: real time feedback for each student and physical manipulatives to promote abstract learning” (2007, p. 183). Price (2008) echos that sentiment adding that learning and cognition theories offer compelling rationales for investigating tangible interaction. A technique that has shown potential in bridging that connection between concrete environments and virtual artifacts is radio frequency identification (RFID).

One of the first wide-spread uses of RFID technologies in the field of education was for enhanced museum experiences whereby supplemental materials were delivered via PDAs, mobile phones, or other handheld devices (Papadimitriou, Komis, Tselios, & Avouris, 2006; Whitehouse & Ragus, 2006). At the Exploratorium, a hands-on science museum in San Francisco, and the Tech Museum in California, participants took the approach of ‘bookmarking’ exhibits by tagging them with a mobile RFID reader for later study (His & Fait, 2005). Chipman and his research team

(2006) developed a similiar project utilizing ‘Tangible Flags’ that leveraged mobile devices to create the link between the real and digital worlds. Alternatively, research reported by Osawa, Noda, Tsukagoshi, & Norma (2007) focused on student interaction during the exploration by using RFID tags to initiate quiz questions and scavenger hunts. Their later study focused on enhancing outdoor learning experiences through a similar technique.

While mobile computing coupled with interactive physical displays provides an outlet for enrichment experiences for older student and adults, they are not the best match perhaps for early childhood learners. Very young children learn by exploring their surroundings, mostly by playing during which they construct mental representations of the world Hengeveld, Voort, Balkom, Hummels, & Moor, 2007). Traditional computer interactions are not ideally suited to this purpose, but combined with tangible interfaces, they can be a powerful tool. According to Hengeveld et all (2007), these dual approach systems offer stimulation of multiple senses and skills, room for social interaction, and more active and personal involvement. They can also be beneficial to anyone having difficulty or inexperience using a mouse or a keyboard (RFID Learning Table, n.d.). Presenters (Sung et all, 2007, ¶ Related Works) at a recent International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL) conference put it best:

> 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. Conventional computers do not support concurrent interaction and physical exploration experience which is most familiar to preschool children.

Prior to Piaget’s formal operational stage (i.e. age 11 approximately), children need concrete, hands-on, experiences rather than abstract concepts to support more natural learning, developing and thinking (Marshall, 2007; Parton, 2004). Marshall (2007) further stresses that tangible interfaces might be particularly beneficial to young children, people with disabilities, and novice users; however, the cognitive benefits of such designs have been largely untested. Despite the lack of empirical research, there are several descriptive studies that appear in the literature and reinforce the potential benefits of using tangible representations of real-world objects in conjunction with digital presentations to add authenticity to the learning experience.

A prototype called ‘Ducks and Frogs’ used the RFID Learning Table to show students how a water recycling system works by placing a manipulative (i.e. a toy duck or frog) on a map illustrating various parts of the water recycling system. When any of the items were scanned, the embedded RFID tag triggered a matching instructional video (RFID Learning Table, n.d.). Both the Learning Table and a product called the ‘RFID mon amour’ allow non-technical personnel to create interactive exhibits by mapping RFID tags to a video or other reference (i.e. a web page, a power point show, or a flash file) through a simple software interface (Whitehouse & Ragus, 2006). A commercial product called the TOM Learning and Therapy System allows students to place wooden objects on an activity board and thus trigger related digital content such as the sound made by the represented animal (Platus, n.d.). However, many researchers have also developed customized hardware/software units to meet the unique needs and goals of their projects.

Sung, Levisohn, Song, Tomassetti, & Mazalek (2007) created such a package called the 'Shadow Box' which consisted of a stationary RFID reader with an output monitor. Three to four year old children were given blocks of wood with embedded RFID tags – in this case some which were shapes of common items (i.e. a lion) and others which were written word equivalents. The child then had to present the two matching puzzle pieces to the RFID reader and in turn receive appropriate feedback displayed on the monitor (Sung et all, 2007). In order to address the needs of an underserved population, multi-handicapped toddlers under four years old, a research project called LinguaBytes was developed for the purpose of stimulating language and communication skills. As a result of the project, a system called KLEEd (Kids Learn through Engaging Edutainment) was setup that contained a sensor-embeded mat and a set of tagged objects to support interactive stories (Hengeveld, Voort, Balkom, Hummels, & Moor, 2007). Another project labeled 'Smart Blocks' allows students to assemble blocks on a special surface called the 'WorkSpace' which contains an RFID reader. Each block and connector also contain unique RFID tags so that as a shape is assembled, the system can interactively update the surface area and volume through the underlying Java program (Girouard et all, 2007). It thus appears that tangible interaction research is a viable strategy to explore especially with young children for learning in the digital age.

Background on Deaf Children

This system was initially developed for the purpose of helping Deaf children acquire language and expand their scaffolding of concepts. Deaf children are most often born to hearing parents, most of whom do not converse fluently in American Sign Language (ASL) (Gentry, Chinn, & Moulton, 2005). Thus, only a small percentage grows up with the opportunity to develop language and vocabulary associations naturally through incidental exposure to language and learning at home (Erting & Pfau, 1997). These students often begin school behind their peers and are much more likely to demonstrate weaker performance on state, national, and international achievement tests (Grigg, Daane, Jinn, and Campbell, 2003; Kindler 2002; Siegal, 2002). Early intervention can help reduce this gap before it begins. "By the time young children with hearing loss enter school they must be directly and purposefully presented with words, concepts, and ideas about the world" (Ardis, 2006, p.1). A traditional approach for accomplishing these tasks is to couple objects in the classroom environment with simple drawings to depict the corresponding signs in addition to teacher-intensive guidance. However, research studies support the notion that technology is a viable and mandated component of deaf education (The National Agenda, 2005; Stifter, 2005). Specifically, a combination of media elements (photos, video clips, and signed animations) tied to tactile experiences through transparent technology might be most effective (Parton, 2006). It was with this goal in mind, that our team began developing a prototype.

Technical Notes

The Vision 3D project, a branch of The Language Acquisition Manipulatives Blending Early-childhood Research and Technology (LAMBERT) Learning Systems, was built in phases.

See figure 1 for the initial design concept. First, a list of 25 high frequency vocabulary words for children in the three to four year old range was constructed. Concrete nouns (i.e. apple) were chosen for the first round of development. A 15-20 second multimedia presentation was then created for each object. The key components for each one was (see figure 2):

- A video of a human interpreter signing the word (along with the object's image)
- Three to five photographs and clipart images depicting variations of the object (i.e. a yellow and red apple, an apple on a tree, etc)
- A video of an avatar (animated character) signing the word beside the object
- The written English translation for the purpose of print recognition.
- An audio file of the English translation to accommodate hard-of-hearing children.

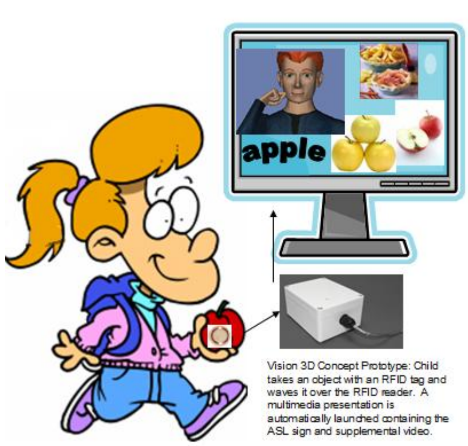

Figure 1 – Concept Prototype

Sign Smith Studio and Adobe Premier were used to edit the videos. Adobe Flash along with software that was developed in-house was used to convert the completed media files into executables that would launch automatically based on the RFID tag number. A subsequent step was to select a type of RFID tag and reader to use. In a previous study (Parton & Hancock, 2008), kindergarten students, who were hearing, were asked to try to activate two low cost RFID readers using two types of inexpensive tags. Although all four RFID hardware configurations worked, the pcProx reader, due to its keyboard mimic properties, with the clamshell tags presented the optimal combination. The size of the clamshell tags makes it easy for children to identify them, contains a slot that makes it easy to attach them to objects, and provides a flat surface on which to place a printed sticker identifying the tag. Finally, physical representations of the objects were selected based on the following three criteria:

1. The artifact had to be easily recognizable. It could be an authentic object (i.e. a box of crayons) or it could be a symbolic object (i.e. a plastic apple).
2. The artifact had to be a typical variation of the concept. For example, a white stuffed tiger would not have been selected since tigers are typically orange.
3. The artifact had to be associated with only one primary concept. For example, a stuffed Dalmatian dog wearing a fireman's outfit would lead to ambiguity over the target vocabulary and would therefore not be selected.

The RFID tags were then attached to these tangible toys and it was time to test the system.

Figure 2 – Sample Components of the Multimedia Presentation for “Apple”

Pilot Study Results

The prototype was setup at the Louisiana School for the Deaf in a preschool room and kids from multiple classes (ages three to five) rotated to the station to “play” with the toys. The children picked up the process very quickly. Their teacher showed them one time in a big group circle and after that the students selected objects from the table and touched the RFID reader with little to no assistance. They would also immediately look at the computer monitor to see the presentation and were noticeably excited as they watched. See figure 3. Since it was the end of the school year and most of the vocabulary was familiar to the students, they would often also sign along with the video. The children were engaged in the learning process and interacted with the manipulatives in a natural way so that the technology became a facilitator rather than a distracter.

Although the results of the pilot study were very encouraging, some areas for further discussion and improvement were discovered. First, the teachers unanimously requested that in future sessions the output should be projected onto the Smart Board to foster a more collaborative, group oriented environment rather than on an individual monitor. Second, the need for an expanded bank of vocabulary concepts was apparent both in terms of the number of words and in terms of the type of words (i.e. not only nouns).

Conclusion

The LAMBERT pilot project was well received by the initial teachers and students who helped test its usability. The RFID technology was well-suited for use with young children based upon these preliminary results. The project is currently being expanded to address the limitations mentioned previously in terms of vocabulary. Pending grant funding, there are also plans to extend studies investigating the impact of the tool on the vocabulary acquisition and retention rate for bilingual children.

Figure 3 – LSD Pilot Study

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