INTERACTIVE MEDIA TO SUPPORT LANGUAGE ACQUISITION FOR DEAF STUDENTS

By

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ABSTRACT

Tangible computing combines digital feedback with physical interactions - an important link for young children. Through the use of Radio Frequency Identification (RFID) technology, a real-world object (i.e. a chair) or a symbolic toy (i.e. a stuffed bear) can be tagged so that students can activate multimedia learning modules automatically. The authors developed a prototype called LAMBERT (Language Acquisition Manipulatives Blending Early-childhood Research and Technology). It is designed specifically for Deaf children who often need additional exposure to language since the majority of their parents are hearing and not fluent in American Sign Language (ASL). When a child scans a toy, a 15 second multimedia presentation is played that depicts the word in ASL and shows related images. After an initial positive pilot study to test feasibility, the system was integrated into the early childhood curriculum at the Louisiana School for the Deaf for four weeks. Twenty four vocabulary words were taught; half of the words were targeted for supplemental instruction through the LAMBERT system. At the end of the unit, students' vocabulary comprehension was tested. This paper discusses the results of the study and implications for easily-accessed multimedia for young children.

Keywords: Deaf, Multimedia, Tangible Computing, RFID, Exploratory Learning, Educational Technology.

INTRODUCTION

Background

RFID Facilitates Physical Connection to Digital Information

Tangible technology is a term that refers to directly linking computer-based activities with real-world physical objects and events (Chipman et al, 2006; Price, 2008; Sung et al, 2007; Valkkynen, Niemela, & Tuomisto, 2006). For young children, those who have yet to reach Piaget's formal operational stage, tangible computing offers a more concrete approach to digital learning and exploratory play (Hengeveld et al, 2007; Marshall, 2007). Although the field is still in its infancy, especially in regards to special needs populations, multiple researchers recognize that tangible computing combines the best of both the digital and physical world in a way that traditional computer interactions cannot (Girouard, et al, 2007; Price, 2008). Presenters (Sung et al, 2007) at an 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 exploratory experience which is most familiar to preschool children.

A technique that has been successful in bridging connections between the physical environment and virtual artifacts is radio frequency identification (RFID). RFID tags can be embedded into almost anything and can subsequently be used to trigger rich multimedia presentations. Using RFID readers is beneficial to anyone having difficulty or inexperience using a mouse or a keyboard including young children (RFID Learning Tablet, n.d.).

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 et all, 2006; Whitehouse & Ragus, 2006). While mobile computing coupled with exhibit information provides an avenue for enrichment experiences for older students, they are not the best match perhaps for early childhood learners (Parton, Hancock, & Mihir, 2009).

Only a small handful of prototypes have been developed that specifically focus on using RFID technologies to facilitate tangible interaction for young children. For example, one research team developed a hardware / software unit called the 'Shadow Box' which is a stationary RFID reader with a connected output monitor. Three to four year old children were given blocks of wood with embedded RFID tags in this case some were shapes of common items (e.g., a lion) and others were written in 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 al, 2007). It appears that tangible interaction research is thus a viable strategy to explore especially with young children, but it is an area that has to date received little formal research attention.

Early Childhood Deaf Education

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; Hoofmeister &Wilbur,1980). "Unlike Signed English, which is a manually coded form of English, ASL is distinct from English in that it has its own syntactic, semantic, and pragmatic systems" (Gentry, Chinn, & Moulton, 2005, p.397). Thus, only a small percentage of children grow up with the opportunity to develop language and concept associations naturally through incidental exposure to language and learning at home (Erting & Pfau, 1997). There is a strong linkage between early signed language exposure for deaf children and later academic achievement (Chamberlain, Morford, & Mayberry, 2000). Therefore, upon entering school, young Deaf children must be purposefully presented with vocabulary concepts, and a need for child and teacher-friendly resources to support that goal is evident (Ardis, 2006; The National Agenda, 2005).

In recent years, research studies have supported the notion that technology is a viable and mandated component of deaf education (Easterbrooks & Stephenson, 2006; Parton, 2006; Stifter, 2005). The National Agenda (2005) directs deaf education to make technology integral to the learning process and to incorporate "… access to contemporary and emerging technologies" (p.35). Specifically, early research on Computer Aided Instruction found that ASL generated on a computer could positively impact the sign language production of deaf children. More recent research also appears to strengthen the connection between multimedia presentation and retention especially in terms of user engagement (Gentry, Chinn, & Moulton, 2005). Although there is a limited amount of data in the literature, descriptive findings suggest that sign language knowledge can be acquired and/or reinforced through multiple rendering formats. A study in 2005 outlined how deaf and hearing children without any prior exposure to sign language could learn signs accurately from computer avatars (Naqvi, Ohene-Djan, & Spiegel). The authors also hypothesize that a connection exists between the appearance of avatars and cartoons which increase the comfort and engagement level for the child.

Until now, though, there is no mention in the literature of research being conducted to tie the benefits of multimedia to a mechanism that is easy to use and age appropriate for Deaf children. It is this real world linkage of objects to signs that is essential to early language acquisition for the deaf, yet this linkage can presently be established only through interaction with an appropriately trained teacher. Therefore, the authors recently developed a prototype system that combines media elements (photos, video clips, and signed animations) with tactile experiences whereby the technology is transparent (Parton & Hancock, 2008).

The LAMBERT System

The Language Acquisition Manipulatives Blending Early-childhood Research and Technology (LAMBERT) project was developed to address the need described earlier for a child-friendly, interactive tool to support ASL vocabulary mastery. The system consists of the following components which are illustrated in Figure 1.

An RFID reader that attaches to the USB port of a desktop or laptop computer. A previous study revealed that the pcProx keyboard emulator style of RFID reader was the best match for the prototype (Parton, Hancock, & Mihir, 2009).

A set of toys that have each been attached to a clamshell style RFID tag. The tag also contains a sticker with an image of the vocabulary concept for reinforcement purposes. or the initial prototype, 25 such toys were included in the kit. The target vocabulary words were all concrete, high frequency nouns (i.e. apple) appropriate for three to four year olds.

Software developed by the researchers that allowed for automatic launching of multimedia presentations that corresponded to the tagged objects. The software works on a Windows platform and hides in the background until a presentation is triggered by an RFID scan. The presentations each lasted 15-20 seconds and featured (Parton & Hancock, 2008):

A video of a human interpreter signing the word (the video is superimposed with an image of the object)

Three to five photographs and clipart royalty-free images depicting variations of the object (i.e. a yellow and red apple, an apple on a tree, etc)

Figure 1. Example of the LAMBERT system and a partial multimedia sequence for "sheep"

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.

A prototype was setup at the Louisiana School for the Deaf in a preschool room. The classroom teacher showed them as a group how to use the system, and then they were allowed to explore. Even at three years of age, the students easily picked up the process and were able to launch the presentations without any problems or assistance. They were noticeably excited as they watched and often signed along with the video (Parton & Hancock, 2008). During the pilot study, the researchers observed that the technology was facilitating in a transparent manner rather than becoming the focus of the learning experience. The pilot study showed that the system was feasible to use with this population group and was favorable received; however, it did not address whether the system would impact vocabulary acquisition.

Methods

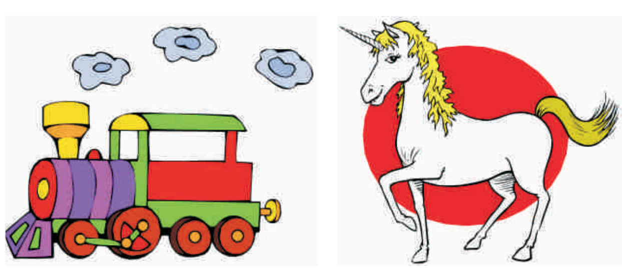
The purpose of this study was to determine what impact, if any, the LAMBERT system had on vocabulary acquisition to determine if a larger scale study was warranted. To this end, the authors set up a quasi-experimental research study in which purposeful sampling was used to select the participants. All seven of the children who attended the preschool class for three and four year olds at the Louisiana School for the Deaf were invited and agreed to take part in the study. Appropriate parent consent forms were obtained. Only minimal demographic information was collected on the individual participants such as the hearing status of their parents and whether the child had been diagnosed with a disability. These children had previous exposure to the LAMBERT system through a pilot project earlier in the school year; thus, they already knew how to operate the system and no technology learning curve was present.

The researchers requested a list of target ASL vocabulary words for a one month time period from the preschool teacher. To maintain consistency, she continued an established pattern of selecting vocabulary words whose English equivalents began with a particular letter for each week in this case "r,s,t,u". Table 1 shows a list of words. There were 24 words total which were then divided into 12 control words and 12 experimental words. They were divided so that each week's worth of words would contain some control and some experimental vocabulary.

The classroom teacher gave a pre-test to the students over all 24 words by showing a clipart image of the vocabulary and asking the children to sign the word. Figure 2 shows the sample of the instrument. She gave the children two attempts to sign the correct answer and then marked the response sheet appropriately (a yes or no). Although no statistical data is available on the validity and reliability of the instrument, it covered all the words the students learned during the study time frame and was reviewed by two instructors. The testing procedure was conducted in essentially the same manner as the teacher had operated in the past, thus she was very well

Control Words	Experimental Words
Rainbow	Ring
Rain	Rabbit
Ribbon	Rope
Robot	Radio
Scarecrow	Star
Snow	Sun
Sand	Train
Spaceship	Telephone
Triangle	Tiger
Teddy Bear	Truck
Unicorn	Tree
Umpire	Umbrella

Table 1. Vocabulary Words



Train - An Experimental Word   Unicorn - A Control Word

Figure 2. Sample of Evaluation Instrument

trained on how to administer the tool. These facts add to content and reliability evidence.

For the next four weeks, all the children were exposed to all of the vocabulary words through traditional teaching methods. In this classroom, those methods include direct one-to-one demonstrations of the sign, authentic experiences with the concepts (i.e. if the word is rain, the kids might go outside on a rainy day for vocabulary reinforcement), and practice with peers. In addition, the LAMBERT system was set up as a center. Figure 3 shows the photo of the children at the center. The 12 experimental words were available at this station as they were introduced throughout the weeks. As described earlier, each word was represented by a tangible manipulative (i.e. a toy) that the children could pass over the RFID reader and see the multimedia presentation. This presentation included a human signer, an avatar signer, the printed English equivalent word, and a variety of images to illustrate the concept. The children were required to go to the center each day for approximately 20 minutes; however, the words chosen and the number of repeat viewings were up to them. The children went to the center in groups of two to three, so in addition to the presentations he/she triggered, they also watched each other interact with the system.

At the conclusion of the four weeks, the students were once again evaluated by the classroom teacher. Using the same instrument, she gave them a post-test to determine if they knew the vocabulary words. They were

Figure 3. Children at the LAMBERT center.

again given two attempts and then she marked the sheet appropriate (no, it was not mastered or yes, it was mastered).

The researchers obtained the scoring sheets for the seven participants and determined that one needed to be removed. This student demonstrated mastery of all the words at the time of the pre-test and subsequently at the post-test so the impact of the LAMBERT system was not relevant. It is interesting to note that this child was the only subject who had Deaf parents and, not surprisingly, was at advanced level compared to his/her peers in terms of vocabulary acquisition.

Analysis

Data analysis was conducted on collected data in order to test the research hypothesis. The null hypothesis states that there is no statistically significant difference between the vocabulary acquisition levels of Deaf three and four year olds who are taught using traditional methods alone versus those who are taught using a combination of traditional methods and the LAMBERT learning system.

The first step in testing this hypothesis was to remove the pre-test responses from the dataset that indicated the vocabulary was already known. In other words, if a child knew the word before receiving any instruction, traditional or LAMBERT-based, it did not make sense to include it. Aside from the child mentioned above, the other six subjects had a mix of words they knew and didn't know at the beginning of the instructional period. This procedure resulted in a remaining dataset of 38 instances of experimental words and 56 instances of control words that were unknown at the pre-test time.

Table 2 gives a descriptive look at the post-test scores. In summary, in regards to words unknown at the pre-test time, 58% of the words taught using the LAMBERT system were mastered by the post-test; whereas, only 18% of the words taught only using traditional methods were mastered by the post-test. A chi-square test of independence was conducted to test for an association between the type of instructional method (control or experimental) and successful signing of the word during the post-test. The chi-square statistic, $X^2(2) = 16.162$, $p = .000$, indicated a significant association between the two variables; therefore, the null hypothesis was rejected. The research hypothesis, that there is a difference between the vocabulary acquisition of participants who were taught using traditional methods and those who were taught using a combination of traditional methods and the LAMBERT system, was supported. The phi coefficient was .415 which indicated a medium to large effect size.

	Post-test Successful	Post-test Not Successful	Totals
Experimental Words	22	16	38
Control Words	10	46	56

Table 2. Descriptive Look at Post-Test Results by Group

Discussion and Conclusions

In an increasingly digital world, young children still need to connect to information through active learning in the physical realm in order to establish strong building blocks of knowledge. Nonetheless, the power of multimedia to engage kids and provide an avenue for repetitive instruction is also well documented, especially for Deaf students (Burik and Kelly, 2003). The LAMBERT system's approach of linking computer videos through toys satisfies both of these concerns in a way that is not dependent on the technology skills of the user. Based on the results of the data analysis from this study, it appears that the LAMBERT system has the potential to impact vocabulary acquisition in a positive manner for Deaf pre-school age children.

There are, however, several limitations of the current study. The sample size is quite small and would need to be increased in order to generalize the results. In addition, multiple factors could have influenced the results. For example, some of the words were taught in week one and some in week four thus possibly making them easier to remember on the post-test. Also, the traditional teaching methods may not have been uniformly applied to all the words some may have received more attention than others. Both the control and experimental words, though, would have been subject to these anomalies.

Perhaps the most interesting finding of the study comes from a closer look at the individual responses of subjects. The only new words that two of the six children learned were ones that were taught using the LAMBERT system. Therefore, a recommendation for future study is to investigate whether the system is more beneficial for a particular sub-population of students. It could be that the LAMBERT system is beneficial to deaf children in general, but to a greater degree for children with specific demographic characteristics whether that be the type of home environment, the presence of a disability, or another factor. In this case, one of the children that only learned words that were taught using LAMBERT, was labeled as autistic.

This study only looked at a one-time snapshot of the comprehension of a set of vocabulary words. Thus it primarily addressed the question of whether the LAMBERT system helped children initially learn words. A future study should look at the retention rate of the vocabulary words and in essence address the question of whether the LAMBERT system helps children to move the concepts into their long-term memory and working vocabulary. In addition, a future study should look at the rate of acquisition of vocabulary. Specifically, it should investigate whether children who become proficient at words both with and without the system learn them faster using LAMBERT.

Finally, a variety of classroom teachers and environments should be included in the next study. The instructor for these children had a very creative approach to teaching the words that included many authentic experiences that are usually not provided to students. In addition, the residential nature of the school gave some of the students an added advantage of being surrounded by Deaf children and adults for extended periods of time. It is possible that the LAMBERT system could benefit students in conventional classrooms and those mainstreamed with hearing children more so than it did in this particular setting. Alternatively, the children might be best served through use of the LAMBERT system in their home environment in addition to the classroom setting where there are less time constraints and the possibility of fostering parent-child interaction.

Although this study was a preliminary look at how the LAMBERT system could help young Deaf children learn ASL vocabulary, it provided an important first step and insight into the types of variables to examine closer. Moreover, the use of tangible media is not limited to children who are Deaf, and thus there are implications and opportunities for research with other population groups. For example, would the LAMBERT system similarly benefit hearing children who are autistic and use ASL to communicate? Would a modified system benefit children who are learning English as a second language? Regardless of the learning objective, multimedia that interacts with the real world appears to an educational approach worth investigating.

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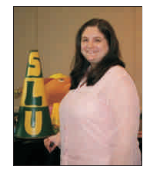

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