

# REVOLUTIONIZING LANGUAGE INSTRUCTION IN ORAL DEAF EDUCATION

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## ABSTRACT

This paper provides an overview of the challenges facing education of deaf children and results obtained thus far in the United States. It then describes Tucker-Maxon Oral School in Portland, Oregon and the introduction of an animated conversational agent, Baldi, into its classrooms and speech lab. The paper outlines ways in which the professional staff has utilized this technology and the reactions of the students to it. The paper concludes with observations about the potential impact on oral education of deaf children.

## 1. BACKGROUND

The overriding consequence of prelingual deafness is a dramatically lessened ability to acquire language at a rate and level that is consistent with the expectations and demands of society. The large majority of deaf children achieve linguistic abilities that severely impact academic and vocational achievement. A wealth of research documents that the average deaf student leaving high school in the United States has, at best, a 3<sup>rd</sup> to 4<sup>th</sup> grade reading level [2]. This has not changed in nearly 100 years. The dominant reason for this low achievement is the dramatically reduced amount of language input and thus language competence brought on by the hearing loss at precisely the time when the brain is most primed to take advantage of such information [5].

Proponents of all philosophies of educating deaf children (oral, sign, or combinations thereof) agree on one important issue: The communication and academic learning demands placed on deaf children in school require small class size. Classrooms for deaf children typically range from 4 to 10 children [4]. Educators agree that this low ratio is necessary if deaf children are to learn successfully.

In addition to the low student-teacher ratio, it is common for schools to supplement the teacher with an assistant. The rationale being that deaf children require intensive one-to-one and small(er) group instruction to achieve communication and academic competence. In addition many programs for deaf children employ speech/language pathologists to provide additional therapy on an individual or small group basis. The amount of time allocated for this support typically varies from 15 to 60 minutes per week. In addition to these school-time additions most schools and programs for deaf children offer intensive parent instruction and guidance [1]. The assumption is that parents who understand the process and demands of learning to communicate will be better able to support that development. Again, increasing the amount and quality of time-on-task communication practice.

Taken together these four factors – low student-teacher ratio, instructional assistants, one-on-one instruction from the speech/language pathologist, and parental involvement – are put in place to increase the amount of “time-on-task” that each deaf child spends learning communication and academic skills.

Unfortunately, as noted above, this expenditure of resources and energy has not provided the typical deaf student with sufficient language, whether oral or signed or both, to achieve even minimal reading and writing competence. Children in an oral communication approach must overcome spending as much as their first 18 to 24 months with no or very little auditory input and thereafter must cope with a degraded auditory signal, no matter how good the amplification device. Children in a sign language approach most often live in a home where their parents are trying to learn a second language and help teach it at the same time.

Infant hearing screening programs offer great promise for the future, since they will identify children with hearing loss at birth so that they have the maximum opportunity to learn language [5]. However, until such programs become widespread, the majority of deaf children will continue to be identified at around 18 to 24 months of age and will require intensive schooling to acquire linguistic and academic competence. Thus, it is necessary to develop more effective and efficient means of instruction. Reducing class size even further, adding additional instructional assistants, and/or requiring more time from parents do not seem feasible given the current time and financial constraints placed on families and education.

Interactive language technologies offer a very promising and cost effective means of increasing the quality of education for deaf children, particularly as it pertains to developing and refining spoken communication skills. In this article I discuss the use of interactive language technologies, in the form of an animated conversational agent called “Baldi,” and describe our experiences using Baldi for learning and language training at Tucker-Maxon Oral School.

## 2. TUCKER-MAXON ORAL SCHOOL

Tucker-Maxon is a 51-year-old independent school for profoundly deaf children in Portland, Oregon. We were founded by five families who wanted their deaf children to learn to talk and acquire the academic and social competence they needed to succeed in regular education, without the use of sign language. We currently enroll 53 children ranging from infants through high school. Our infants are seen twice a week with a parent and our preschoolers are concurrently enrolled in a regular preschool with hearing children and in a small self-contained class. Our elementary children are in self-contained classes or small groups that include hearing children of similar ages. Five of our elementary children split their day between a self-contained class and a class in their neighborhood school. In addition several elementary children and all of our junior and senior high children are enrolled in regular schools with daily support from one of our teachers. We have 10.5 teachers, an audiologist, speech pathologist, and 6 teacher aides. Our adult-to-student ratio in classrooms is three-to-one. Twenty-eight of our students have cochlear implants and the remainder wear powerful hearing aids.

All of our students receive daily individual speech and language instruction from their teacher and the children in self-contained classes receive 30 minutes per week of instruction from our speech pathologist [7]. Our academic curricula follow guidelines established by the Oregon Department of Education. Parent participation is an integral component of our program at all age levels. They are expected to observe class and confer with their child's teacher on a monthly basis, participate in four conferences per year, and be actively involved in homework assignments.

The oral communication skills and academic abilities of our students far exceed the national averages cited above. Our students have graduated from nearly every high school in the metropolitan area and over 40 colleges and universities. While we are able to provide a superior oral education, every member of the staff continually searches out ways to do even better by our students. A most promising innovation we have incorporated in this regard is Baldi, who has the potential to provide the same or better high-quality education with much more efficiency.

### **3. BALDI – AN ORAL LANGUAGE TUTOR**

Since the summer of 1997 Tucker-Maxon has been cooperating with the Center for Spoken Language Understanding at Oregon Graduate Institute and the Perceptual Science Laboratory at the University of California at Santa Cruz to develop and refine an animated conversational agent, Baldi, which can easily be incorporated into the classroom instruction routine. A three-year NSF Challenge Grant funds this effort. From the outset this project has been based on the principles of participatory design, i.e., the users of the software - teachers and students - work closely with the researchers and programmers in every phase of design, development, and implementation. (More information on the specifics of the process that we follow appears in "Participatory Design: Classroom Experiences.")

In August 1997 two teachers, the speech/language pathologist, and I completed a one-week short course in how to develop applications using the CSLU Toolkit, which is the software environment in which Baldi resides. (A detailed description of the CSLU Toolkit and Baldi appears in the three companion papers of this symposium.) During the short course we became convinced that Baldi could become an additional conversational partner for our students. A partner who would listen carefully, respond appropriately, and offer constructive feedback. In essence, performing the tasks of a never tiring, well-trained, and cost effective instructional assistant. We envisioned immense gains for our students as we increased their meaningful time-on-task for language learning.

Intel donated 4 computers, two of which went into a classroom of 10 to 12 year old children, one in a class of 7 to 9 year olds, and one in the speech lab. We began creating applications, individually and in cooperation with the researchers and programmers who were at school on a regular basis. These applications provided students with the opportunity to learn and practice new academic vocabulary, to engage in speech perception tasks, to practice speech production of phonemes and words, to solve math problems, and to answer comprehension questions following a story. The power of well designed lessons using Baldi was demonstrated by a 9-year-old girl who asked to repeat a listening/speech lesson three times until she had a perfect

score. She then asked to have her results printed out so that she could show me.

The design team - teachers, speech pathologist, and researchers - met on a weekly basis to compare notes and exchange ideas. These meetings generated an ongoing "wish-list" of improvements the staff wanted to have incorporated into the Toolkit and Baldi. Sometimes we asked for improvements that were beyond the capability of the technology, but many, many modifications and improvements were made that make it easier and easier to create more complex and interesting applications. In addition to the regular members of the design team we invited several deaf adults, all of whom are excellent lipreaders, to assess the quality of Baldi's performance. Many of their suggestions have also been incorporated.

At the beginning of the second year of the project we added another teacher with her class of 7- to 9-year-olds, completed a second short course at OGI, and, again thanks to Intel, added 10 computers to the project. In addition two researchers were assigned full time at Tucker-Maxon. The work of creating applications continued at an even higher level as the computer programmers added features to the Toolkit and as the teachers became more skillful. Periodic meetings of all members of the team continue and we have begun teaching students how to create their own applications. In each of the three classrooms and the speech lab Baldi has become an integral part of the instructional routine.

### **4. CLASSROOM APPLICATIONS**

In his classroom of 10- to 12-year-old students, teacher George Fortier has been creating interactive media activities with the CSLU toolkit for all classroom subjects. This year, he has transformed his students from users to creators by taking them on a natural course of scientific inquiry.

During the first two months of the 1998-1999 school year, George developed learning and language training applications in which students experienced the range of capabilities available within the toolkit. Next, George revealed to his class how each toolkit object functioned, and worked with the students to develop new learning applications using the graphical authoring tools. Students were then encouraged to work independently in pairs to build similar applications. George continues to introduce the students to new features of the toolkit, but no longer asks them to recreate his applications. Rather, he leaves them with the open-ended task of creating new applications that incorporate the new object or feature.

George Fortier is continually exploring new avenues through which his students can express themselves. He finds the toolkit a novel and dynamic medium which not only motivates his students to seek knowledge, but also to show what they have learned in creative, personal ways. In a recent social science activity, George combined content area research on the Iroquois Native Americans with computer skill practice using the toolkit. He showed students how to use the tools to align the animated face with natural speech. He asked them to incorporate this feature into their applications on the Iroquois. Once all groups complete the project, they will vote on the best application, and this will be available from the school Web site.

The 8 to 10 year old students in Alice Davis' class work on the computers individually each day to practice vocabulary and review subject lessons. One day each week they attend a half-hour

computer session, in which they learn how to use the toolkit to make their own applications. The instructor usually suggests the computer activity and content themes. For example, one week the class read the story "The Three Billy Goats Gruff." Students had difficulty with the concepts "on the bridge", "over the bridge" and "under the bridge". The teacher decided to use Friday's computer session to develop applications to review these concepts.

On Friday, the students were given paper copies of pictures from the story. As a group, they were asked to place the pictures in the correct order. Once the students had discussed the story and agreed on the correct sequence of events, each child moved to a computer terminal and opened an unfinished template application about the "Three Billy Goats Gruff". This included the first picture of the story and Baldi. The next two dialogue states were on the screen, but empty. After watching how to display a picture and type in a prompt, the students chose their own picture to display next and entered their own text into the blank states. The students were asked to use the prepositions "on", "over", and "under" in their descriptions. Once completed, the dialogues were run and the students made revisions (e.g., moved the picture to a different location on the screen, changed the prompt, or corrected their use of the prepositions.). At this point if the students wished to add to the dialogue, they no longer had a template to fill in. Rather, they used their current application as a model, dragging similar objects to the canvas, entering media and text information, compiling, testing and editing. When the activity was complete, each student shared their dialogue system with the group.

The youngest students using the toolkit are 5 children, ages 6 to 8, who spend half of each school day in the classroom of Kerry Gilley. During the other part of the day, they are in a mainstream classroom. With the help of her students, Kerry creates toolkit applications that reinforce their use of every day vocabulary and sentences. The goal of the applications made during her class is to provide an additional mode through which the students can practice language that is immediate in their lives.

Every Monday, Kerry and her students create a "news" application to which they return during the week for review and vocabulary practice. On Monday each student brings in a news item and related picture to talk about. As each student presents his or her news, the instructor sits at the computer and fills in a dialogue template based upon the child's presentation. After all the students have shared their news, the group scans in the pictures and together run the toolkit dialogues to review the news of the day. Each student converses with Baldi, with the dialogues varying mainly in the content provided by the student. For example:

**Baldi:** "What is <STUDENT'S NAME> news?"

*The picture appears.*

**Student:** responds with the news topic (e.g. "Mommy's birthday")

**Baldi:** "Tell me about that."

**Student:** responds with more information (e.g., "Mommy's birthday is Valentine's Day.")

The students repeat the dialogue at specific times during the week for review.

Presently students in Kerry's class are creating mini-autobiographies using the toolkit. The purpose of the activity is to develop language skills to talk about themselves and to introduce the concept of a timeline by presenting their history in

chronological order. For this activity, the children are asked to bring in one photograph for every year of their life. The instructor and assistant scan in the photographs and create an 'autobiography' dialogue template to which the children add content. When the templates are complete, the instructor works with each child to create sentences about the pictures displayed in the dialogue. The outcome of the activity is a dialogue dedicated to and designed in part by each child in which Baldi presents and narrates pictures about each year of the child's life.

Clearly these teachers and the speech pathologist value Baldi's presence. The applications described above required a great deal of new learning, time, and energy to develop. Professionals as busy as these do not lightly incorporate such additional tasks into their planning time. That they have done so demonstrates the instructional power this new technology provides.

The students also perceive Baldi very positively. In response to the question: "Why do you like Baldi?" they responded with:

"Because I can hear him."

"He understands me."

"He doesn't get mad at me."

"He sounds good."

Answering "Is he a good teacher?" they said:

"Yes, he knows about everything."

"I learn from him."

"He teaches me how to say words."

"He helps me remember."

"I can do my lessons many times."

An intriguing aspect to the children's positive response to Baldi is that they perceive him as a true partner. When he makes mistakes, i.e., doesn't accept responses that they know are correct, they say things like, "Baldi needs to listen better." They don't criticize the computer, but the communication partner with whom they are engaged. It is also interesting to think of the dynamic of students being able to control Baldi. In no other learning situation can they demand repetition as often as they want or need, make the voice louder or softer, slow down or speed up the rate of speech, at will. I am confident that having this control makes Baldi more appealing to the children.

## 5. THE FUTURE

Midway through the second year of this project it is clear that Baldi is meeting the expectations that we originally envisioned. He is functioning as a competent instructional assistant able to provide deaf students meaningful practice with listening, lipreading, and talking; practice that increases their abilities and knowledge. Children have learned new concepts and vocabulary solely through interacting with Baldi. In addition teachers report, they have improved the accuracy of phoneme perception and production. Exactly the kinds of gains we expect to come from practice with an experienced teacher assistant. As the technology improves and as we gain sophistication with utilizing it and become more adept at taking advantage of all its capabilities children will make more advances, the ultimate reason for using any technology.

During my 35 years as an educator two technological advances have had a profound impact on oral education of deaf children. The first was the development of the electret microphone (a spin off from the space program) which allowed

our students to begin wearing ear level hearing aids that brought a significant increase in clarity and fidelity [6]. The second was the introduction of the cochlear implant, which brings meaningful sound to those children that hearing aids do not help [8]. Both of these technologies fundamentally altered the way deaf children are taught spoken language and their success at achieving competence.

I believe that the toolkit and Baldi will have a similar impact on oral education. This technology addresses the critical issue of deaf children learning speech and language – massive amounts of monitored practice with appropriate feedback. In the not too distant future I envision every classroom of deaf children whose teacher has the goal of teaching spoken communication utilizing Baldi, or some surrogate relative. They will have available many complete applications, which will teach specific vocabulary, develop and refine listening and speech skills, and tutor students in every academic area. There will also be templates that the teacher can easily and quickly use to create personalized lessons. Baldi will be able to take on the face and voice of celebrities, sports stars, parents, teachers, and children. Every child will have his or her own personal tutor who will provide meaningful speech and language learning. This learning will not be confined to school hours. Using the Internet or hand-carried disks, students will be able to practice at home, or even on the school bus. The power of this extra practice will be multiplied as it allows parents to become more intimately knowledgeable and involved in daily learning.

This increase in time-on-task learning will change forever the dismal results I reported in the opening of this paper. It will bring more and more deaf children the communication and academic skills necessary to survive in a highly competitive world, for as Helen Keller told us: "Speech is the birthright of every child, it is the deaf child's one fair chance to keep in touch with his fellows."

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#### REFERENCES

- [1] Adam, A., Fortier, P., Schiel, G., Smith, M., Soland, C. (1990). *Listening to Learn: A Parent's Handbook*. Washington, DC: Alexander Graham Bell Association for the Deaf.
- [2] Commission on Education of the Deaf (1988). *Toward Equality: Education of the Deaf*. Washington, DC: United States Government Printing Office.
- [3] Ling, D. (1976). *Speech and the Hearing-Impaired Child: Theory and Practice*. Washington, DC: Alexander Graham Bell Association for the Deaf.
- [4] National Association of State Directors of Special Education. (1992). *Deaf and Hard of Hearing Students: Educational Guidelines*. Alexandria, VA: NASDSE.
- [5] National Institutes of Health. (1993). *NIH Consensus Statement: Early identification of hearing impairment in infants and young children*. Washington, DC: Public Health Service.
- [6] Pollock, M. (1975). *Amplification for the Hearing-Impaired*. New York: Grune and Stratton.
- [7] Stone, P. (1988). *Blueprint for Developing Conversational Competence*. Washington, DC: Alexander Graham Bell Association for the Deaf.

- [8] Tucker, B. (1999). *Cochlear Implants: A Handbook*. New York: McFarland and Co.