Voice Recognition and Speech-to-Text Pilot Implementation in Primary General Education Technology-Rich eMINTS Classrooms

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<u>Speech-to-Text Pilot Software</u>

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Abstract

Text to speech (TtS) and voice recognition (VR) software has been in use for over a decade. This qualitative study examines the use of TtS and VR tools in primary general education classrooms. Extant research has limited foci of closely guided instruction in the classroom, typically for students with learning disabilities to improve communication arts skills. The intent of this study was to determine how teachers and students would implement and use TtS and VR software in technology-rich general education classrooms to support student learning needs.

Text to speech (TtS) and voice recognition (VR) software have been examined as both an accommodation and intervention for students with disabilities, usually on a one-to-one basis, with a researcher or aide, especially as a tool for engaging and improving reading. These research efforts are typically conducted after school or during summer months, with children with special needs and of limited duration as reported by Joseph Sencibaugh in his recent meta analysis (2007). Researchers have suggested further study for implementing assistive technology in regular general education classrooms to "level the playing field" among all students in the classroom (Sencibaugh, 2007). Universal design for learning (UDL) research suggests that specific benefits could be derived by many general education students, not just students with special needs, when using assistive technology (AT) in the classroom (Abell, 2005; Acrey, Johnstone, & Milligan, 2005; Downing, 2006; Garderen & Whittaker, 2006; Hitchcock, Meyer, & Rose, 2002;

McGuire, Scott, & Shaw, 2006; Sencibaugh, 2007; Wehmeyer, 2006). Using AT in general education settings can be viewed as a "cognitive prosthesis" (Edyburn, 2006a). As cognitive prosthesis AT is used as a scaffold that will allow struggling students to achieve on a level with their peers. When no longer needed, the scaffold can be reduced or abandoned. A review of the literature found there are no studies extant of multiple technology-rich classrooms[1] in different schools implementing TtS and VR software simultaneously to examine the benefit for all students in the classroom.

Project description

The primary interest for this project was to determine the effectiveness of providing TtS and VR software in technology-rich general education classrooms in grades three through six. The general education classrooms were selected with a homogeneous mix of students, not just students with, or without, special needs. These elementary classrooms typically have struggling emergent readers, English language learners (ELL), and students that struggle with writing and editing skills. Also of interest was the potential of the software for use in response to intervention (RtI) general education classrooms as an accommodation and/or intervention.

In any classroom the instructional time that is lost through remedial teaching puts severe demands on teacher's time and school building resources. Recovery of instructional time and improved student performance is crucial. Any software that could help with regaining instructional time is worth investigation. TtS and VR software has the capacity to act as a facilitator in many ways and allow students to work independently

[1] "technology-rich classroom" as defined by eMINTS standards consists of: a student to computer ratio in the classroom of no less that one computer for every two students, high speed internet access, teacher laptop, data projector and SMART Board™ (interactive white board), printer, scanner, digital camera, and student productivity software along with a teacher who has completed the intensive eMINTS professional development program (more than 200 hours in a two-year period).

while restoring instructional time for the teacher (Dabbagh & Kitsantas, 2005; Franklin, 2007; Iiyoshi, Hannafin, & Wang, 2005; McNamara, O'Reilly, & Best, 2006). Software does not “care” how many times students may ask to have a word repeated to them before they understand how it is said. Nor does software “care” how many times a dictionary definition is asked to be repeated, or used in a sentence, or read to a student. This use of a cognitive prosthesis as a scaffold for all students in the classroom allows for use by individual student need and level of proficiency adding to student self-efficacy (Edyburn, 2006a).

With TtS and VR being possible solutions for skill building that do not involve intense teacher management, this study sought to investigate the implementation of TtS and VR software in technology-rich general education primary classrooms. The study continued through the course of the school year to determine use over one academic year.

Lastly, universal design for learning (UDL) has as a core concept that any assistive device, or AT, may be beneficial to all students, not just those students who have special needs (Abell, 2005; Gordon, 2002; Harac, 2004; Howard, 2004; Pisha & Coyne, 2001; Santovec, 2005). Any general education student can potentially find benefit from using AT in the classroom. Computer technology frequently has gone from an initial classroom use as intervention or accommodation to mainstream use; spell-checking and word prediction are two common examples (Pisha & Coyne, 2001). UDL is a framework for equity-in-learning for all students in the classroom.

enhancing Missouri's Instructional Networked Teaching Strategies (eMINTS) classrooms were known to have the infrastructure and teacher knowledge to support this proposed implementation (see Appendix, Exhibit A for eMINTS research basis). The eMINTS teachers have completed more than two hundred hours of high quality (as defined by both the Missouri Department of Elementary and Secondary Education (MO DESE) guidelines and No Child Left Behind legislation) professional development (PD) over two years. The eMINTS Comprehensive Professional Development (eMINTS-CPD) facilitators work with teachers to implement constructivist based inquiry learning through the adoption of technology into the classroom curricula. Classrooms are equipped with a ratio of no less than one computer for every two students. Every classroom has a data projector connected to a SMART Board™ (interactive white board), scanner, digital camera, printer, and high speed connections to the internet. Over the course of two years teachers are taught to transform their teaching to constructivist, inquiry based methodologies that encourage a deeper student understanding than surface level content memorization while working in cooperative learning groups ("Hallmarks of an Effective eMINTS Classroom," 2005).

Within eMINTS classrooms students quickly come to treat technology as simply another tool for learning. eMINTS-CPD helps teachers prepare students for becoming proficient software users and investigating how they can best exploit software to match and enhance their own learning styles and help peers learn ("Hallmarks of an Effective eMINTS Classroom," 2005). eMINTS classrooms were selected as the most effective classroom environments to explore the use of TtS and VR software for this project.

Literature Review

Relatively little is known about the implementation and continued use of TtS and VR software in primary grades in general education classrooms. Challenges that have been identified as barriers to effectively implementing and using AT in general education settings include insufficient computer to student ratio, inadequate teacher technology training, insufficient funding for software for all classroom computers, or districts cannot complete the infrastructure needed for technology-rich classrooms (Alcantud, Dolz, Gaya, & MartÃ-n, 2006; Balajthy, 2005; Boone & Higgins, 2007; Edyburn, 2006c). If all these needs have been met, teachers may still be teaching students how to use technology, rather than teaching with technology as promulgated in eMINTS classrooms[2].

Computer AT has been used to help students with special needs for over two decades (Forgrave, 2002; Quenneville, 2001). After twenty years of AT in the classroom there are no definitive guidelines for the selection of AT for specific special needs. With the rapid change of software in the general market place it is increasingly difficult for teachers to stay current with advances (McKenna & Walpole, 2007; Mears, 2006). The challenge for teachers working with students with learning disabilities (LD) is finding effective software (Hasselbring & Bausch, 2005). If a student is in a wheelchair sitting at the front steps of the school the need for a wheelchair ramp is obvious. If a student with a learning disability is standing at the doorway to the classroom it is not so obvious what is needed. T. Hasselbring and M. Bausch identified this project tenet,

> …teachers are searching for ways to educate students with disabilities more effectively. Yet too many teachers are unaware of the potential of assistive technologies to empower students struggling to work independently at their grade level. (2005)

Multiple studies have reported benefit from TtS and VR software for students with LD. These studies generally include a small number of students who work intensively for

[2] All participating teachers had successfully completed eMINTS Comprehensive Professional Development (eMINTS-CPD) prior to the start of the project. Training consists of more than two hundred hours of PD over two years, see: http://www.emints.org/programs/comprehensive/ see Appendix, Exhibit B.

mastery of software directly with researchers over a short period of time, generally three to four weeks in summer school or nine weeks during the school year (Beacham & Alty, 2006; Boon, Fore, & Ayres, 2005; Englert, Zhao, & Dunsmore, 2007; Forgrave, 2002; Fuchs, Fuchs, & Hamlet, 2006; Hetzroni & Shrieber, 2004; Higgins & Raskind, 2004; Jerome & Barbetta, 2005; Lancaster, Lancaster, & Schumaker, 2006; Montgomery & Marks, 2006; Quenneville, 2001; Whittaker, 2003).

Other researchers have suggested positive benefits should be possible when effective LD strategies are used in general education classrooms (Barack, 2006; Erickson, 2004; "Recommended Practices and Parent Perspectives Regarding AT Use in Early Intervention," 2006; "Using assistive technologies to ameliorate reading difficulties," 2007) yet the research base does not contain studies conducted across multiple schools in classrooms with sufficient technology resources (hardware, software, and human) to support all the students in the classroom. Dave Edyburn (2006b) expressed the need for varied technology tools and cognitive supports for struggling general education students. These tools can be of great benefit whether the supports are in place for an academic career or only during skill(s) mastery (Edyburn, 2006b). By introducing TtS and VR software in early elementary grades those students that may use AT software throughout their academic career, as a cognitive prosthesis, will become familiar with technology and have access long before being identified for special services. This study examines the possible benefits for all learners in technology-rich general education classrooms when using TtS and VR software.

Research questions

The objective of this pilot project was to examine the learning potential possible when TtS and VR software are implemented in technology-rich general education classrooms based on teachers' perceptions of student use. The specific questions were:

1. How would teachers model the software for student implementation?
    a. How would students implement the software?
    b. Would there be a difference in use over the course of the school year?
2. Would there be an observable difference in use between identifiable group(s) of students?
    a. Would there be an observable difference in use between classrooms and schools?
3. What activities were best suited, over time, to use with the software?
4. What were the teacher perspectives on continued use of the software?

Methodology

Conceptual model

The target population was general education teachers in grades three through five that were successfully teaching in technology-rich classrooms. Additionally, teachers must have completed technology training and implementation at least one year prior to the start of the study to demonstrate persistent use of technology. Special education teachers working with students from the selected classrooms were invited to participate. Assistant Commissioner for Special Education at MO DESE, Melodie Freidebach, identified the eMINTS program as having access to teachers that met these criteria.

The director of the eMINTS National Center and the eMINTS Area Instructional Specialist (eMINTS-AIS) with the most extensive background in special education and assistive technology were asked to review schools and classrooms for a purposive group to invite to participate in this study. It was determined there was an insufficient number of RtI classrooms available for this project. After reviewing the possible eMINTS classrooms and teachers three suburban St. Louis County districts were selected. All teachers met the criteria for participation. Participants were selected from three districts representing multiple classrooms in the same building. One Special education teacher in each building participated.

The project design of using TtS and VR software as UDL, rather than as specific AT for meeting student needs as defined in an IEP, was considered. The possibility that time intensive components, such as training the software to recognize a students voice at a 95% success rate, might not be successful was reviewed. It was unknown if the time requirement, 45 minutes per child, would be restrictive. It was not known if the passage for voice training would be successful. Overall the potential of the software warranted the implementation on a UDL basis. Conceptually the program was thought of as a “mentor” as software would repeat a word, or sentence, as often as a child would ask it to. The conceptualization did not project the program as an expert system as it was not guiding students through a task; however, the software had the capacity of acting as a scaffold for facilitating learning by enabling the student to achieve a level of understanding and achievement he or she was not capable of reaching without the program resources. The use of the software as a scaffold had potential to return to the teacher instructional time that would otherwise be spent on mechanics of the task, not on the learning process associated with the activity.

Project timeline

The study participants met in Spring of 2005 to select the software they would use in their classrooms for the 2006-2007 school year. Several different TtS and VR software packages were demonstrated by special education consultants familiar with various software packages. Teachers collaborated on possible classroom uses and asked questions about the programs. Building principals and the technology or network administrator or information technology (IT) coordinator accompanied participating teachers. Several concerns central to the selection of the software emerged: cost per room (site license or license by workstation), ability to run the software across the network (to supply students with their work or program settings anywhere in the building), program extras (especially the ability to translate to and from Spanish, word predication, multiple use dictionaries, simple operation, access into PDF documents), and which software package could easily be used by students in grades three through five. Teachers were allowed time to work with the different programs and generate ideas. After discussion and walkthroughs the teachers selected Read & Write GOLD™ (R&WG).

Over the summer materials for teacher training, student training and classroom implementation were finalized. eMINTS facilitators and a consultant curriculum specialist reviewed R&WG documentation, tutorials, and training for alignment with eMINTS and project goals. Site licenses for R&WG were purchased and installed on school servers. Upgrades were made to student PCs for additional memory. One set of headphones for each student PC were purchased. Teachers practiced with the program before students arrived for the beginning of school.

The eMINTS facilitators reviewed the R&WG website and introductory R&WG training CD. They found the multimedia material to be appropriate for teacher and student use. Working with the teachers it was determined the CD also met the teacher needs for introducing the software to their students. One day of training was provided for all teacher participants using on the R&WG materials. Training was not aimed at helping students with special needs, but at how general education students could effectively implement the program. Training was developed to model program features to enable children to be more effective and efficient learners through implementing resources in R&WG. Each teacher was supplied with the R&WG training CD for introducing the software. Additionally, the complete training manual from the R&WG website was printed and one copy given to each school for reference. Participating teachers bookmarked the R&WG website on their laptops for easy reference.

Teacher training continued after the initial training day with classroom visits by eMINTS staff to provide problem solving and coaching in the classroom setting. Web-based forums in Moodle (on online collaborative environment) were also provided to teachers to enable collaborative problem-solving and sharing among teachers and eMINTS staff. Classroom visits also provided an opportunity for eMINTS staff to model effective teaching strategies. Ideas were exchanged in Moodle about specific software and hardware challenges, success stories, and how classrooms were using the software on a daily basis. A second training day was used to bring together all the teachers after they had implemented R&WG. Teachers came to the training to share what they had found effective and to learn from each other what “best practices” they had for their classrooms. A community of learners was built among the teachers in the project and facilitated by the Moodle site and personal contacts by eMINTS staff.

Over the course of the 2006-2007 school year participants were supplied with technical and instructional support by eMINTS staff. During the school year teachers kept logs and participated in online discussions. Within buildings participating teachers shared their concerns and successes. At the end of the school year teachers shared observations in a focus group and responded to a survey. Three different tools were used for data collection: online postings (logs and discussions), face-to-face focus group responses, and a hard copy survey. Because of the nature of collegial support within the focus group an individual voice can be lost so the survey allowed every voice to be heard.

To ensure all participants had an opportunity to report their experiences fully, the survey was designed with open ended questions and a chance to respond individually. All responses were transcribed and reviewed for common themes and coded. Analysis of the coded themes from all sources was arranged in response to the four primary questions (initial implementation; observable difference among groups; continued areas of student use; teacher observation(s) on overall effectiveness of the software and continued use).

To allow for emergent issues and concepts not foreseen during the framing of the hypothesis, responses were examined to allow recognition of pervasive themes that emerged during coding.

Participants and Settings

Teachers in elementary classrooms in the St. Louis suburban area were purposively reviewed to be invited to participate in this study. The level of teacher expertise for technology integration was determined by the eMINTS AIS. Teachers that demonstrated a strong understanding of inquiry learning and constructivist methods, as taught in eMINTS CPD, were identified. After identification of teachers the individual districts and buildings were reviewed. Principal support was required. Twelve teachers were invited to participate in the study, including the special education teachers from each building and one additional ELL teacher. One teacher chose not to participate in the study and one teacher dropped from the project before the first meeting. Therefore, a total of ten teachers participated in the study.

All participants taught in technology-rich classrooms, except for the special education teachers. The number of years taught by the participating teachers in their current position ranged from one to 22 years. The mean for the group was 8.8 years. The teachers had been in eMINTS classrooms from zero to six years with the mean 3.5 years. There were only two teachers who did not have at least three years experience in the eMINTS program. There was one classroom without any students with an IEP and one classroom had twenty-one children with IEPs. The mean was 5.9 for students in each classroom with an IEP. ELL students in classrooms ranged from zero to 24 (the ELL specialist met as resource teacher with 24 ELL students over the course of the school day) with a mean of 3.60. (See Exhibit C for a chart of this information.) One of the special education classrooms served students from kindergarten to eighth grade. Most students had at least one year of prior experience in an eMINTS classroom so they were familiar with extant classroom technology. R&WG would be new to the students as well as the teachers.

Analysis

At the end of the school year a focus group was held with all participating teachers. The recording of the focus group was transcribed. Teacher logs and discussions were downloaded from Moodle. A survey was distributed prior to the focus group and collected before the focus group started. In the coding of all data sources individual teacher identities were replaced with anonymous common names to retain individual participant comments and observations over the course of the school year. Survey responses were transcribed and identified in the same anonymous manner. After all transcriptions were completed and files downloaded from Moodle, all files were downloaded into ANsWR, a qualitative analysis software package developed by the Center for Disease Control.

When all documents were loaded all entries were read with topics for common themes recorded. After the initial read through statements were grouped with sub-themes identified and grouped according to their relationship to the four research questions as follows:

1) teachers model the software

  a) student use

  b) any differences over year

    i) introduction to the software,

    ii) implementation, and

    iii) changes with continued use,

2) differences in use between

  a) students,

b) groups of students and

c) classrooms in different schools

3) over time, what was the best use of the software, and

4) teachers' perspectives on continued use of the software.

Emergent themes were coded in the same manner (i.e. major level 1, minor level a, sub level i).

Research question one: How would teachers model the software for student implementation?

When teachers were trained they decided to use the same R&WG materials for introducing the software to students in their classrooms.. Teachers also used the tutorial and reviewed the "help" functions built into the program with their students. Seven of the ten teachers used the R&WG CD provided by the vendor to introduce their students to the software. The other three teachers used walkthroughs of the menu items and student-led exploration. When introducing the program teachers noted two universal student reactions: the students were excited and wanted to experiment with the new headsets.

> "I think it was very easy to implement in the classroom. It just went right in; there were no real challenges for getting them to use it or anything like that and they found it beneficial very quickly."
>
> "I thought that the introductory part that we went through, the actual training part, it was fun. We actually had our students go through a similar training because also it was new to us so, doing it that 3rd [time] it was really useful to us. The kids were really excited; they liked that part of it."

> "I don't know about you guys, but our 5th and 6th graders had the headphones on and they thought that they were all that and a bag of chocolate! And of course we had to let them play with them for awhile. The introductory CD that we received was a big plus. I mean, we couldn't have made it without that."

Teachers were well aware that this technology was student appropriate and perhaps easier for the students to grasp than the teachers themselves.

> "I think the kids almost typically picked up a lot of the technology parts of it easier than I did . . . it became so automatic I was just amazed that whenever they (especially the TtS) [needed] something from the computer, something they had written, would get those earphones out and away they'd go."

Second and third grades student "experts" were encouraged for peer help in one classroom.

> "I had helpers to like . . . 2nd and 3rd grade, so a lot of 11 and 10 year olds prior experience with computers . . . but I had a few that were kind of called 'experts' that once we'd go through a program and they had caught on pretty quickly, they would help go around and help others who needed help."

Use of "experts" was reported in other classrooms but the need was not as prevalent since upper grade school students, as a class, were more technology self-sufficient.

> "By 5th grade, mine are pretty tech savvy and we went through our orientation and what they didn't remember they went straight to the tutorial and looked it up; not a problem."

Teachers reported they felt the students were well prepared by the eMINTS classroom experiences to learn the program, use the needed components, and help other students when they were challenged. Students explored the program as time allowed. Discoveries were shared among students with teachers frequently learning of new uses when they saw a student actually using a new feature.

Research question 2: Would there be an observable difference in use between any identifiable group(s) of students?

How would students implement the software? O*ver the course of the school year?*

Research Question Two and the two sub-questions from Research Question One were closely related in the teacher's responses so they are presented together. Initially all students used the software. This practice did not last long as some students found they were not benefiting from using the program. Groups developed over time and were defined by the learning activity. Some students used the software most of the time, others just as needed to make a specific website or assignment clear. In some classrooms all students used R&WG as an editing tool for their compositions. Students were self-sufficient in learning when and how to use the software. There were differences over time as specific activities defined use for some students. There were issues with sufficient headphones as each pair of students had one set of headphones. After an introduction to the software all the students wanted to use the headphones but this changed over time.

> "I think I had, well, a little bit of class management in that everybody wanted the headphones, and so once the novelty wore off, then my better readers really didn't need that. So they weren't grabbing the headphones, but at first every body wanted the headphones."
>
> "…initially it was a big ordeal, but then we did the 'Paper, Rock, Scissors' and you know, fought it out. But afterwards most of the times when we used the

> headphones, they knew who needed them and who didn't. The ones that could read the WebQuests on their own and familiarize themselves with the process of every thing--they really didn't use them. They left them for who needed them, whoever that may be. So, I liked that part of it."

Students developed their own access schemas. Some students would turn the volume up on the headphones so that each child could listen to one side of the headset. Other students tried to plug more than one headset into the bus port on the PC. One solution that was volunteered during the focus group was to purchase a "splitter" that would plug into the bus port and allow two sets of headphones to be connected to the "splitter" so the student pair could both listen at the same time.

As the implementation progressed the students started to regulate their need for assistance with the software. "The headphones and the TtS made some of my better readers crazy because they didn't have the patience to wait . . ." This theme was discussed from several different perspectives:

> "I'd say, 'You don't have to use it. It is just an option.' They were like fine. There is a certain group that always uses them, and then there are those kids that won't pick them up"

Teachers reported that students used the software effectively for projects and WebQuests.

> "I have to agree with you 100% on the assistance to the low readers with projects. As we have researched several projects throughout the year, the option to listen to material that is above low readers' abilities has been a major plus to their projects' material."

> "As we work on our last big project for the year, I am, once again, glad to have R&WG for my students. We are creating Missouri scrapbooks, and my students have many things to look up on websites about Missouri. They, of course, use R&WG whenever necessary. They also can reread/proofread the articles they have written for their scrapbooks, using R&WG."

Teachers saw all student writing as a target for improvement. Writing, editing, and rewriting were common tasks that students used R&WG for in all classes. Teachers reported that spending more time with writing improved the final product.

> "I made a requirement that everybody had to listen to their writing, which I think a lot of people have said in Moodle on our discussion list . . ."

Teachers also reported that students heard and recognized obvious errors that they, at first, did not believe they had made. Editing was not a struggle as the software was reading their work to them.

> "Mine were a surprise because they never want to do a second draft; they never want to edit because it's perfect the first time, and they would get it back and they're like, 'It isn't reading it right, there's something wrong here!' because they were leaving out little words or no punctuation and all of a sudden the software was incorrect, but I think they got an awakening."

> "We expanded their writing. The kids who didn't want to write, wanted to write more so they could listen because they wanted to spend more time listening to it than they did . . . so there was a pay off there. You know, if I only get to listen to it for three sentences that wasn't worth it; so I found they worked more."

Writing and editing was agreed on by all teachers as being a classroom benefit of R&WG. Teachers viewed it as an expert editing system for reading *exactly* what the students had written. The TtS was important because the children realized it read only what they had written, correct or not. The students found that the software was reading their compositions as written and began to revise and edit based on the TtS sessions. Editing with R&WG became a task that six of the teachers required before peer editing or teacher conferencing for writing.

> An unanticipated result of the headphones was agreed on by all the teachers. "Even some of our students that we really had to work with. . . they were on task and focused. That is *the* best element. I mean, once those headphones go on its like, okay I know what I'm going to do. So that was a wonderful side benefit of it for sure."

The design intent of R&WG by the publisher was for AT for use by students with special needs on an individual basis. In order to determine if the use by students with IEPs was different than with general education students the focus group was asked about any observable differences noticed between these students with IEPs and general education students.

> "I didn't see any difference and I have maybe I think 4 or 5 of my students who fell through the cracks for special ed. definitions and are weak readers. They get maybe reading assistants who help them, but they don't have an IEP. And that just really solved their problems, but they are considered general ed. students but their reading was weak."

> "Even for my Title I kids (I have six) I have more Title I kids than I do the IEP kids. I have a lot of at risk kids who should receive services, but don't because of where they're at, but there's no difference."

> "The only difference I would say was the difficulty with trying to train people to use this. I mean, your higher readers obviously are going to have a little bit more ease with that; that would be the only difference."

During these comments teachers were nodding their heads and agreeing. It could not be determined from the video if there was unanimous agreement. It appeared that all eight observable teachers were in agreement, nodding their head "yes." From all data sources there did not seem to be any difference between IEP students in the classroom and general education students. The special education teacher noted that in her classroom when students came in from general education classrooms R&WG was constantly in use.

Research Questions Three: What activities were best suited, over time, to use with the software?

Teachers agreed that WebQuests and student writing were both positively affected by student use of R&WG. They saw these two areas as critical to learning and were all in agreement that effective student use increased time spent on writing and allowed teachers to concentrate on the learning goals of the WebQuest rather than on reading to students or helping with word pronunciation and selecting needed passages on the webpages.

> "I think one of the biggest successes was just the ability to read the WebQuest when the kids are doing research."

> "All the students have benefited from the use of the program with their writing. It is a part of the writing and editing process for them to use the text to speech

> portion. This process has become second nature for all students and they enjoy this portion the most."
>
> "I love having the ability to have my students proofread their work on R&WG. We started back in October with our autobiographies and every writing activity since, the kiddos know to R&WG their work before we conference or they publish. This is a wonderful feature!"

Although the English Language Learner (ELL) population in the participating classrooms was small teachers observed:

> "I noticed the greatest change in ELL students who could hear the changes and the correct pronunciation of things; I think their writing improved. Some of our most challenging ELL students were really able to improve on their writing styles. …I mean they just picked up … they picked up on it so easily in class, and they learned to adjust to their own learning style."

It is unknown if ELL students found increased ownership of their work when they could control their learning environment more effectively using the computer.

Teachers continuously reported that all the students were "excited" to use the software, not just initially, but throughout the year. On closer examination of the use of "excited" the sentiment expressed seemed to be synonymous with "engaged."

> "The kids know and they feel maybe more special, but they enjoy it. They have benefited from it, and I think that they are <u>excited</u> about it and the other kids are like, why don't we have this."

> "with this they can actually locate the information they need and they're excited about it too—'Look what I found!'—and understanding what they're supposed to be looking for."

From all data sources "excited," "excite," or "exciting" were used no less than 26 times by teachers to describe student and/or teacher reactions to the software or specific functions.

Research Question Four: What were the teacher perspectives on continued use of the software?

Teachers all agreed that the program was of benefit to their classrooms even though they were disappointed with the VR component. VR was time consuming and repeatedly failed when their elementary students tried to train the program to recognize their voices. One successful project was recording student comments into MP3 files using R&WG. The individual files with each voice recording were then inserted into PowerPoint presentations by the students. When other students independently watched the presentations they could activate the voice files and listen to them. With the success of the other components teachers were very confident of the beneficial role of TtS and the supporting applications.

> "It ought to be automatic when schools supply computers that they get this program."
>
> "I've been an eMINTS teacher for 5 years I think, so I can't imagine not having my computers, my SMART Board™ and this is just another component that is just another thing to have."

> "…it's an additional program that provides support for kids, and that's really what it's all about."

One of the last comments in the focus group had teachers again nodding their heads in agreement;

> "I know that one of the questions that you asked us to comment on was should it be implemented in the eMINTS program, and I honestly think that it should. I honestly think that it is addressing all students' needs and that's what eMINTS is about. It's about inquiry-based learning. It's about addressing students' individual needs and bringing everyone together and I think the headphones and the TtS is one component of that."

Component use of supporting modules in R&WG

Teachers commented on the complexity of the program and the lack of time to explore all the features of the program. Teachers commented that students had more time to explore the program than they did. Students would share a function they had found before the teacher was aware it was in use. This approach demonstrates one of the goals taught in eMINTS classrooms: enabling students to recognize and effectively use technology that facilitates their learning. Modules that were effectively used were: homophone ("One feature I would like to play more with is the homophones. We all know we teach this, but it doesn't transfer. I have been fiddling with this feature with a few of my "frequent flyers" in the use of incorrect homophones."), almost universal was the word prediction or, as the students referred to it, the "blue ball," dictionary, math calculator, graphics organizer (all eMINTS teachers have training on another graphic organizer), and fact-folders.

Conclusion

The research base for using TtS and VR as a UDL component strongly suggested the positive learning results this study has reported. Some challenges that emerged should be carefully considered before classroom implementation. The most significant contra-issue that emerged was the need for an age-appropriate process for the students to train the software so voice recognition could be effective. However, it should be noted this project implemented the software in a fashion not intended by the developers of R&WG. This study implemented R&WG as a support tool available for all students in general education classrooms following UDL methodology, not as a tool intended exclusively for children with special needs. In the role as AT for students with special needs there would be sufficient time and specific training strategies put in place to train the software for proper voice recognition.

Also noted was the need for close coordination with the school IT staff and technical support. File saving issues were not widely reported but a single lost student folder can be very discouraging to teacher and student, and ultimately, a classroom. R&WG is a robust and mature product but the implementation in school settings adds issues of conflicting server and desktop applications, especially with filters, virus detection, and firewall interaction. Rarely can teachers diagnose and solve these issues. IT needs to be a strong partner in initial implementation and monitoring effective network and desktop needs over the school year for both teacher and student access and use. Program conflicts also need to be resolved although this issue again tended to be site specific based on server, network, and desktop configurations.

The process for teaching the software to recognize a voice has to be reviewed for use in primary grades. Primary teachers do not have the time to walk through the 45 minute process with every student. R&WG is working on a solution, both for grade level specific readings and multiple shorter sessions. Piloting the software during summer sessions with a limited number of participants may be the best way to gain site-specific information prior to multiple classroom implementations during the busy start of the school year.

After acknowledging challenges teachers were universal in their support of the software in their classroom. They observed positive student outcomes and noted that an increase in instructional time, due to increased student self-reliance, was beneficial to their classrooms. They were anticipating use during the next school year as they had created a conceptual model that would guide them in what was successful in their classroom and could explore features that other teachers had reported were successful.

Successes were abundant and teachers unanimously supported the continued use of R&WG in their classrooms for the next academic year. In at least one district, school funding was being reviewed to expand the software into all third, fourth and fifth grade classrooms. Many successes were universally occurring as academic achievements and in classroom management. Academically, teachers found the most value in student work when reading and writing. R&WG was most effective when used from the beginning of a writing project to the end, including the editing cycle. Although methods varied teachers encouraged the use of word prediction, dictionary use for meaning, listening to new words that were not recognized (but were familiar when spoken), and editing student writing in all forms. All teachers reported effective use of editing although teachers varied in the amount of editing required with the software before turning to traditional teacher writing conferences or peer editing.

In some classes editing was required with the student work being read back by R&WG, in other classes peer editing was added. Another variation was requiring at least one round of self-editing with the software before conferencing with the teacher to review the writing. With all these methods, teachers reported they observed an increase in student efficacy when writing, writing level achievement (complexity and length of writing), and time on task devoted to writing.

Classroom management for effective learning changed as students implemented the new learning tools. A universal observation was the additional time teachers gained to facilitate learning as they were no longer reading websites to students or helping them pronounce words and phrases. Students found that learning the software enabled them to understand the material on the websites independently and not depend on teacher or peer assistance. Teachers also noted the increased student efficacy when increasing their personal level of responsibility for their learning. The mathematics calculator was used and preferred by some students over the calculator used in classroom instruction. The talking calculator seemed of benefit to some students but was not universally used. Teachers seemed to focus on the benefits of communication arts. Classrooms were equipped with several other programs for mathematics; it is not known if this limited the use of the calculator functions in R&WG.

Learning groups in each classroom developed strategies for using the software. Teachers reported that all students would use the software at times, but by January the students with low reading and/or writing skills would reach for the headphones routinely.

When new WebQuests were introduced, high use of the software was seen for pronunciation of new words and understanding through dictionary use for all students. When a website challenged an infrequent user of the software, headphones would be shared or the students took turns listening to R&WG read the webpage. An increased understanding of the material presented on websites was prevalent among students as reported by the teachers.

It was clarified in the focus group that students understood the website material when R&WG helped them through the pages. The observer/researcher added one question during the focus group to clarify student website use. To ensure teacher observations and experiences were accurately related, the moderator asked, “Did the students understand the websites when they had the software read it to them?” All teachers agreed the students understood what was read to them as exhibited through their writings and discussions about the content. Other teachers added that students might review a paragraph or sentence, using the software independently, several times without a request for teacher intervention before moving on. Students used terms from the webpages correctly, could pronounce the words correctly, and incorporated ideas from WebQuests into their writing, demonstrating mastery.

Teachers were unanimous in their agreement that instructional time was recovered during web activities by student mastery of the tools. Teachers found they were doing more “idea facilitation” than helping students read websites.

Other common practices were sharing headphones to allow two students to listen at the same time, “fact finder” (folders for student information), teacher and peer acknowledgement of “student experts” for trouble shooting, word prediction use when writing and editing, spell check, homophone identification for writing and editing, and low skill level readers being successful activity partners with higher skill level readers through implementation of the multiple tools.

General education teachers were creative and implemented the software as a classroom learning tool for all students. Over the course of the year students and teachers developed strategies for effective use of the software. Writing and editing with R&WG was mandatory in some settings. Students regulated their own learning by defining for themselves when they would use R&WG for WebQuests and other activities when only a single function, especially the dictionary, was used. Teachers reported that students also began to recognize who "needed" the headphones. This classroom adaptation has exposed general education teachers to AT and proven to them that improvements in learning are possible with software intended for IEP students. It is unknown if any IEPs will be modified to include access to R&WG when students move to grade levels beyond those in this project.

Continued student use of R&WG in AT and UDL settings

One concern noted is with the continued use of the program. Some students may benefit from use of TtS and VR software throughout their academic career but may not have it available to them. Other students will develop the needed skills to complete assignments and be successful learners without cognitive prosthesis. In the classroom educators will need to be cognizant of the necessity to review the appropriateness of the software, be it by formal assessment or individual learner progress.

It was not in the scope of this project to formally assess communication arts, or mathematics skills, over the course of the school year. Assessment of actual student need for this learning scaffold seemed to be self-regulated. Formal assessment should be a component for consideration, especially as a student progresses through grades, to determine if the student has mastered skills or still needs this supporting scaffold. In an editorial D. Edyburn accurately described what many teachers observed in their classroom with initial use; the challenge will be to continue to monitor the level of success both with and without this scaffold:

> "Repeated measures of performance, with and without the cognitive prosthesis, may initially illustrate a pattern of high performance with the tool and low performance without it. However, over time, the two trend lines may converge such that performance with the tool remains high and performance without the tool reveals high performance. Such a pattern illustrates learning and indicates that the cognitive prosthesis has functioned as a scaffold. At some point, it is likely the cognitive prosthesis can/will be abandoned since the skills necessary for acceptable performance have been internalized (2006a)."

One of the foundational tenets of eMINTS-CPD is the belief that students become engaged, self-directed learners when taught in constructivist classrooms with technology-rich surroundings to facilitate learning. Students see technology as just another tool for learning. The hardware and software are not "technology," but learning tools just like pencil and paper. This project confirmed that when students were given the opportunity to direct their learning with technology enabling tools they quickly mastered the software and were able to exploit the resources within the program to benefit their individual learning styles.

Emergent theme, additional outcome

One emergent theme, not reported previously in the literature, was the improvement of "focus" for both struggling and grade level readers when using the headphones. This was reported by eight of the participating teachers. During the focus group the other teachers seemed to agree with this observation. This study did not use a teacher "hands-on" approach for implementing R&WG but rather was introduced by the teacher and driven by student needs, comfort level with the software, and exploration of uses that fit individual learning styles. As previous researchers have hypothesized, this study supports, but does not quantify, the effectiveness of the software used as a scaffold when used by students for mastery of grade level skills.

Additional research

At the outset of this project one of the operational demographics was to include general education classrooms using RtI. This was not possible. RtI classrooms were reviewed and were not in sufficient number within the eMINTS community. As RtI progresses in the state of Missouri it would be beneficial to repeat this project with a carefully monitored review of classroom assessments and the approach to interventions that could be made with TtS and VR software, especially for additional support and instruction in the communication arts.

Teachers reported ELL students being more engaged when using the software. Rather than relying on another human resource ELL students could work more independently hearing words in both Spanish and English. Students also had ownership in the way that their compositions were read back to them. They controlled the computer environment, speed of the speech, and could replay the selection as many times as needed. ELL student self-efficacy with this measure could be investigated in this environment.

Student “focus” may be of interest to researchers. It has been widely reported in the literature that students are affected by different types of computer based learning.

Formal assessment using random control trials would establish a statistical basis for increased student achievement. Trials that allow students to use R&WG for all components on high stakes test, except actual reading comprehension questions, would empirically confirm the observational data gathered from teachers in this project. Also of interest would be examining the ratios of students referred for identification for special services from classrooms using TtS and VR software to classrooms of similar demographics.

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Appendix

Exhibit A

Compendium of Research-Based Components
eMINTS (enhancing Missouri's Instructional Networked Teaching Strategies) Program

This compendium summarizes the current essential components of the eMINTS program and relates each component to relevant research data and/or program evaluation results that validate the inclusion of the component in the program. The components described are the substantial educational intervention that comprises the eMINTS program.

Component	**Description (when introduced/revised)**	**Relevant Research/Program Evaluation/Historical Rationale**
Technology as intervention	MINTs – 1997	ACOT research demonstrated that the introduction of technology into classrooms can significantly increase the potential for learning, especially when used to support collaboration, information access, and the expression and representation of students' thoughts and ideas (Dwyer, 1994).
Constructivism as pedagogical intervention	eMINTS – FY00	Constructivism was formally identified as the main pedagogical intervention in summer 1999 as the first cohort of eMINTS teachers was selected (Brooks, 1993; Jonassen, 1999).
Classroom as unit of intervention - Systemic school intervention	MINTs – 1997 - - - - - - - - - - - - - - - - eMINTS Expansion program FY02 attempted building level intervention –	Specific research not available – program leaders used prior practice of establishing "pilot" classrooms to "seed" innovation as justification for choosing the classroom as the unit of intervention. With emergent research and Title II.D reform this strategy was expanded to systemic school-wide intervention. - "From the effective schools research (e.g., Purkey & Smith, 1983) to studies of teachers' work and teacher learning (McLaughlin & Talbert, 1993; Hall & Resnick, 1998) to the current literature on school restructuring and high performance school organizations

	application required schools to catalog and relate school-wide reform efforts to eMINTS	(Newman & Wehlage, 1995; Mohrman & Lawler, 1996; Darling-Hammond, 1996), evidence abounds that if you want to improve student learning, you must improve the schools in which that learning takes place." (O'Day, 1998)
Equipment placed in classroom rather than in computer lab	MINTs project – 1997	Keefe and Zucker (2003) meta-analysis of ubiquitous computing including historical aspects
Prescriptive hardware and software suite		
• SMART Board and projector	MINTs project – 1997	Teacher request – other interactive whiteboards reviewed by eMINTS staff in 2002 (IPM, Webster Board, Gateway Plasma Board). Tests and demos did not convince staff to recommend change. Waiting for SMART/Gateway Plasma board to be available at 72" size. Visual learning research
• Laptop for teacher	MINTs project – 1997	Teacher request – rationale was for teacher use at PD sessions and for home use in planning and to gain tech fluency. Also to be a back-up unit if classroom workstation down. Specs for FY05 to change – delete floppy drive, add CD burner and DVD (Keefe & Zucker, 2003).
• Teacher workstation including printer scanner and digital camera	MINTs project – 1997	Teacher request – workstation needed to run programs on SMART Board. Main teacher computing unit. Specs for FY05 to change for camera – allow other storage than floppy disks. (Keefe & Zucker, 2003)
• Videoconferencing equipment	MINTs project – 1997 Deleted from eMINTS - 2000	Teacher request - initial plan to deliver some PD via video, engage students and teachers in VTC exchanges. Video equipment discontinued after FY00 due to funding constraints.
• One computer for every two students	MINTs project – 1997	Space considerations initially – preference to use full-sized units rather than laptops. Cooperative learning pedagogy emerged after

		initial years of MINTs. “Students in cooperative teams are more active, self-directing, and expressive, all of which may be associated with achievement gains. Students take direct responsibility for teaching each other and receiving help from each other, There is structural support for peer tutoring and mutual support, so peer norms for achievement emerge, Importantly, students are often given differentiated roles so that students of different ability levels have relatively equal status within their groups,” (Kagan, 1994)
• High Speed Internet Connections	MINTs project – 1997 Revised for eMINTS - 1999	Teacher request – mitigation of assessed need for reliable connections in classroom. 10MG connections provided in early stages of program. Reduced to T-1 for eMINTS in 1999.
• Software Limitations – Microsoft Office	MINTs project – 1997 Inspiration concept-mapping software added by eMINTS program 2001 following teacher and staff request.	Focus on teaching and learning rather than on content or software specific skill development. “Software did not prove to be a limiting factor…ACOT high school teachers took and early lead in imaginative integration of technology across the curriculum by adapting general productivity tools … Elementary teachers, too, learned the benefits of tool software…” (Dwyer, 1994)
Professional Development Program		
• Duration of at least 2 years	MINTs project – 1997	“Teachers need time to move through the different stages of development in order to utilize technology … to their advantage.” (Sandholtz & et al., 1990)
• Formation of geographic “clusters” for delivery of professional development	MINTs project – 1997	“…the learning community is exemplified when people from multiple constituencies at all levels collaboratively and continually work together (Louis & Kruse, 1995), "enhancing their capacity to create things they really want to create" (Senge, in O'Neil, 1995, p 20). Such collaborative work is grounded in what Newmann (reported by Brandt, 1995) and Louis and Kruse labeled reflective dialogue, in which staff conduct conversations about students and teaching and learning, identifying related issues and problems. Griffin (cited by Sergiovanni, 1994a, p. 154) referred to these activities as *inquiry* and believes that as principals and teachers inquire together they

		create community. Inquiry helps them to overcome chasms caused by various specializations of grade level and subject matter. Inquiry forces debate among teachers about what is important. Inquiry promotes understanding and appreciation for the work of others. And inquiry helps principals and teachers create the ties that bind them together as a special group and that bind them to a shared set of ideas. …Participants in such conversations learn to apply new ideas and information to problem solving. Key tools in this process are shared vision; supportive physical, temporal, and social conditions; and a shared personal practice." (Hord, 1997)
• Paired with classroom visits by Cluster Instructional Specialist	MINTs project – 1997 "circuit rider" concept Began as technology support and evolved to pedagogical support with less emphasis on technical support – eMINTS 2002	"…Professional development in the classroom can occur in one of these three major forms: modeling, team teaching, or observation (for monitoring purposes). Depending on where the teacher is in the process, the coach may model a specific strategy. When the teacher is using a new instructional strategy, the coach may serve as a team teacher, guiding the classroom teacher as needed….and reflective coaching cannot occur without time for planning and discussion. The teacher and reflective coach must routinely schedule meeting times during the teacher's planning periods." (Rock, 2002)
• Cognitive coaching by CIS	eMINTS - 1999	Costa and Garmston, the founders of Cognitive Coaching, define it as a set of strategies, a way of thinking and a way of working that invites self and others to shape and reshape their thinking and problem solving capacities. In other words, Cognitive Coaching enables people to modify their capacity to modify themselves. The metaphor of a stagecoach is one used to understand what a coach does--convey a valued person from where s/he is to where s/he wants to be. ("Overview of cognitive coaching," 1999)
• Principles of andragogy to guide construction of professional development modules	eMINTS - 2003	"In practical terms, andragogy means that instruction for adults needs to focus more on the process and less on the content being taught. Strategies such as case studies, role playing, simulations, and self-evaluation are most useful. Instructors adopt a role of facilitator or resource rather than lecturer or grader." (Knowles, 1995)

• Reflection as an activity within professional development sessions and as part of graduate credit requirements	eMINTS - 2001	"As an idea critical reflection focuses on three interrelated processes; (1) the process by which adults question and then replace or reframe an assumption that up to that point has been uncritically accepted as representing commonsense wisdom, (2) the process through which adults take alternative perspective on previously taken for granted ideas, actions, forms of reasoning and ideologies, and (3) the process by which adults come to recognize the hegemonic aspects of dominant cultural values and to understand how self-evident renderings of the 'natural' state of the world actually bolster the power and self-interest of unrepresentative minorities(Brookfield, 1995)."
WebQuests as lesson planning tool	eMINTS – FY00	Using WebQuests as a lesson planning tool was first added to the program in January 2000 with Dr. Bernie Dodge as presenter at the first eMINTS Winter Conference. Dodge, Bernie. (Dodge, 1995).

References for Compendium of Research-Based Components

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Exhibit B

eMINTS-CPD

Professional development for educators by educators

The eMINTS National Center offers professional development programs created by educators for educators. Leading experts at the University of Missouri, the Missouri Department of Elementary and Secondary Education and the Missouri Department of Higher Education have collaborated to produce programs that

- **inspire educators** to use instructional strategies powered by technology
- **engage students** in the excitement of learning
- **enrich teaching** to dramatically improve student performance

Programs range from short-term, customized awareness sessions (including online options) to full school or organizational-wide implementations requiring a long term commitment. Professional development geared to the needs and interests of preK-16 educators is delivered either by eMINTS staff or locally-based trainers who have completed eMINTS "train-the-trainer" certification.

Transforming preK-16 education through technology requires changes in the skill levels of both teachers and learners. Today's students demand learning tasks that challenge and stimulate them as they use technology tools to acquire knowledge and skills for the 21st century.

eMINTS instructional model

eMINTS changes how teachers teach and students learn. Its instructional model provides a research-based approach to organizing instruction and can be implemented in any subject area at any level. The eMINTS instructional model enables educators to

- create classrooms where all students are motivated to succeed socially and academically,
- fully incorporate technology investments into teaching and learning,
- complement existing preK-16 curriculum with critical-thinking requirements found in national, state and local curriculum standards and
- build enthusiasm and creativity into daily teaching.

National recognition

- More than 38,000 students in 2,000+ classrooms, grades 3–12, learn the eMINTS way every day across Missouri, Maine, Utah, Nevada and Alabama with more joining the adventure soon.
- Two Missouri universities are incorporating eMINTS into their pre-service teacher education programs.
- eMINTS named in new federal educational technology legislation, ATTAIN, in May 2007.
- eMINTS Comprehensive Professional Development awarded International Society for Technology in Education (ISTE) Seal of Alignment in 2005.
- U.S. Department of Education recognized the eMINTS National Center and Peabody Elementary, a St. Louis, MO, eMINTS school, in its 2004 National Educational Technology Plan, “Toward a New Golden Age in Education.”
- The eMINTS National Center recognized in the 2004 National Ed Tech Plan’s success stories in the categories of Leadership and Teacher Training.

Compelling results

eMINTS professional development programs are proven valuable and effective.

- Insure that significant investments in technology translate into improved student performance.
- Provide strategies that produced statistically significant differences on state-wide tests for Missouri third- and fourth-grade eMINTS students when compared to students not enrolled in eMINTS.
    - eMINTS students in subgroups (special education, low income, Title 1) reduce up to half of differences in test scores attributable to subgroup classification.
- Help teachers meet NCLB highly-qualified teacher criteria.

Exhibit C

	Number of years taught in current position	Number of years in eMINTS		Students in classroom: ELL	Students in classroom: IEP	Log of normal distribution: Years in current position	Log of normal distribution: Number of years in eMINTS
	11	0		24	3	0.172	0.000
	3	3		0	3	0.127	0.135
	7	6		0	2	0.155	0.216
	18	3		0	12	0.191	0.135
	6	4		3	1	0.150	0.165
	22	0		0	21	0.199	0.000
	11	5		1	3	0.172	0.192
	1	6		0	1	0.097	0.216
	4	3		0	12	0.136	0.135
	5	5		7	1	0.144	0.192
mean	8.80	3.50		3.50	5.90		
median	6.50	3.50		0.00	3.00		
mode	11.00	3.00		0.00	3.00		
st dev	6.76	2.17		7.55	6.79		
skew	1.00	-0.65		2.71	1.51