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# Advances in Technology for Special Education

The following is a section of the *Nineteenth Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act (IDEA)*. The full text of the material is presented, but the figure number has been changed for this free-standing version.

This module reports on work conducted by John Woodward at the School of Education at the University of Puget Sound. The research described in this report was funded through the Office of Special Education and Rehabilitative Services (OSERS), public school districts, and the Microsoft Corporation.

REMARKABLE PROGRESS has been made during the past ten years in using technology to meet the needs of students with disabilities. Research projects in this field have primarily been funded through the U.S. Department of Education, Office of Special Education Programs (OSEP). Researchers in special education and software developers have demonstrated that technology can dramatically improve the quality of a student's life and allow access to more complex learning environments. Challenges once considered daunting now are surmountable for many students with disabilities, and technology is allowing them to become more productive workers and active, independent learners. A comprehensive analysis and discussion of these trends has been recently described in a historical review of technology research in special education over the past decade.* What follows are some of the highlights of that report.

* Woodward, J., & Reith, H. (submitted for publication). An historical review of technology research in special education. *Review of Educational Research.*

**TECHNOLOGY USE FOR STUDENTS WITH SEVERE COGNITIVE AND PHYSICAL DISABILITIES**

Some of the most striking examples of how technology has enhanced the lives of students with disabilities during the past decade include the ways researchers have customized technology to meet the needs of students with severe cognitive and physical disabilities. At times, the solutions to the everyday problems that confront these students are seemingly obvious and "low tech" in nature.

Specially designed everyday items such as pencils, scissors, and silverware -- all technologies at one level -- are examples of these types of solutions. These solutions, which all require time to design and manufacture the implements, and a commitment to train the student in their use, can result in considerable independence for young learners.

Other students require more novel solutions, and researchers have found ways to apply technologies which were until recently only available to corporations and the military. Voice recognition and word prediction systems, virtual reality, and expert systems have all rapidly declined in cost over the past ten years and have become widely available for a variety of purposes.

Researchers at Utah State University (Hofmeister et al., 1994), for example, have developed an expert system program that can help service providers such as teachers and school counselors identify solutions for a wide range of student behaviors. The system allows teachers to access in-depth descriptions of problems such as teeth grinding or self-injurious behavior in persons with moderate retardation and can also present them with research-based remediation programs tailored to the teacher's skill level (i.e., the teacher's capacity to deliver the recommended program of instruction). Because it adjusts its output to the teacher's skill level, the expert system does not recommend remedies the teacher cannot implement.

In the past, teachers or care providers addressing a student's behavior problem would have to investigate it in any one of a number of complex manuals and then search the professional literature for appropriate interventions. This process was time-consuming and often ineffective. The expert system program developed by the Utah researchers has dramatically reduced the time required to identify appropriate interventions and has been able to offer a significant level of professional development at the same time.

Researchers at the University of Delaware (Brown & Cavalier, 1992) have used voice recognition systems for individuals with severe disabilities as a way of enhancing communication. Although voice recognition has commonly been used as an alternative to keyboard input for desktop computers, it can also be used to control everyday appliances. By training students with severe disabilities to produce a limited number of commands in a consistent manner, they can gain greater control over their surroundings, as demonstrated by the example in figure 1.

Figure 1
Example of the Use of Voice Recognition Systems

*Sue is a individual with profound mental retardation and cerebral palsy. Given her condition, what appears to us as "the simple things in life" are of profound importance to her. She enjoys watching home movies on a TV mounted above her bed, images of her sister showing off her new car, her mother giving the family dogs a bath, and her little nephew dancing in the kitchen. She recognizes the figures, and with sounds nearly unintelligible to most people, she calls them by name and laughs with glee.*

*Recently, Sue has learned how to control these images and communicate with other devices in her environment through a simple application of a voice recognition system. By learning some basic commands, Sue was able to control a variety of appliances such as a VCR, an audiocassette player which reads the pages of her favorite storybooks, her massage pad which she often lies on, and a radio tuned to her favorite country western music station.*

*This is a marked change from life in her residential facility where most adults had abandoned virtually any effort to engage her in meaningful activities because they had no sense of her needs. Since the voice recognition system was installed, care providers have noticed a significant change in her behavior. She's more alert and animated. The staff even feels that she can do more on her own, and partly as a result of these changes, she has moved to a less restrictive environment near her family.*

Applications of virtual reality and word prediction systems offer even more remarkable examples of how technology can fundamentally change a student's day-to-day experiences, leading to greater success and independence.

Research conducted at the Oregon Research Institute (Inman, 1996) in Eugene, Oregon, shows how students with cerebral palsy can learn to navigate wheelchairs in a safe "staging ground" of narrow corridors, desks and chairs, and crowded sidewalks contained in a virtual environment before attempting to navigate them through the real world. The potential for using virtual reality to teach students with physical disabilities how to perform common tasks safely while they receive a considerable level of practice and feedback from an assistant is immense.

Word prediction programs enable mainstreamed students with physical disabilities to complete ordinary tasks such as writing. In one study recently conducted by researchers at the University of Oregon (Todis, in press), a fifth-grade girl with cerebral palsy used a word prediction program to complete daily assignments that were once almost impossible for her to do. Before she started using the word prediction program, the student was only able to use one finger to type assignments on the laptop computer attached to her wheelchair, and she found it very difficult to finish her assignments on time. Now that she uses the word prediction program, she can type the beginning letters of a word and the computer will generate a list of words that use those letters. The girl can then choose the appropriate word rather than laboriously typing it out. This feature of the word prediction program has allowed her to complete assignments on a timely basis.

**TECHNOLOGY FOR STUDENTS WITH MILD DISABILITIES**

Providing adequate instruction for students with learning disabilities has become one of the central challenges to public education over the past decade. Increasingly, these students are taught in a variety of learning environments and spend the majority of their day in their general education classrooms. For these students (as well as those with attention deficit disorders, behavior disorders, and mild mental retardation), acquiring basic skills at the same rate as their peers who do not have disabilities is a perpetual problem.

During the past ten years, a number of ways have been found to design or modify software programs so that students with disabilities can learn basic skills more readily. For example, an important skill any student must have before he or she can study any advanced level of mathematics is a mastery of math facts. The number of students in middle schools who still do not know their multiplication tables is a common lament in the media. A large part of the problem is that students are often overwhelmed with the number of facts they must learn at any one time. Because they must memorize 100 separate facts in a short period of time, students rely on finger counting, guessing, or they simply give up.

In response, special education technology researchers at Vanderbilt University in Tennessee (Hasselbring, Goin, & Bransford, 1988) created a drill and practice program that carefully pre-tests students on what they already know and then gradually introduces a small set of facts for instruction. Once the student masters the first set, new facts are introduced along with a random but limited number of old facts. Microcomputers are well-suited to this kind of instructional management, and they provide the consistency and controlled practice -- not to mention the time -- that usually is not available in the classroom. This program is now available as a commercial product. Other researchers have conducted similar work in vocabulary instruction (Johnson, Gersten, & Carnine, 1987) as well as basic skills practice on fractions, decimals, and ratios, using microcomputer and videodisc programs (Moore & Carnine, 1989). The students using these programs show significant gains in the acquisition of basic skills.

Reading is one of the most difficult academic skills for many students with disabilities. Early research at Florida State University (Jones, Torgesen, & Sexton, 1987; Torgesen, Waters, Cohen, & Torgesen, 1988) indicated that the different presentational features of the microcomputer -- text, sound, and graphic animation or pictures -- could be used effectively to teach students with learning disabilities how to read or "decode" words. Later efforts showed that using a microcomputer to read words back to students through a speech synthesis program was a particularly promising way to enhance beginning reading instruction.

Work in the early l990s showed that microcomputer instruction could also be an effective medium for helping students understand or comprehend textbooks. Understanding these texts has always been a particularly crucial issue for students who struggled with the large amount of information and challenging vocabulary so often found in social studies and science texts.

Through widely available commercial programs like *Hypercard*™ from Apple Computers, researchers at the University of Las Vegas, Nevada (Higgins & Boone, 1990, 1991), can make traditional printed text more "dynamic" for students with learning disabilities. Programs like *Hypercard*™ allow the user to click buttons or boldface text, link directly to other text or graphic information, and display it. This idea is widely used today as millions of Americans scan the Internet with user-friendly browsers that allow them to jump from one source of information to the next. By using a *Hypercard*™ version of the traditional text, a student can

click on the word "monument," for example, and a definition of the word or a picture of a monument like the Jefferson Memorial appears on the screen. Appropriate definitions or pictures that are based on the context in which the word appears can be added. Similar efforts that use flexible software authoring programs like *Hypercard*™ to modify traditional texts have been developed by researchers at the University of Maryland (MacArthur & Haynes, 1995).

When students reach middle school and high school, they are expected to complete assignments that are increasingly sophisticated in nature. Students are expected to write brief papers that interpret short stories or important historical events. They must also be able explain mathematical concepts, particularly as they appear in the context of everyday events. To be able to complete these types of assignments and begin to acquire the level of literacy required in an information society, students must have mastered basic skills such as math facts, how to spell or decode words, and how to write complete sentences.

Multimedia methods of instruction for middle school students with learning disabilities on historical topics, such as the Civil War, the American Revolution, and the Industrial Revolution, have also been developed at the University of Delaware (Ferretti & Okolo, 1996; Okolo & Ferretti, in press). These students often have difficulty learning from traditional textbooks, which often present historical topics in a superficial and highly descriptive manner. Students with learning disabilities are easily overwhelmed by the large number of names, facts, and dates cited in traditional textbooks. However, many students with learning disabilities are visual learners. Therefore, multimedia presentations such as those just described allow the student to grasp information more easily and at a deeper level.

The researchers taught students with learning disabilities how to collect information on American history topics from a variety of sources, such as CD ROMs, Internet files, audiovisual presentations, and other sources that use different vocabularies or visual presentation strategies that are easier to read and comprehend. The students learn to use user-friendly, commercially available software for personal computers to organize their various source materials into a multimedia presentation that contains written text and visual images. For example, students compose a multimedia presentation based on an interpretation of or argument for the various causes of the Civil War. The special education researchers felt that teaching students to synthesize information and construct defensible arguments, rather than just restate facts presented in the textbooks, is of critical importance, because doing so generates greater student interest, increases motivation, and provides the opportunity to develop higher-order thinking skills.

In an effort to teach secondary students with learning disabilities the kinds of skills and knowledge needed in the workplace, researchers at the University of Puget Sound in Washington (Woodward & Baxter, 1997) have designed an integrative approach to teaching mathematics and writing. The project teaches students how to collect and analyze data, communicate effectively both orally and in brief written communications, and work with others in small groups or teams.

The mathematics instruction teaches the students to understand concepts such as fractions, percents, ratios, and their applications in everyday settings (e.g., the students may operate a mock business). Moreover, students learn to use calculators and spreadsheets -- two widely used technological tools in the workplace -- to solve problems. Students communicate their findings orally, and in one page reports that often contain data and charts. Students use the program *Microsoft Works*™ to do much of the work, and Microsoft Corporation provides support for the project and helps disseminate curricular products.

## SUMMARY

Technology-based research and development projects funded by OSERS during the past decade have helped a wide range of students with disabilities achieve better educational results and more independence. Researchers have been able to tailor specialized applications of common as well as novel technologies to meet the unique needs of students with severe disabilities. Their solutions have resulted in increased mobility and independence, enhanced communication, and improved capacity to participate in regular classrooms.

For the larger number of students with disabilities such as learning disabilities, attention deficit disorder, behavior disorders, and mild mental retardation, advances in technology-based instruction have helped these students master basic skills and develop higher-order thinking skills. Technology can provide the time and the appropriate level of practice that enables students with disabilities to develop higher skill levels in spelling, beginning reading, or math facts, which many students have difficulty mastering. Students can also use various technologies to help them solve problems and to complete complex assignments. In the future, as more innovative technologies, particularly multimedia tools, become commercially available, research on using technology to teach students with disabilities may influence the way educators think about using technology in education for all students.

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