PERSPECTIVES ON APPLICATIONS OF TECHNOLOGY IN THE FIELD OF LEARNING DISABILITIES

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This article describes how concepts related to the use of technology in education have evolved with particular emphasis on their implications for people with learning disabilities (LD). The article reflects my personal perceptions as a "participant observer" in a variety of activities related to technology applications in special education beginning in the early 1960s (Blackhurst, 1965, 1967). At that time, educators were focused on the potential that *audio-visual aids*, such as 16mm film projectors and tape recorders, had for instruction. Researchers and instructional designers also were engaged in developing *programmed instruction* materials that had their foundation in Pressey's 1926 invention of the first teaching machine (Blackhurst & Edyburn, 2000). As mainframe computers and their applications became more prevalent, *technology* gradually emerged as the terminology of choice.

In the mid- to late 1960s, conceptualizations about technology were broadened to *media and materials,* and a national network of Special Education Instructional Materials Centers was established to provide practical assistance on the use of instructional materials to teachers throughout the nation (Warfield, 1968). By 1970, *instructional technology* emerged as a topic of interest (Commission on Instructional Technology, 1970), and two broad categories of technology were commonly acknowledged: *systems technology* and *media technology* (Blackhurst & Hofmeister, 1980).

Advances in both instructional technology and mainframe computer technology continued in the early 1970s. The late 1970s and early 1980s saw the introduction and refinement of the microcomputer, undoubtedly the most influential technology of the late 20th century. The 1980s also witnessed an increased emphasis on assistive technologies and the emergence of technology literature and computer software targeted directly at special education. Significant technology legislation, such as the Technology-Related Assistance for Individuals with Disabilities Act (P. L. 100-407) was passed, among others (Blackhurst, 1997). Major technology advances, such as the evolution of the Internet, occurred during the 1990s. Additional in-depth information about historical developments may be obtained elsewhere (e.g., Blackhurst, 2005; Blackhurst & Edyburn, 2000).

Technology Types and Education

Over the years, historical events have led to a broadened view of technology – one that goes far beyond the focus on machines. My current perspective is that six distinct types of technology impact education. Following are brief descriptions of each, accompanied by illustrations of their use and potential for people with LD, some being more directly pertinent to LD than others.

The ***technology of teaching*** refers to instructional approaches that are systematically designed and applied in very precise ways. Such approaches typically include the use of well-defined objectives, precise instructional procedures based upon the tasks that students are required to learn, small units of instruction that are carefully sequenced, a high degree of teacher activity, high levels of student involvement, liberal use of reinforcement, and careful monitoring of student performance. Instructional procedures that embody many of these principles include approaches such as direct instruction (Carnine, Silbert, & Kameenui, 1990), applied behavior analysis (Alberto & Troutman, 1995; Wolery, Bailey, & Sugai, 1988), learning strategies (Deshler & Schumaker, 1986), and response prompting (Wolery, Ault, & Doyle, 1992). Most often, machines and equipment are not involved when implementing

various technologies of teaching; however, they can be, as will be illustrated later.

There are differing opinions about the nature of ***instructional technology,*** but a presidential Commission on Instructional Technology (1970) provided the following definition:

> Instructional technology is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction. (p. 199)

Typical applications of instructional technology may use conventional media such as videotapes, computer-assisted instruction, or more complex systems, such as hypermedia instruction programs and the World Wide Web (Web). An excellent example, found to be effective with students who have LD, is the reading instruction program *Read 180* developed by Hasselbring (1996). Okolo (2000) describes additional ways that technology may be used to support instruction of students with LD, such as the use of electronic books, anchored instruction, and network-based learning. Concepts related to the universal design for learning (Rose & Meyer, 2000) also have significant implications for the delivery of instruction.

It is important to note the various components of the above definition and to realize that technology is a tool for the delivery of instruction. In this conceptualization, technological devices are considered as means to an end, and not an end in themselves. Thus, use of technology cannot compensate for instruction that is poorly designed or implemented.

Assistive technology (AT) employs various types of services and devices designed to help people with disabilities function within their environment. AT includes mechanical, electronic, and microprocessor-based equipment, nonmechanical and nonelectronic aids, specialized instructional materials, services, and strategies that people with disabilities can use to (a) assist them in learning, (b) make the environment more accessible, (c) enable them to compete in the workplace, (d) enhance their independence, or (e) otherwise improve their quality of life. These may include commercially available or "home-made" devices that are specially designed to meet the idiosyncratic needs of a particular individual (Blackhurst & Lahm, in press). Examples include communication aids, alternative computer keyboards, adaptive switches, and services such as those that might be provided by speech/language pathologists, physical therapists, and occupational therapists. Edyburn (2004) wrote a provocative article about how assistive technologies are currently affecting learning, and speculates about ways they may change in the future. An example that illustrates the special implications that AT has for students with LD is provided later in this article.

In addition to seemingly miraculous surgical procedures that are technology-based, many individuals are dependent upon ***medical technology*** to stay alive or otherwise enable them to function outside of hospitals and other medical settings. It is not uncommon to see people in their home and community settings who use medical technology. This also is the case with some students in public schools. For example, some devices provide respiratory assistance through oxygen supplementation and mechanical ventilation. Others, such as cardiorespiratory monitors and pulse oximeters, are used as surveillance devices that alert an attendant to a potential vitality problem. Nutritive devices can assist in tube feeding or elimination through ostomies. Intravenous therapy can be provided through medication infusion, and kidney function can be assumed by kidney dialysis machines (Batshaw & Perret, 1992). In addition to keeping people alive, technologies such as these can enable people to fully participate in school, community, and work activities. Implications for those with LD who have severe medical conditions are obvious.

As the name implies, ***technology productivity*** tools include computer software, hardware, and related systems that enable people to work more effectively and efficiently. For example, computer software such as database programs can be used to store and rapidly retrieve information; word processing programs can be used to easily edit text material; FAX machines can facilitate the transmission of written documents over long distances; expert system computer programs can aid in decision making, such as the educational placement of students with disabilities; and videoconferencing facilities can reduce the need for travel. Okolo (2000) addresses specific suggestions for using productivity tools with students who have LD, including specialized writing tools, such as writing organization tools, spelling checkers, speech synthesis and word prediction software, writing prompts, and multimedia composing tools. She provides a wealth of other information related to the use of technology in curriculum for students with LD.

Information technologies provide access to knowledge and resources on a wide range of topics. The Internet and its Web component is the most prominent example of information technology. Not only can the Internet provide information to professionals who offer special education services (e.g., the Web addresses in the Appendix), Web sites can also be used by people with LD to facilitate learning (e.g., online tutorials

about how to use features of software programs); productivity (e.g., e-mail, online conferencing); personal enrichment (e.g., using search engines to locate information); and the use of leisure time (e.g., online solitaire, interactive games).

Each of the above technology types, used singly, has significant implications for the delivery of special education services. It is important to remember, however, that they may also be used in combination. For example, Bausch (1999) used a membrane keyboard that consisted only of number and control keys *(assistive technology)* with a computer program *(instructional technology)* that was designed according to principles consistent with a constant time-delay response prompting procedure *(technology of teaching)* to provide math facts instruction to students with LD.

Using Technology with Students with Learning Disabilities

While an understanding of the different types of technology is important, our primary concerns should relate to issues such as making decisions about the types of technology that are most appropriate for individual students and ensuring that those technologies are obtained, implemented appropriately, and evaluated to determine their effectiveness. Fortunately, the Individuals with Disabilities Education Act (IDEA) includes a mandate that supports such activities. Specifically, IDEA requires that AT be considered for every student who has an individualized education program (IEP).

AT consideration is not just for students who have physical disabilities or sensory impairments. Any technology that is necessary to aid a student in meeting IEP goals and objectives qualifies as an AT. Thus, if a student with a spelling disability needs an electronic spelling aid to assist in meeting goals related to English composition, that would qualify as AT for that student and should be written into the student's IEP. Several conceptual models may be used to facilitate selection of technologies to meet individual needs (e.g., Blackhurst & Lahm, in press; Bowser & Reed, 1995; Chambers, 1997; Wile, 1996; Zabala, 1995, 2002).

Professional development is another important issue. It is imperative that teachers and related personnel develop knowledge and skills that will enable them to provide technology services to students with LD. Elsewhere, I have provided models and procedures that may be used to guide technology professional development efforts at both the pre- (Blackhurst, 2002) and inservice (Blackhurst, 2001) levels.

Clearly, technology has the potential for improving the education and quality of life of people with LD.[1] The final perspective I would like to express here, however, is that many of the current technology applications used with individuals who have LD reflect the "state of the art." That is, decisions about the use of technology for students who have LD are frequently based upon unsubstantiated claims by hardware and software vendors, the availability of technology that has previously been purchased by a school district, or the recommendations of well-meaning, but poorly informed, people. Many decisions based on such factors result in successful applications of technology. Often, however, they lead to the selection and use of technologies that are less than optimal, or result in failure to identify the best technology solutions.

A major challenge facing us is to move decisions about technology applications to the point where they reflect a "state of the science." That is, we must continue to conduct research and study the application of technology devices and services in objective ways so that we can make informed decisions about their selection and use to best meet the needs of people with LD.

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APPENDIX
WEB SITE RESOURCES RELATED TO TECHNOLOGY AND LD

Alliance for Technology Access
http://www.ataccess.org/

Customizing Technology Solutions for College Students with LD
http://www.ldonline.org/ld_indepth/technology/customizing_technology.html

LD and Assistive Technology
http://www.gatfl.org/ldguide/default.htm

Richard Wanderman's LD Resources
http://www.ldresources.com

Tools for Living with LD
http://www.ldonline.org/ld_indepth/technology/ccld_assistive_technology. html

Universal Design for Learning
http://www.cast.org

FOOTNOTE

[1.] Space limitations preclude additional elaboration about this topic. In addition to the references already cited, more detailed information may be obtained from Ashton (2005); Cook & Hussey, 2002; Edyburn (2005); Lewis (1993, 2005); Lindsey (in press); and Majsterek & Edyburn (1993). Web site addresses related to technology and LD also are appended to this article (courtesy of Dave Edyburn).