Assistive Technology for Individuals with Disabilities: A Review and Synthesis of the Literature

Sandra Alper and Sahoby Raharinirina
UNIVERSITY OF NORTHERN IOWA

Despite the emphasis on technology and the rapid proliferation of assistive technology devices, little is known about the specific uses of assistive technology with persons who vary in disability type, severity, and age. The present study conducted a comprehensive review and a systematic analysis of published reports of assistive technology and skill acquisition of persons with disabilities. Uses of assistive technology, its benefits and obstacles, are reviewed. The results provide indications why technology is often abandoned. Implications for practitioners and researchers are discussed.

The passage of the Technology-Related Assistance for Individuals with Disabilities Act (Tech Act) of 1988 has contributed to the increased attention on the role that assistive technology (AT) can have in improving the functional needs of individuals with disabilities. Its passage and the establishment of technology-related projects greatly contributed to an increased public awareness in the use of AT by individuals with disabilities to improve their lives (Wallace, Flippo, Barcus, & Behrmann, 1995). When the Tech Act was amended in 1994, it reflected a further redirection in policy, away from previous medical isolationist philosophies to philosophies focusing on AT for individuals with disabilities in the context of school, work and community settings (Wallace, et al., 1995).

The Assistive Technology Act of 1998 (P.L. 105-394), further clarifies and extended the terms and/or programs originally introduced in the Technology-Related Assistance for Individuals with Disabilities Act (Tech Act) of 1988 and its 1994 amendments. For example, the Assistive Technology Act of 1998 states:

(1) The term "assistive technology device" means any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities.

(2) The term "assistive technology service" means any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device. Such term includes:

(a) the evaluation of the assistive technology needs of an individual with a disability, including a functional evaluation of the impact of the provision of appropriate assistive technology and appropriate services to the individual in the customary environment of the individual;

(b) services consisting of purchasing, leasing, or otherwise providing for the acquisition of assistive technology devices by individuals with disabilities;

(c) services consisting of selecting, designing, fitting, customizing, adapting, applying, maintaining, repairing, or replacing of assistive technology devices;

(d) coordination and use of necessary therapies, interventions, or services with assistive technology devices, such as therapies, interventions, or services associated with education and rehabilitation plans and programs;

(e) training or technical assistance for an individual with disabilities, or, where appropriate, the family members, guardians, advocates, or authorized representatives of such an individual; and

(f) training or technical assistance for professionals (including individuals providing education and rehabilitation services), employers, or other individuals who provide services to, employ, or are otherwise substantially involved in the major life functions of individuals with disabilities (§ 3 [3-4]).

The Assistive Technology Act of 1998 also includes the following findings regarding the relationship between AT and how it may be used by persons with disabilities to perform tasks skills associated with education, work, and social/cultural life:

(1) Disability is a natural part of the human experience and in no way diminishes the right of individuals to -

(a) live independently;

(b) enjoy self-determination and make choices;

(c) benefit from an education;

(d) pursue meaningful careers; and

(e) enjoy full inclusion and integration in the economic, political, social, cultural, and educational mainstream of society in the United States.

(2) Technology has become one of the primary engines for economic activity, education, and innovation in the Nation, and throughout the world. The commitment of the United States to the development and utilization of technology is one of the main factors underlying the strength and vibrancy of the economy of the United States.

(3) As technology has come to play an increasingly important role in the lives of all persons in the United States, in the conduct of business, in the functioning of government, in the fostering of communication, in the conduct of commerce, and in the provision of education, its impact upon the lives of the more than 50,000,000 individuals with disabilities in the United States has comparable to its impact upon the remainder of the citizens of the United States. Any development in mainstream technology would have profound implications for individuals with disabilities in the United States.

(4) Substantial progress has been made in the development of assistive technology devices, including adaptations to existing devices that facilitate activities of daily living, that significantly benefit individuals with disabilities of all ages. Such devices and adaptations increase the involvement of such individuals in, and reduce expenditures associated with, programs and activities such as early intervention, education, rehabilitation and training, employment, residential living, independent living, and recreation programs and activities, and other aspects of daily living (§ 2 [a] [1-4]).

The Individuals with Disabilities Education Act (IDEA) Amendments of 1997 (IDEA 97) mandates that the AT needs of all students with disabilities be considered as part of the IEP planning process. Many of these students can benefit from inclusion and specialized AT for its great potential for enhancing their capabilities (Zhang, 2000). For example, IDEA 97 puts an emphasis on "providing greater access by children with disabilities to the general curriculum and to educational reforms, as an effective means of ensuring better results for these children" (Federal Acquisition Regulations for Content of IEP, 1999, p. 12594). Findings mentioned in the Individuals with Disabilities Education Improvement Act of 2004 stress the importance of ensuring children's "access to the general education curriculum in the regular classroom, to the maximum extent possible, in order to meet developmental goals and, to the extent possible, the challenging expectations that have been established for all children, and be prepared to lead to lead productive and independent adult lives" (§ 601 [c] [5] [A]). In both these legislative contexts, IEP teams are required to consider AT with respect to meeting a student's goals and objectives (e.g. using AT to obtain greater access to the curriculum and developmental goals).

The Assistive Technology Act of 2004 (P.L. 108-364) amends the Assistive Technology Act of 1998 (29 U.S.C. 3001 et seq.), by including an addition to the term *assistive technology service* by stating that it also: "includes a service consisting of expanding the availability of access to technology, including *electronic and information technology* [emphasis added], to individuals with disabilities" (§ 3 [5] [G]).

Barriers to Assistive Technology Implementation

Many agree that technology has great potential for enhancing the capabilities of individuals with disabilities (Zhang, 2000). Assistive technology (AT) can serve as a cognitive prosthesis, that is, technology that corrects an impairment for individuals with disabilities (Cavalier, Ferretti, & Okolo, 1994) and can help them access the general curriculum. It can also be used as a support for completing a task or learning new material (Anderson-Inman, 1999; Raskind, 1994). Nevertheless, there appear to remain a number of barriers to the successful inclusion of AT into the everyday lives of persons with disabilities.

Despite the increased attention to and awareness of the potential of AT to help individuals with disabilities access the general curriculum and acquire transitional skills, as reflected in the federal legislation, several barriers remain. First, despite the existing educational technology (Zhang, 2000), accessible technology is unavailable to many students with disabilities and their families. For example, Norman (1994) observed that not all groups have equal access, primarily due to limited financial resources. Second, the high costs of equipment and lack of funding to access devices or services, as well as lack of information regarding AT for families of individuals with disabilities, are often primary barriers (Wehmeyer, 1998). Third, professionals' lack of knowledge about technology can be a major obstacle. For example, few training programs for special education teachers include courses or class sessions on AT applications and issues (Todis, 1996). Fourth, lack of ongoing support can constitute a main problem. Fifth, eligibility issues are often important obstacles, and have led to the underutilization of AT by individuals with disabilities (Wehmeyer, 1998).

Additionally, even in cases where AT was available to persons with disabilities and their families, the purchased devices were often abandoned (Todis, 1996). Major reasons for abandonment include (a) lack of consideration of the individual with a disability and/or family's needs (Parette, 1997); (b) assistive technology selected for the person by family members or therapist (Scherer, 1993); (c) complicated design factors of the device regarding setup, programming, and portability (Scherer, 1993); (d) insufficient funding for the device (Todis, 1996); (e) unreliable technology (Sherer, 1993; Todis & Walker, 1993); (f) lack of technical support (Lode, 1992); and (g) equipment drawing negative attention to an individual (Todis, 1996).

In addition, Todis (1996) found that students' educational and social needs could be successfully met only if the following factors were present: (a) the student's education program was based on the family's goals and values; (b) AT and student's goals were linked; (c) family, student, and professionals work collaboratively; (d) communication is ongoing; (e) equipment is replaced or modified as needed; and (f) problems were immediately resolved as soon as they arose.

Purpose of the Present Study

Despite the legislative emphasis on technology and the rapid proliferation of AT devices being developed and made available to consumers, little is known about the specific uses of AT with persons who vary in disability type, severity, and age. The purpose of the present study was to conduct a comprehensive review and systematic analysis of published reports of AT and skill acquisition of persons with disabilities. Attention would also be placed on assessing whether this literature was addressing recommendations and requirements embedded in AT legislation.

Methods and Procedures

Criteria for Article Inclusion

To be considered for inclusion in the present review, articles needed to meet the following criteria: (a) participants were individuals with disabilities; (b) participants were 3 years of age and older; (c) the articles published in English language refereed journals between 1988 and 2003; (d) they included AT device(s) as the independent variable; and (e) they provided assessment of skill acquisition. The year 1988 was chosen because the Tech Act was passed that year.

Search Procedures

Criteria for search and inclusion of articles followed guidelines provided by Martella, Nelson, and Martella-Marchand (1999). Specifically, article search procedures involved three components: (a) electronic-based searches in the Library Information Access System through the Educational Resources Information Center (ERIC) electronic database using any or a combination of the following key descriptors: AT, technology, disabilities, and learning disabilities; (b) a hand-based search of refereed journals publishing articles on disabilities and/or technology; and (c) a traditional search using the reference section of articles obtained through the above two methods. Using these procedures, a total of 60 articles were found that met the inclusion criteria.

Article Analysis

A content analysis form (see Table 1, Appendix A) was generated to provide a summary of each article. The analysis form was divided into 12 categories: (a) author and publication source and date; (b) number of studies included in each publication; (c) participant characteristics including age, grade, number, and disability label; (d) individualized assessment prior to selection of AT; (e) independent variable; (f) dependent variable; (g) design; (h) training setting; (i) other non AT training materials; (j) degree of family involvement; (k) degree of ongoing support; and (l) results.

These categories were derived from recommendations of the Tech Act of 1988 and the Assistive Technology Act of 1994 reauthorized in 1998, and a review of the literature on the needs of persons with disabilities for AT, benefits and obstacles of AT for this population, and expert opinion. For the latter, 10 families of students with disabilities, 5 teachers, and 3 university professors were surveyed in regard to the validity of these factors.

Two researchers analyzed the content of each of the 60 articles independently. Each researcher read each article separately, transcribing data to the content analysis form as they read. Nine (15%) articles were randomly selected and used to calculate interrater reliability utilizing the following formula: number of agreements divided by the sum of the number of agreements and disagreements divided by 100 (Kazdin, 1982). The degree of interrater reliability ranged from 82.35% to 97.06%, with a mean of 89.30%.

Results

A summary of the content analysis of the 60 articles is presented in Table 1. The following sections summarize the major findings relative to the 12 categories.

Number of Studies

The 60 articles included in the review reported a total of 68 studies: 56 (93.33%) articles involved a single study each, two (3.33%) articles included the results of two studies, one (1.67%) article reported three studies, and one (1.67%) article reported the result of five studies.

Participant Characteristics

Participant number. Of the 68 studies in the review, 58 (85.29%) included participants with disabilities only. Ten (14.70%) studies involved participants with and without disabilities. Of the latter, six (60%) involved more participants without a disability than participants with a disability, two (20%) included more participants with disabilities than those without a disability, and two (20.00%) had an equal number of participants with and without a disability.

Seven (10.29%) studies had a single participant, 22 (32.35%) included 2 to 5 participants, 7 (10.29%) involved 6 to 10 participants, 6 (8.82%) studies included 11 to 20 participants, and 9 (13.24%) involved 21 to 30 participants. Six (8.82%) studies had 31 to 40 participants, 2 (2.94%)

involved 41 to 50, 5 (7.35%) had 51 to 60 participants, and 4 (5.88%) served 60 or more participants.

Participant age and grade level. Eleven (16.18%) of the studies reviewed did not provide participants' ages. Otherwise, participants' ages ranged from 5 to 12 in 25 (36.76%) of the studies reviewed, 13 to 15 in 23 (33.82%) studies, 16 to 21 in 22 (32.35%) studies, and 22 and up in 17 (25.00%) studies. Only two (2.94%) studies served participants from 2 to 4 years of age. These percentages total greater than 100 because several studies involved participants whose ages could be categorized in more than one age range.

Seventeen (25.00%) studies included elementary school participants only, 11 (16.18%) involved middle grade participants only, 5 (7.35%) had high school participants only, and 5 (7.35%) served postsecondary education participants only. Two (2.94%) involved elementary and middle school participants, 4 (5.88%) included elementary and secondary school participants, and 3 (4.41%) served middle and high school participants. Seventeen (25.00%) studies served participants without grade classification (e.g., home-bound, community-service receivers, or workers). Three (4.41%) studies did not provide participants' grade levels or information to classify them. Only 1 (1.47%) study involved pre-school participants.

Disability label. Thirty-six (52.94%) studies involved participants with learning disabilities and 24 (35.29%) served persons with mental retardation. Individuals with Down syndrome were served in 10 (14.71%) of the studies, persons' developmental problems were addressed in 7 (10.29%), and individuals with behavioral problems and autism were reported in 7 (10.29%) of the studies. Other disability labels included behavioral problems and autism in 7 (10.29%) of the studies, cerebral palsy and attention deficits were addressed in 6 (8.82%) of the studies, speech impairments in 6 (8.82%) studies, physical disabilities in 4 (5.88%) studies, and visual impairments in 3 (4.41%) studies. These percentages total greater than 100 because several articles addressed more than one disability type.

Focus of the Studies

Fifty-four (79.41%) studies were conducted to investigate the effectiveness of the use of AT in impacting participants' skills, 5 (7.35%) to develop and validate the AT being used, and 4 (5.88%) to replicate a study. One (1.47%) study was conducted to assist a teacher struggling with a student with special needs, 2 (2.94%) to observe how participants used the AT involved, 1 (1.47%) to reduce physical demands on the participant, and 1 (1.47%) to help participants access test materials.

Independent Variables

Independent variables included using video (e.g., computer-based, videotapes, and videodiscs) in 11 (16.18%) of the studies, writing software in 10 (14.71%) studies, computer-based study (e.g., a combination of word processor, calendar, and outlining applications used as study tools) in 10 (14.71%) studies, multi-media (e.g., combination of text and graphics applications) in 9 (13.24%) studies, speech recognition in 4 (5.88%) studies, software games in 4 (5.88%) studies, prompting devices in 3 (4.41%) studies, and speech synthesis software in 3 (4.41%) studies. Palmtop personal computers were used in 8 (11.76%) studies, Internet software in 1 (1.47%) study. Four (5.88%) studies involved facilitated or augmentative communication devices.

Dependent Variables

Skill improvement was targeted in 46 (67.65%) of the studies. Transitional skills were addressed in 35 (51.47%) studies, and academic skills were targeted in 33 (48.53%) studies. Skill maintenance was addressed in only 22 (32.35%) of the studies, and skill generalization in only 13 (19.12%) studies.

Design

Thirty-two (47.06%) studies employed a group experimental design. Of these, 14 (20.59%) used pretests and posttests, 4 (5.88%) used one-shot design, 3 (4.41%) utilized two-group within-subjects, 2 (2.94%) used time series, 2 (2.94%) employed posttests, 1 (1.47%) utilized a static group design, and 1 (1.47%) employed 2X2 factorial design. Twenty-seven (39.71%) studies used a single-subject design of which 14 (20.59%) studies utilized multiple baseline across participants, 7 (10.29%) employed multiple baseline across behaviors, and 6 (8.82%) used posttest baseline, multiple baseline with withdrawal, A-B, A-B-A, or reversal design. Eight (11.76%) studies utilized qualitative methodology. One (1.47%) study used a combination of a single-subject and group design.

Training Settings

The most frequently listed training setting was the general education classroom in 13 (19.12%) studies, followed by the self-contained classroom or segregated school setting in 12 (17.65%), studies, and by the computer room in 8 (11.76%) studies. Seven (10.29%) studies were conducted in resource rooms and 2 (2.94%) in remedial classrooms. Three (4.41%) studies took place in the home setting, 6 (8.82%) in an activity center setting, 8 (11.76%) occurred in exceptional places (e.g., office, university room, or testing room), and 2 (2.94%) in work setting. Of the 68 studies reviewed, only 7 (10.29%) were conducted across settings.

Individualized Assessment Prior to AT Selection

The majority of studies, 43 (63.24%), did not include individualized assessment of participants prior to selection of

AT. Only 25 (36.76%) studies mentioned individualized participant assessment or used an ongoing assessment and modification to customize AT to meet participants' individual needs. One study reported that a participant had to be dropped during the intervention because of mismatch between the child's ability characteristics and AT characteristics. Another study indicated that a participant had to wrap his finger with tape so that it would not hurt when he was using the AT device.

Other Training Materials

Forty (58.82%) studies did not report use of non-AT training materials. Twenty-eight (41.18%) utilized other materials such as handbooks, textbooks, reference books, written lists, worksheets, self-evaluation sheets, and/or postboards for training.

Family Involvement

No family involvement was reported in 53 (77.94%) of the studies reviewed, although one of the studies reported that, after the intervention, parents asked what AT had been used to train their child. Only 15 (22.06%) studies mentioned family involvement. Activities in which families were involved included transportation and/or medicine administration in 3 (4.41%) studies, providing input prior to the intervention in 3 (4.41%) studies, observing and/or recording participants' behaviors in 5 (7.35%) studies, or providing interview responses or attending participants' presentations after the intervention completion in 4 (5.88%) studies.

Ongoing Support

No ongoing support to participants and their families was reported in 46 (67.65%) studies. Ongoing support for participants was mentioned in only 22 (32.35%) studies. The duration of ongoing support in these studies ranged from a few hours to a few years. Only 2 (2.94%) studies reported AT training for family members on an as-needed basis.

Discussion

Federal legislation reflects the significant role that technology can play in the attainment of academic, vocational, and adult life goals by individuals with disabilities. The purpose of this study was to conduct a comprehensive review and analysis of reports of AT and skill acquisition of persons with disabilities published between 1988 and 2003. Based on the results, the more notable finding are discussed below.

Participant Age

Only 1 (1.47%) of the studies reviewed involved participants aged younger than 5. These findings indicate that very young individuals with disabilities are not receiving AT as a tool to assist them in acquiring skills related to their disability challenges. This is consistent with Judge's (2001) findings. Judge's survey of 91 preschool special education personnel revealed that technology applications were commonly used in small group or individual activities that were neither developmentally appropriate nor related to the ongoing activities in the classroom. One possible reason for these findings was teachers' concerns about lack of developmentally appropriate software for young children. A second factor reported by Judge's participants was difficulty of adapting software for different student ability levels.

Only 17 (25%) of the studies involved participants age 22 and up. This suggests that adults with disabilities are not receiving AT for skill acquisition. This finding concurs with those of Sharpe (2002). In his examination of transition issues related to high school, postsecondary, and workplace settings and types of accommodations and technologies used in these settings, Sharpe found that the percentage of participants decreased steadily as age increased. Sharpe also found that the frequency of use of AT devices declined from the postsecondary level to the workplace. Izzo and Lamb (2002) pointed that many persons with disabilities are unaware of post school service providers and the services they can provide. Thus, these individuals are unable to identify the appropriate agencies and services that can address their specific needs.

The great majority of the studies in this review included participants between 5 and 21 years of age. Edyburn's (2001) review of the 2000 special education technology literature yielded similar results.

Disability Type

Participants in the majority of the studies in this review were labeled as having learning disabilities or mental retardation. People with physical disability labels or behavioral problems and autism, were the least served. Only 9 (13.24%) studies addressed these disability types. These findings are consistent with those of other review studies. For example, Edyburn (2001) found that learning disabilities and mental retardation were two of the three most common disability types addressed in the special education technology literature in 2000. Similarly, Sharpe's (2002) Project Grad survey results indicated that learning disabilities were the most frequent disability label reported by participants. Edyburn (2001) also reported that only one fourth of the articles he reviewed explicitly indicated reference to a specific disability. He maintained that this might be due to the increasing emphasis on generic technology applications that are useful for individuals of all abilities.

In the studies reviewed here, persons with visual impairments were the least frequently served. This might be related to the high cost of highly specialized AT devices. Taylor

(2004) reported AT cost as the leading barrier for people with disabilities who have tried to obtain AT but have been unable to do so. Similarly, Sharpe (2002) observed a general relationship between frequency of use and overall expense and/or complexity of AT devices in his participants' survey results. That is, the more costly, complex, or specialized the AT devices, such as a refreshable Braille display, the less frequently they are used.

Skills Addressed

The majority of studies in this review targeted academic or transition skills. This is partially consistent with Edyburn's (2001) findings, which indicated that the most common technology applications used in the articles he reviewed were related to academic subjects, namely math, reading, and writing. It could be that functional skills, such as communication and social skills, are not clearly defined, as they require assessment of specific aspects and cultural elements present in environments in which persons with disabilities function. Skills that each individual needs to learn in order to appropriately function in these environments are also specific. AT devices have to be appropriately customized to meet each individual's needs, rather than be configured to address elements that more generically apply to many.

Only a small number of studies in this review targeted skill maintenance and skill generalization. This is of great concern since skill generalization is imperative for the attainment of independence by individuals with disabilities across settings. Persons with disabilities often experience difficulty applying learned skills to untrained settings, and/or skills as a means of adapting to new situations, solving problems, and living in different environments. An inability to transfer or generalize skills hampers ability to function more independently. Therefore, it is critical that educational programs contain generalization activities (Burgstahler, 2002; Polloway & Patton, 1993; Ryndak & Alper, 2003).

Setting

The majority of the studies reviewed involved training in general education classrooms and other school settings. Only a few studies provided training in the home and the community. These data are consistent with Sharpe's (2002) finding that a great majority of post-secondary students reported that they learned to use AT while in school, while only 3% report that they first used AT in the workplace.

Individual Assessment

The majority of the studies in this review failed to involve individualized AT assessment prior to the selection of the AT devices used by participants. This finding is particularly disturbing because lack of individualized assessment of AT equipment has been found to be a major obstacle to the general use of technological devices by students with disabilities (Wehmeyer, 1998). Likewise, it is a frequent reason for equipment abandonment (Parette, 1997). The lack of individualized AT assessment suggests that certain studies may not be effectively matching students' needs and features of AT equipment.

Family Involvement

The fact that family involvement and ongoing support were reported in only few of the studies we reviewed, is a concern. Lack of support and family involvement has been identified as another major reason for equipment abandonment (Lode, 1992). Defur, Todd-Allen, and Getzel (2001) reported that parents expressed a lack of respect for their contributions and frustration due to feelings of being treated less than equal by professionals. Parents also indicated that they wanted to be engaged in personal relationship-building activities with professionals as partners in planning their children's transition.

Limitations of the Study

Several limitations of this study should be noted. They include: (a) only studies in articles published in English language refereed journals were reviewed; (b) the review was restricted to the period between 1988 to 2003; and (c) only studies that involved skill assessment and acquisition were included. Therefore, the review excluded what is referred to as "fugitive" literature (Martella, et al., 1999, p. 493), including (a) dissertation studies; (b) studies in books; (c) programs in operation but not published; (d) studies available online; (e) studies involving children younger than 3 years of age; (f) studies reported in non-English languages; and (g) studies that may have been conducted using AT but never published. Thus, the external validity of our results may be limited.

Implications for Practitioners

Practitioners must be aware of the importance of involving families of persons with disabilities and allow them to identify their own goals and desires or choices (Alper, Mull, & Soenksen, 2004). Practitioners also need to emphasize skill maintenance and generalization across settings in the curriculum (Alper, 2003; Cowen, 1993; Repetto & Correa, 1996; Rozenthal-Malek & Bloom, 1998). They need to utilize existing AT that can assist in achieving this purpose (Anderson-Inman, Knox-Quinn, & Horney, 1996; Bryant, Rivera, & Warde, 1993) because AT plays a critical role in the lives of people with disabilities (Taylor, 2004). It is particularly important that students be able to maintain and generalize skills while still in school because services are fragmented and difficult to access in post school settings (Anderson-Inman, Knox-Quinn, & Szymanski, 1999; Dahlke, 1993; Mull, Sitlington, & Alper, 2001).

Implications for Researchers

Researchers need to explore the use of AT devices in relation to variation in type and degree of disability. A related need is to define eligibility criteria for diagnosis of a disability in research participants. This is particularly important for external validity because definitions of disabilities and criteria for eligibility for services vary from state to state.

There is also a need to investigate effective teaching strategies for maintenance and generalization. Without skill maintenance and generalization, valuable time and resources have to be used to retrain AT-related skills learned in one setting to another setting.

Researchers also need to focus more on how partnerships and collaboration between teachers, families, and service providers can be implemented across settings. Knowledge obtained from such research is crucial to smooth transition. One related need is to involve teachers in studies conducted with their students. Their involvement can instill a feeling of inclusion and researcher-teacher partnership, and a sense of responsibility of finding better means to help students access instructional materials. It can also be a meaningful way to help them embrace research as a useful classroom practice. This would ensure continuation of the use of the AT devices investigated in the classroom, and be a welcome outcome of the time and effort invested in the research interventions and/or related outcomes.

Conclusion

It has been 18 years since the passage of the Tech Act, yet many of the recommendations and requirements embedded in this legislation are not being addressed in the literature. Enabling persons with disabilities to take full advantage of AT is imperative for their success in home, school, and community settings. It is critical that appropriate technology and support services be available so that persons with disabilities are not denied the full benefit of education programs. It is also imperative that professionals who are working directly with these persons and their family members be adequately trained to provide the support and accommodations necessary for people with disabilities to enjoy the full benefits of AT. Much more work is needed in this increasingly critical area.

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Note. References marked with an asterisk were analyzed in this review.

Dr. Sandar Alper is a Professor and Associate Dean of Graduate Studies and Research at the University of Northern Iowa. Dr. Sahoby Raharinirina is a Research Associate in the National Institute of Technology for Inclusive Education, at the University of Northern Iowa. Correspondence regarding this article should be addressed to Sandra Alper, 159 Schindler Education Center, University of Northern Iowa, Cedar Falls, Iowa 50613. Email to sandra.alper@uni.edu.

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Appendix A

Table 1.
Summary of Content Analysis

Citation	Age	Grade Level	N	Disability Label	Design	Independent Variable	Dependent Variable	Training Setting	AT assess-ment	Other Training material	Family involve-ment	Ongoing support	Results
Anderson-Inman, L., Knox-Quinn, C., & Horney, M. A. (1996)	12 to 16	Middle and high schools	30	LD	Modified longitudinal	Inspiration software	Take notes; organize reading information; study for tests	Inclusive classroom	No	Yes	No	Yes	Positive effects at three different adoption levels associated with intelligence and reading test scores
Anderson-Inman, L., Knox-Quinn, C., & Szymanski, M. (1999).	Not provided	High school	1	LD	Case	Computer-supported studying using scaffolding	Synthesize information	Resource room	Yes	No	No	Yes	Developed new strategies; overcame occasional obstacles; became internally motivated
	Not provided	Post-secondary	1	LD	Case	Computer-based study strategies	Manipulate and organize information	Resource room	Yes	No	No	Yes	Learned, applied, developed, maintained, and generalized various study strategies
	22	Post-secondary	1	Multiple	Case	Networked notetaking support	Take and study notes	School	Yes	No	No	Yes	Used the computer to efficiently take representative class notes; maintained and generalized skills
Ayres, K. M., & Langone, J. (2002)	6 to 10	Elementary	3	Mild to moderate intellectual disabilities	Multiple baseline across participants	Computer-based simulation of a grocery store checkout counter	Initiate and complete purchasing responses	Self-contained classroom	No	No	No	No	Acquired purchasing skills; did not generalized to but changed purchasing behavior in the community setting
Berninger, V., Abbott, R., Rogan, L., Reed, E., Abbott, S., Brooks, A., Vaughan, K., & Graham, S. (1998)	Mean: 8.6	Elementary school	48	Multiple	2X2 factorial design	1. Pencil response; 2. Computer response	Growth in spelling; transfer gain	University room	No	No	Yes	No	No differences except computer was better for difficult words overtime
Calhoon, M. B., Fuchs, L., & Hamlett, C. L. (2000)	Mean: 16.13	9th to 12th	81	LD	Repeated measures counter-balanced	1. Teacher-read test text; 2. Computer-read test text; 3. Computer-read test text with video; 4. Standard test administration	Math problem-solving achievements; participants' perceptions	Self-contained resource room, computer room	No	Yes	No	No	Significantly and comparably increased performance assessment scores under the teacher-read, computer-read, and computer-read with video conditions; preferred the 3 accommodations comparably
Cavalier, A. R., & Brown, C. C. (1998)	42	Not applicable	1	Multiple	Multiple baseline across behaviors	Speech recognition, television	1. Vocalize with consistency; 2. Connect different voices with different devices; 3. Learn the concept of device activation and de-activation; 4. Exhibit different emotions	Home	Yes	No	Yes	Yes	Successfully controlled devices via vocalization, chose expression, and displayed positive affect
Dalton, B., Winbury, N. E., & Morocco, C. (1990)	Not provided	4th	2	LD	Cases	1. Word processor and spelling checker; 2. No spelling checker	Operate the program; respond appropriately to the spelling checker feedback	School	Yes	Yes	No	No	Independently managed the device, increased spelling accuracy, expressed satisfaction with device

Table 1. continued

Citation	Age	Grade Level	N	Disability Label	Design	Independent Variable	Dependent Variable	Training Setting	AT assessment	Other Training material	Family involvement	Ongoing support	Results
Dattilo, J. & Camarata, S. (1991)	21, 36	Post-secondary, resident	2	Severe motor and speech deficits; profound mental retardation	Multiple baseline across participants	Touch Talker augmentative system	Initiate conversation; social validity	Dormitory; residential care facility	Yes	No	No	No	Markedly increased and improved conversation participation; satisfaction of friends, trainers, and care takers
Dattilo, J., Guerin, N., & Cory, L. (2001)	10 to 14	Not provided	4	Multiple	Multiple probe, single-subject design replicated across participants	Computerized leisure education game	Assess leisure preferences; acquire information to make informed leisure choices; knowledge of benefits of acquiring information to make informed leisure choices; social validity	Summer day camp	No	No	Yes	No	Acquired information, made informed leisure choices, maintained skills, expressed satisfaction
Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2001)	20 to 45	Transition and program service-providing agency	12	Mental retardation	Within-subjects design.	1. The Web Trek browser; 2. Microsoft Internet Explorer	Level of independence and accuracy in performing internet access tasks; level of task completion	Technology or service-providing agency offices	No	No	No	No	Decreased dependency, enhanced self-determination and control over own life; completed tasks with fewer errors; preferred the Web Trek
Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2002a)	19 to 46	Transition program, vocational program	12	Mental retardation	Two-group within-subjects	1. Traditional prompting; 2. Schedule Assistant automated time-management system	Schedule accuracy; level of assistance required	Testing setting with vocational and residential tasks, and simulated real-world distraction	Yes	No	No	No	Increased independence in performing the tasks, expressed satisfaction
Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2002b)	18 to 70	Not provided	10	Mental retardation	Two-group within-subjects design.	1. Visual Assistant; 2. No Visual Assistant	Level of independence and accuracy in completing multi-step tasks	Work	No	No	No	No	Improved task accuracy, decreased use of external prompts
Dicarlo, C. F., & Banajee, M. (2000)	2	Not provided	2	Developmental delay, nonverbal	Multiple baseline across participants	Alpha Talker, a device with small switch; Dual Rocking Level Switch, a device with a large picture separation surface area	Communicative initiation behaviors	Inclusive classroom	Yes	No	Yes	No	Increased specific initiations of communicative requests and self-initiated gestures and sign language use; abandoned unclear vocalizations; moved closer to specific initiated communicative behavior of a typically developing peer
Elkind, J., Cohen, K., & Murray, C. (1993)	Not provided	Elementary and middle schools	28	Dyslexia	Pre-posttest	Computer-based readers software	Reading comprehension skills; attitude toward reading and AT	Self-contained school	No	No	No	No	Improved achievements for most; decreased achievements for some
Ellerd, D. A., Morgan, R. L., & Salzberg, C. L. (2002)	24 to 37	Not applicable	4	Multiple	Pre-post tests	Video-presented single- and paired establishing job scenes	Identify preferred community jobs	Service facility	No	No	No	No	Differentially responded to different job scenes with consistency

Table 1. continued

Citation	Age	Grade Level	N	Disability Label	Design	Independent Variable	Dependent Variable	Training Setting	AT assessment	Other Training material	Family involvement	Ongoing support	Results
Embregts, P. J. C. M. (2002)	14 to 18	Not applicable	5	Mild intellectual disability	Reversal design	Video feedback and self-management procedures	Manage interaction behaviors	Residential facility	No	Yes	No	No	Increased appropriate social behaviors; decreased inappropriate social behaviors; staff satisfaction
Embregts, P. J. C. M. (2003)	13 to 15	Not applicable	6	Multiple	Multiple baseline across subjects	1. Video feedback and self-management strategies; 2. Video and graphic feedback	Manage behaviors	Residential facility	No	Yes	Yes	No	Increased appropriate behaviors, decreased inappropriate behaviors; some maintained skills
Epstein, Willis, Conners, & Johnson (2001)	10	Elementary school	1	ADHD	Reversal	Reminder prompts	Follow instructions; complete tasks; level of satisfaction	Classroom and home	Yes	No	Yes	Yes	Increased initiation and completion of daily tasks at school; no change at home; parent, student, and teacher satisfaction
Ferretti, R. P. MacArthur, C. D. & Okolo, C. M. (2001)	10 to 16	Elementary school	87	Multiple	Pre-posttest	Strategy-supported project-based learning	Understanding of historical content and inquiry processes; knowledge gain; self-efficacy	Inclusive classrooms	No	Yes	No	Yes	Gained knowledge, improved self-efficacy, learned processes of historical inquiry
Furniss, F., Lancioni, G., Furniss, F., Lancioni, G., Rocha, N., Cunha, B., Seedhouse, P., Morato, P., & O'Reilly, M. F. (2001)	20 to 36	Not applicable	3	Severe developmental disabilities	Multiple baseline across participants, counterbalanced	1. Single instructions via VICAID palmtop; 2. Card system instructions	Perform multi-step tasks and maintain performances; preference	Activity center	Yes	No	No	Yes	Increased correct responding on tasks with the AT device; preferred the device to card system
	Adults	Not applicable	4	Severe developmental disabilities	Multiple baseline across participants, counterbalanced	1. Single instructions via VICAID palmtop; 2. Card system instructions	Perform multi-step tasks and maintain performances; preference	Activity center	Yes	No	No	Yes	Increasingly performed tasks with accuracy with the AT device; preferred the device to the card system
	Adults	Not applicable	6	Severe developmental disabilities	Multiple baseline across participants, counterbalanced	1. Single and clustered instructions via VICAID palmtop version 2; 2. Card system instructions	Perform multi-step tasks and maintain performances; reduce the number of instructions	Activity center	Yes	No	No	Yes	Correctly performed tasks at high levels with consistency; most effectively maintained high levels of performances with clustered instructions format; preferred the device to the card system
	Adults	Not applicable	4	Severe developmental disabilities	Multiple baseline across participants, counterbalanced	1. Clustered instructions via VICAID palmtop version 2; 2. No instruction	Perform multi-step tasks and maintain high performances; reduce the number of instruction occasions	Activity center	Yes	No	No	Yes	Maintained high levels of task performances; reduced the number of instruction occasions
	Adults	Not applicable	6	Severe developmental disabilities	Multiple baseline across participants	Instructions via VICAID palmtop	Perform multi-step tasks; social validity	Work	Yes	No	No	Yes	Effectively performed tasks; positive co-workers' AT evaluation

Table 1. continued

Citation	Age	Grade Level	N	Disability Label	Design	Independent Variable	Dependent Variable	Training Setting	AT assess-ment	Other Training material	Family involve-ment	Ongoing support	Results
Glaser, C. W., Rieth, H. J., & Kinzer, C. K. (1999)	13 to 15	Middle school	19	Mild mental retardation	Time-series design	Multimedia-based anchored instruction	Classroom interaction types and quality	Inclusive classroom	No	Yes	No	No	Increased number and quality of interactions, question initiation and discussion participation; decreased off-task or socially inappropriate behaviors
Goldsworthy, R., Barab, S. A., & Goldsworthy, E. I. (2000)	10 to 16	Not provided	59	ADHD	Pre-posttest	1. Interactive software; 2. Therapist-directed problem solving; 3. Attention-placebo	Transfer social problem-solving skills; social skills; level of engagement and attendance	Computer room	No	No	Yes	No	Problem-solved better than control group but as good as therapist-directed group; no difference in social competence
Graham, S., & MacArthur, C. (1988)	10 to 12	Elementary school	3	LD	Multiple baseline across subjects	Computer word processor	Revising behavior performances; self-efficacy changes	Resource room	No	Yes	No	Yes	Improved, maintained, and generalized revising behaviors; gained confidence
Higgins, K., & Boone, R. (1990)	Mean: 14.6	9th	40	LD	Small group A-B-A	1. Lecture; 2. Lecture and computer study guide; 3. Computer study guide	Social studies achievements; attitude	Classroom, computer room	No	Yes	No	No	Performed higher and retained performances under hypertext computer study guides conditions
	Not provided	9th	5	LD	Small group A-B-A	Computer study guide instruction	Social studies achievements; retention	Computer room	No	Yes	No	No	Performed higher and retained performances under the computer study guide condition
Higgins, K, Boone, R., & Lovitt, T. C. (1996)	Mean: 14.6	9th	25	LD	Pre-posttest	1. Lecture; 2. Lecture and hypermedia study guide; 3. Hypermedia study guide	Retention of factual information; retention of inferential information	Inclusive classroom, computer room	No	Yes	No	No	Improved retention abilities
Higgins, E. L., & Raskind, M. H. (2000)	9 to 18	Elementary and secondary	52	LD	Pre-posttest	1. Discrete 2. Continuous speech recognition; 3. General computer instruction	Word recognition and spelling skills; reading comprehension achievement; cognitive process skills	School	No	No	No	No	Improved spelling and reading comprehension skills
Higgins, K., & Raskind, M. H. (1995)	Mean: 24.9	Post-secondary	29	LD	Pre-posttest	1. Speech recognition; 2. Transcriber assistance; 3. No assistance	Holistic writing performances; fluency	University	No	No	No	No	Scored higher in writing using AT
Hine, M. S., Goldman, S. R., & Cosden, M. A. (1990)	8 to 13	3rd, 4th, 5th, 6th, 7th.	11	Multiple	Counter-balanced	1. Single computer-based story writing; 2. Dyad computer-based story writing	Writing error monitoring skills; writing error correcting skills	Summer school program laboratory	No	Yes	No	No	Performed better under dyad condition
Hollenbeck, K., Rozek, T. M. A., & Tindal, G. (2000)	Not provided	7th	50	LD	Modified counter-balanced	1. Teacher-paced video read-aloud test; 2. Student-paced computer read-aloud test	Reading skills; math skills; math knowledge; math test access	School computer room	No	Yes	No	No	Performed better under the student-paced computer accommodation

Table 1. continued

Citation	Age	Grade Level	N	Disability Label	Design	Independent Variable	Dependent Variable	Training Setting	AT assess-ment	Other Training material	Family involve-ment	Ongoing support	Results
Howell, R. D., Erickson, K., & Stanger, C. (2000)	Not provided	1st	60	Multiple	Pre-posttest	1. Regular and supple-mentary software-based reading; 2. Regular reading	On-set word decoding skills; phonemic awareness skills; sight word recognition skills; develop-mental writing and spelling skills	Inclusive classrooms	No	Yes	No	No	Learned skills
Hutinger, P. L., Johanson, J., & Stoneburner, R. (1996)	7 to 13	Not provided	14	Multiple	Modified longitudinal	Assistive technology applications	Social skill gain; academic skill gain	Classroom, home	Yes	No	Yes	No	Improved social and emotional behaviors, gained in cognitive development, communi-cation, and motor development; improved attitudes
Irish, C. (2002)	9 to 11	4th, 5th	6	Learning disabilities in math and cognitive disabilities	Multiple baseline across participants	Memory Math multimedia software	Perform basic multiplication facts	Special education resource	Yes	No	No	Yes	Demonstrated increased accuracy on multiplication performances; maintained performances
Kelly,B., Gersten, R., & Carnine, D. (1990)	Not provided	9th, 10th, 11th	34	LD	Pre-posttest	1. Videodisc instructional design curriculum; 2. Basal fractions curriculum	Math skills	Remedial classrooms, general classroom	No	No	No	No	Attained high achievements
Khemka, I., & Hickson, L. (2000)	Adults	Not applicable retardation	90	Mild mental	One-shot individual tests	Video-simulated social inter-personal situations of abuse	Provide abuse prevention-focused decisions	Adult agency day program room	No	No	No	Yes	Suggested more direct and other-dependent decisions aimed at stopping or resisting physical abuse than sexual or verbal/ psychological abuse
Kyhl, R., Alper, S., & Sinclair, T. J. (1999)	16, 17, 19	High school	3	Mental retardation	Multiple baseline across participants	Videotaped instruction simulating natural settings	Acquire, maintain, and generalize functional word reading skills	Classroom	No	No	No	No	Acquired target words; maintained and generalized performances
Lancaster, P. E., Schumaker, & Deshler (2002)	Mean: 16.7 to 17	Mean: 10.5 to 11.3	22	Multiple	Multiple-probe across participants	1. Live instruction; 2. Hypermedia instruction; 3. No instruction	Self-advocacy knowledge; self-advocacy skills; satisfaction	School resource center	Yes	No	Yes	No	Acquired self-advocacy knowledge and skills, expressed satisfaction
Lancioni, G. E., & Bracalente, D. O. (1998)	16.2, 16.9	Not provided	2	Multiple	Multiple baseline across behaviors	Portable orientation system device	Independently enter activity into the device with accuracy; complete travel moves with accuracy	Rooms familiar to participants	Yes	Yes	No	Yes	Independently enter activity destinations, independently completed travel moves, maintained skills
MacArthur, C. A. (1998)	9, 10	Not provided	5	Multiple	Multiple baseline with a withdrawal	1. Standard word processor; 2. Word processor with speech synthesizer and word prediction.	Write word sequence legibly and spell with accuracy; write composition; recognize words with accuracy; social validity	School computer room.	No	No	No	No	Improved writing legibility and spelling skills, liked the device

Table 1. continued

Citation	Age	Grade Level	N	Disability Label	Design	Independent Variable	Dependent Variable	Training Setting	AT assess-ment	Other Training material	Family involve-ment	Ongoing support	Results
MacArthur, C. A., Graham, S., Haynes, J. B. & DeLapaz, S. (1996)	Not provided	5th, 6th, 7th, 8th	55	LD	Post-test comparison group	10 spelling checkers	Correct spelling errors	Self-contained classes, special education classes	No	No	No	No	Corrected spelling errors differently depending on error severity and spelling checkers
	Mean: 12.05	6th, 7th	27	Severe LD	Counter-balanced one group posttest	1. Microsoft word processor with spelling checker; 2. No spelling checker	Correct spelling errors	Remedial classes	No	No	No	No	Identified and corrected more spelling errors using the spelling checker when correct suggestions were provided
MacArthur & Haynes (1995)	Mean: 16.3	9th, 10th	10	LD	Repeated measures, counter-balanced	1. Hypermedia reading aid basic version; 2. Hypermedia reading aid enhanced version	Identify key terms; identify main ideas; attitude	Classroom	No	No	No	No	Achieved higher with the enhanced version, liked the program
Maki, H. S., Vauras, M. M. S., & Vainio, S. (2002)	10	3rd, 4th	2	Severe writing disabilities	Single-subject A-B design	Combination of cognitive strategy, procedural facilitation, and computer-assisted tutoring	Spelling, decoding, revision, composing skills	School room, home	No	Yes	Yes	Yes	Gained in and maintained spelling accuracy, revision skills, decoding accuracy, knowledge of writing process, improved attitude
Mechling, L. C., & Gast, D. L. (1997)	10 to 13	1st, 4th	4	Down syndrome with moderate intellectual disability	Multiple baseline across behaviors with a withdrawal	Augmentative communication device using the system of least prompts	Complete chained tasks	Special education school lunch room, restroom	Yes	No	No	No	Increased performance levels for each task
Mechling, L. C., & Gast, D. L. (2003).	12, 17, 18	Not provided	3	Multiple	Multiple baseline across behaviors	Simulated multimedia program	Generalize reading of words; generalize location of corresponding grocery items	Private office	Yes	Yes	Yes	No	Generalized word reading and location of grocery items except for different brand items
Mechling, L. C., Gast, D. L., & Langone, J. (2002).	9 to 17	Not provided	4	Multiple	Multiple probe across behaviors	Computer-based video instruction with matching activities	Generalize reading of grocery words; generalize location of grocery items	Self-contained school and center	Yes	Yes	Yes	No	Generalized word reading and location of corresponding grocery items in a store
Mitchell, R. J., Schuster, J. W., Collins, B. C., & Gassaway, L. J. (2000).	14, 16	Middle school	3	Mild mental retardation and cerebral palsy or epilepsy	Multiple probe across behaviors	Faded auditory prompting system	Correctly and independently complete 3 multi-step tasks; generalize skills	Bathroom in a self-contained class-room	Yes	Yes	No	No	Acquired and generalized the skills, maintained the skills differently
Norman, J. M., Collins, B. C., & Schuster, J. W. (2001)	8 to 12	Not provided	3	Multiple	Multiple probe across behaviors	Video modeling and prompting followed by trainer prompting	Self-help skills	At the back of a self-contained class-room	No	Yes	Yes	No	Acquired, maintained, and generalized the skills; progres-sively decreased task completion time

Table 1. continued

Citation	Age	Grade Level	N	Disability Label	Design	Independent Variable	Dependent Variable	Training Setting	AT assessment	Other Training material	Family involvement	Ongoing support	Results
Okolo, C. M. (1992)	Mean: 10.2	7th, 8th	29	LD	Pre-post-test control group	1. Computer-assisted math instruction with attribution retraining 2. Neutral feedback	Attributions; persistence; multiplication attainment	Resource room	No	No	No	Yes	Did not improve attribution scores; increased persistence; completed more levels of the program; obtained higher problem test scores
Okolo, C., & Ferretti, R. P. (1996a)	Mean: 12.3	4th	65	LD, speech or language disability	Pre-posttest group comparison	Multimedia project-based instruction	Knowledge about industrialization; attitude; interactional behavior patterns	Inclusive classrooms	No	Yes	No	Yes	Improved knowledge of the topic and attitude toward cooperative learning and self-efficacy; played more active roles in group activities
Okolo, C., & Ferretti, R. P. (1996b)	Mean: 12.3	Not provided	21	Multiple	Pre-post-test control group	1. Cooperative learning and word processor 2. Cooperative learning and multimedia	Motivation to learn; knowledge gain	Self-contained school	No	Yes	No	No	Gain substantial knowledge; expressed and exhibited enjoyment in participation
Okolo, C. M., & Ferreti, R. P. (1998)	Not provided	6th	33	Mild disabilities	Single static group	Multimedia design projects	Social studies knowledge gain; argumentation skills; motivation to learn	Inclusive classroom	No	Yes	Yes	No	Gained knowledge; understood and demonstrated skills in argumentation; improved attitude toward cooperative learning and motivation to learn
Olney, M. (1995)	22	Not applicable	1	Autism	Case	Facilitated communication	General communication gains	Multiple natural settings	Yes	No	No	Yes	Achieved greater command over day-to-day events; could express complex ideas and emotions; exhibited unique ways of self-expression
Olney, M. F. (2001)	16 to 42	Not applicable	9	Mild to moderate mental disability Severe mental retardation	Post-baseline test design	1. Facilitated communication blind condition 2. Facilitated communication nonblind condition	Spelling; reading comprehension	Home, agency office, or community program site	Yes	Yes	No	No	Four participants responded at a greater than chance level using facilitated communication
Raskind, M. H., & Higgins, E. (1995)	19 to 37	Post-secondary	33	LD	Counter-balanced design	1. Proofreading with speech synthesis assistance; 2. Proofreading with human assistance; 3. Proofreading with no assistance	Performance in proofreading	A private room	No	No	No	No	Detected more spelling, usage, capitalization, and punctuation errors with speech synthesis assistance, but not grammar-mechanical errors and content-organization
Raskind, M. H., & Higgins, E. (1999)	9 to 18	Elementary and secondary	39	LD	Pre-posttest control group	1. General computer instruction; 2. Discrete speech recognition	Word recognition; reading comprehension; spelling; reading strategies	School rooms	No	No	No	No	Significantly gained in reading comprehension, cognitive processes, spelling, and word recognition

Table 1. continued

Citation	Age	Grade Level	N	Disability Label	Design	Independent Variable	Dependent Variable	Training Setting	AT assessment	Other Training material	Family involvement	Ongoing support	Results
Schlosser, R. W., Blischak, D. M., Belfiore, P. J., Bartley, C., & Barnett (1998)	10	Not provided	1	Autism and severe communication disorder	An adapted alternating treatments design	1. Auditory feedback; 2. Visual feedback; 3. Auditory-visual feedback	Spelling achievement; performance maintenance	School library or corner of a self-contained classroom	Yes	No	No	No	Performed and maintained performances more efficiently in the provision of auditory feedback, then in combination with visual feedback
Taber, T. A., Alberto, P. A., Hughes, M., & Seltzer, A. (2002)	11 to 14	Middle school	14	Moderate cognitive disabilities	Multiple-probe across groups	Five-level prompting system, cell phone	Recognize when lost; use a cell phone for assistance; generalize safety skills	School and community	No	Yes	Yes	Yes	Successfully identified when lost and operated a cell phone to call for help
van Daal, V. H. P., & van der Leij 1992)	Mean: 9.7	Elementary	28	Written language impairments	Pre-post-test	1. Copying from the computer screen; 2. Reading then writing from memory; 3. Reading and writing with speech feedback	Reading accuracy and fluency; spelling performance	Special education school	No	No	No	No	Spelled more efficiently under the copy with speech feedback condition; read accurately and fluently under all conditions
Wise, B., Olson, R., Anstett, M., Andrews, L., Terjak, M., Schneider, V., Kostuch, J., & Kriho, L. (1989)	Not provided	3rd to 6th	58	Reading disabilities	Pre-posttest	1. Speech synthesizer with feedback; 2. No computer reading	Word recognition improvement; attitude changes	Remedial reading class	No	No	No	No	Improved word recognition ability and attitude toward reading
Zhang, Y. (2000)	7 to 13	5th	5	LD & behavioral problem	Case study	ROBO-Writer	Writing abilities and behaviors	Computer room	No	No	No	Yes	Improved writing behaviors and performances
Zhang, Y., Brooks, T., Frields, T., & Redelfs, M. (1995)	7 to 13	2nd, 3rd, 4th, 5th.	33	LD with written language deficits	Three-group pretest posttest comparison	1. Microsoft Word 4.0; 2. ROBO-Writer; 3. Paper-and-pencil	Writing quality and length	Resource room	No	No	No	No	Obtained higher scores in holistic quality, spelling and grammar with the ROBO-Writer, but not in essay length