Technology Use for Students with Mild Disabilities in the United States

Cindy L. Anderson*, Kensuke Fukushima**, Shigeru Ikuta***

Abstract

Recent literature on assistive technology uses for students with mild disabilities in the United States were carefully surveyed. Studies focused on the use of traditional computer-assisted-instruction use for students with disabilities; technology use for the subjects, Mathematics, Reading, and Written expression, was investigated. Interactive video has shown promise for increasing problem-solving skills when used as an anchor for problem solving. Multimedia scaffolding features such as text-to-speech synthesis, built-in dictionaries, and graphic organizers have shown their usefulness in helping students with reading deficits. The technologies hold the promise of increasing learning for those students whose disabilities have prevented them success in the past. Assistive technology might be the key to learning for students with mild disabilities.

Key Words : assistive technology（支援技術）, mild disabilities（軽度発達障がい）, technology use（技術利用）, United States（米国）

1. Background

The Congress of the United States of America originally passed the Education of All Handicapped Children Act in 1975 (Kendall, 1978). This law, now called the Individuals with Disabilities Education Act (IDEA), outlined rules and regulations that defined categories of disabilities and the special education programming since its passage. Several revisions to this original law have occurred, but the revision of 1997 included, for the first time, a definition for assistive technology and a requirement for assistive technology consideration and services for students with disabilities (Office of Special Education and Rehabilitative Services, 1997). This was called “a defining moment” for assistive technology (Edyburn, 2000), because

*College of Education, Roosevelt University　** Department of Education, Teikyo University
*** Social Information Studies, Otsuma Women’s University

schools were required for the first time to consider assistive technology for all students with disabilities.

IDEA defines 13 categories of students with disabilities: autism, deaf-blindness, emotional disturbance, hearing impairment, mental retardation, multiple disabilities, orthopedic impairment, other health impairment, specific learning disability, speech or language impairment, traumatic brain injury, or visual impairment. Emotional disturbance, mental retardation, and specific learning disabilities make up the largest group of students with disabilities, identified as 59 percent of the special education population in 2003–2004 (National Center of Education Statistics, 2005). Most of these students are considered to have mild disabilities, also known as high incidence disabilities. These high incidence disabilities will be the focus of the present paper.

A student with mental retardation is defined by IDEA as a student with "significantly sub-average general intellectual functioning existing concurrently with deficits in adaptive behavior and manifested during the developmental period that adversely affects a child's educational performance" (Office of Special Education and Rehabilitative Services, 2004). Students with mild mental retardation must be identified as having an intellectual capacity of at least two standard deviations below the norm. They are often educated in general education classrooms with some academic scaffolding provided from special educators.

A student with an emotional-behavioral disability is defined as a student who exhibits one or more of the following characteristics over a long duration and to a marked degree that adversely affects a student's educational performance: "an inability to learn that cannot be explained by intellectual, sensory, or other health factors; an inability to build or maintain satisfactory interpersonal relationships with peers and teachers; inappropriate types of behavior or feelings associated with personal or school problems; a general mood of unhappiness or depression; a tendency to develop physical symptoms or fears associated with personal or school problems. The term includes schizophrenia but the term does not apply to children who are socially maladjusted, unless it is determined that they have an emotional disturbance" (Office of Special Education and Rehabilitative Services, 2004). Students with mild emotional disturbance are often educated in the general education classroom with a behavioral plan built into their Individual Educational Plan (IEP) that is designed to improve behavior.

The third high incidence disability is the specific learning disability. A student with a specific learning disability (LD) is described as being a student with "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning disabilities which are primarily the result of visual, hearing, or motor handicaps, or mental retardation, or emotional disturbance, or of environmental, cultural, or economic disadvantage" (Office of Special Education and Rehabilitative Services, 2004). This definition has been called a deficit definition, identifying students with learning disabilities as children who have a learning potential that is average or above as measured by an individually administered intelligence test, with individually-administered achievement scores indicating a severe discrepancy from expected scores based on the results of the intelligence assessment. Students with learning disabilities are identified in core areas such as reading, writing, and / or mathematics. The 2004 version of IDEA is also encouraging a definition of students with learning disabilities as those children who continue to fail even after a tiered structure of increasingly individual scientifically-proven instruction (National Center for Learning Disabilities, 2007). The special education placement for students with learning disabilities usually is the general education classroom with instructional support in the general classroom.

These three disability areas, while generally considered mild disabilities, must also be considered for assistive technology according to IDEA. The latest version of IDEA (2004) defines assistive technology as “any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities. The term does not include a medical device that is surgically implanted, or the replacement of such device” (U. S. Department of Education, 2004a). The students and their families must be considered for assistive technology services by their sending schools or agencies. Assistive technology services are defined as “any service that directly assists a child with a disability in the selection, acquisition, or use of an assistive technology device. Such term includes:

1. The evaluation of the needs of such child, including a functional evaluation of the child in the child’s customary environment;
2. Purchasing, leasing, or otherwise providing for the acquisition of assistive technology devices by such child;
3. Selecting, designing, fitting, customizing, adapting, applying, maintaining, repairing, or replacing of assistive technology devices;
4. Coordinating and using other therapies, interventions, or services with assistive technology devices, such as those associated with existing education and rehabilitation plans and programs;
5. Training or technical assistance for such child, or where appropriate, the family of such child; and
6. 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 such child.” (U. S. Department of Education, 2004b).

As the policy towards assistive technology has developed, the research into effective assistive technology for students with mild disabilities has also been refined.

Blackhurst and Lahm (2000) have identified the field as having six categories: the technology of teaching, or systematic methods of teaching such as applied behavioral analysis; assistive technology, or specially designed or purchased devices intended to make the environment accessible; medical technology, or machines designed to help people with unique medical issues; technology productivity tools; information technology; and instructional technology. Technology for students with mild disabilities is most commonly characterized by the use of technology productivity tools, information technology, and instructional technology. The remainder of this article will serve as a review of the recent research studies of the use of this technology for students with mild disabilities.

2. Present Situation on Technology Use in the United States

2.1 Mathematics

Research in the use of technology for students with disabilities in the area of mathematics has examined both using video context with students with disabilities to increase problem-solving skills and using computer-assisted instruction to increase computation skills. Each has shown increases in the mathematics skills of the students with mild disabilities.

Researchers at Vanderbilt University studied the results of using interactive laserdisc video with students with mild disabilities, assessing its effects on students' problem-solving skills (Cognition and Technology Group at Vanderbilt, 1992; Cognition and Technology Group at Vanderbilt, 1997, Cognition and Technology Group at Vanderbilt, 1998). Their use of video was designed to put mathematics into an authentic context where the students had to find the necessary information needed to solve the mathematics problems. The video presented scenarios that could be paused whenever the students saw mathematical information needed to solve the problems. Researchers refer to this as anchored instruction. Results demonstrated that use of the contextual videodisc improved the computation skills of students with disabilities, the problem-solving skills of students with disabilities, and the attitudes of students with disabilities toward mathematics (Cognition and Technology Group at Vanderbilt, 1997, Cognition and Technology Group at Vanderbilt, 1998, Bottge & Hasselbring, 1993).

This video-based, anchored instruction has continued to be researched by Bottge and his colleagues (Bottge, 1999; Bottge, Heinrichs, Chan, & Serlin, 2001; Bottge, Heinrichs, Mehta, & Hung, 2002; Bottge, Heinrichs, Mehta, Rueda, Hung, & Danneker, 2004). Bottge (1999) compared the effects of contextualized math instruction (CP) with traditional word problem instruction (WP) on 17 middle school students in a remedial class and 49 average students in two pre-algebra classes. The remedial students were paired by ability and then randomly assigned to the two groups while the pre-algebra students were randomly assigned as a whole class to one of the two groups. The research measured video effects on word problems, on a transfer problem, and on an extended transfer problem that required the students to apply the skills that were taught.

Students in the experimental group used a problem-solving videodisc, Bart's *Pet Project*, to determine the cost to make a cage for the pet. The videodisc presented information that the experimental group needed to solve the problem. Students in the control group did parallel activities. Four assessments, a fractions computation test, a word problem test, a contextualized test, and a transfer assessment, were used. In addition, a transfer test was given ten days after the posttests. The transfer activity in this study asked students to decide if they could afford to build a kite frame when given some money and materials. The extended transfer problem required the highest scoring remedial students from each group to build a skateboard ramp from a schematic drawing.

Results demonstrated the effectiveness of contextualized instruction. Scores on the contextualized problem test and the transfer task were significantly better for the video group than the control group. On the extended task, the video group was able to solve the problem more quickly than the control group.

Bottge, Heinrichs, Chan, and Serlin (2001) studied the effects of another videodisc, *Kim's Komet*, which was designed to help students understand nonlinear functions, variables, rate of change, and reliability through a video scenario about a pine derby race. Students were grouped into four classes, three pre-algebra classes and one remedial class. All groups included students with disabilities. The researchers were comparing the remedial group using the video anchor with the pre-algebra group using video anchor. Then both these groups were compared with the groups using traditional instruction. Teachers were also interviewed students about their perceptions on the instruction. After watching the video, these two groups also built their own cars and raced them. Groups not using the video were given traditional instructions and traditional word problems to solve. Results demonstrated that all groups were not statistically significantly different in posttest scores from the remedial group, with the exception of one measure, where the pre-algebra students in the experimental group and the traditional groups outscored the students in the remedial class (p=.01 and p=.02 significance levels respectively).

Bottge, Heinrichs, Mehta, and Hung (2002) again used video to investigate the effects of contextualized instruction, but with this study, used a general education classroom. Using a quasi-experimental design, researchers investigated problem-solving skills of both general education students and students with disabilities using a computation test, a story problem test, and a transfer task were the assessments. The experimental group was given a video, *Fraction of the Cost*, featuring three students trying to determine if they can afford to build a skateboard ramp while the control group did similar activities without the video. Results on assessments varied with greatest gains being made by students without disabilities. Further investigation into the students with disabilities on the contextualized and transfer assessments showed higher gains by the students with disabilities in the experimental group but not significantly higher gains.

Bottge, Heinrichs, Mehta, Rueda, Hung and Danneker (2004) investigated skill transfer to students' technology class and studied what additional instruction is needed for students with disabilities to achieve commensurate to their non-disabled peers. In this study, experimental students again used the video, *Fraction of the Cost*, and worked out contextualized problems, while the control groups did similar activities on paper. Each group had some students with mild disabilities in the class. Posttest results for both groups were mixed. Posttest results with students with disabilities demonstrated that many in both groups did not understand the math that was needed to solve the problems. Four received additional assistance in the resource room.

In the second phase of the study, students from both groups build a hovercraft in their technology education classroom, using the skills learned earlier. Results of the transfer activity demonstrated that the students using the video remembered the math concepts better than the students in the control group. The four students receiving extra help in the resource room improved their scores on the video test but these skills failed to transfer to the hovercraft activity.

A second area of research into the effectiveness of technology in mathematics with students with disabilities explored the efficacy of using computer-assisted instruction (CAI) with students with mild disabilities. In general, these studies reflect success when using CAI with students with mild disabilities. Gleason, Carnine & Boriero (1990) studied the effects of CAI tutorials to train students in story problems by comparing the use of CAI to traditional instruction in story problems. Woodward & Gersten (1992) used a video-based CAI tutorial to teach fractions and, like the previous study, used achievement as a measure of success. These researchers also looked at the opinions of the teachers as a measure of the efficacy of using this medium with successful responses.

Two other researchers used achievement measures of students with mild disabilities also to evaluate the success of CAI games in mathematics. Bahr and Reith (1991) measured the scores of students with mild disabilities on single-digit subtraction and multiplication facts while using these computer-based games. However, they studied these students using varied goal structures: cooperative, competitive, individualistic and no goal structures. The results failed to demonstrate that the goal structures affected score differences, although all groups were able to increase their achievement scores significantly while using the CAI games.

More recently, Irish (2002) developed a CAI program that trained students with mild disabilities to use a mnemonic device to solve multiplication computations. She studied the effects of the implementing the software combined with regular classroom instruction on the achievement of multiplication facts. She also measured how the effects of using CAI transferred to pencil and paper tasks. CAI sessions introduced students to one mnemonic device at a time with sessions lasting 20 minutes and a review of 5 to 10 minutes. Students took a Real Quiz at the end of each software use. Results indicated that five of the six students improved their accuracy on the electronic quizzes, while all six students demonstrated increased accuracy on the paper and pencil probes. Those students who were active in the study for the longest amount of time demonstrated the greatest gain.

Fuchs, Fuchs, Hamlet, Powell, Capizzi, and Seethaler (2006) studied the effects of CAI on number combination skills in first graders who were at considered at risk. In this study, researchers used software that flashed a number combination using both addition and subtraction facts on the screen, requiring students to retype the number combination from memory. Students were assessed on an arithmetic number combination test and a transfer test of story problems. Results demonstrated significant effects on addition facts only.

Using technology for students with mild disabilities in the area of mathematics has demonstrated success. Studies have demonstrated the success the use of video as a context for instruction (Cognition and Technology Group at Vanderbilt, 1998; Cognition and Technology Group at Vanderbilt, 1993; Bottge & Hasselbring, 1993; Bottge, 1999). Studies have also demonstrated the benefits of using CAI with students with disabilities (Hasselbring & Goin, 2005; Bahr & Rieth, 1997; Gleason et al, 1990).

2.2 Reading

Many students with mild disabilities are diagnosed as having language, reading and writing deficits. Several technologies have been researched as beneficial to these students. These technologies range from text-to-speech (TTS) synthesis to materials that include features that are included in the universal design for learning (UDL) protocol. Materials that are considered to be universally designed include technology-based materials such as graphic organizers, pop-up definitions, simplified text and text-to-speech synthesis. Results of these studies demonstrated that use of these technologies maintained or increased students' skills.

Several studies looked at the effect of using text-to-speech synthesis as a method for increasing reading comprehension of textbooks. Boone and Higgins (1993) looked at using this tool for reading basal textbooks with students with mild disabilities and determined that scores for the students using the tool were at least as good as those not using the tools and in many cases better. Herbert and Murdock (1994) investigated the use of TTS on reading for students with learning disabilities and found that vocabulary knowledge improved when text-to-speech was used.

Reading fluency increases in students with emotional / behavioral disabilities were found when TTS was used (Dawson, Venn, and Gunter, 2000). Comprehension also was impacted by TTS with improvements demonstrated by 70 % of dyslexic students when measured by the Gray Oral Reading Test (Elkind, Cohen, & Murray, 1993).

Elder-Hinshaw, Manset-Williamson, Nelson & Dunn (2006) developed a universally designed, multimedia program for a summer reading program. Students were assigned a PowerPoint project that was developed by students after they were taught a strategy designed to help them select the main idea of reading selections. Results indicated that students were motivated by the multimedia when applying this strategy to increase the comprehension of the reading selections.

Lance, McPhilips, Mulhern, and Wylie (2006) investigated the use of tools designed to scaffold instruction centered on reading disabilities in 93 secondary students. Using *Read & Write Gold*, speech synthesizers, spellcheckers, homophone tools, and a dictionary, researchers compared outcomes of an assistive technology group, a group using only Microsoft *Word*, and a control group. Results indicated that the assistive technology group improved in reading comprehension, homophone error detection, spelling error detection, and word meanings. The *Word* group demonstrated improvement in spelling error detection, and word meaning but did worse on homophone error detection. The control group showed no significant improvement.

Campbell and Mechling (2009) studied the effectiveness of teaching phonics with SMART Board technology with three students with learning disabilities. Researchers used the SMART board with PowerPoint to present letter sounds and letter names with instruction and assessment on selected letters for each of the three students. Researchers also wanted to measure incidental learning, so the letters not specifically assigned to a student became the learning that was assessed. During each session, 104 trials were used in which all letters were presented randomly, with the researcher taking turns asking the students to identify their letters and sounds. Researchers measured the naming of the selected letter sounds and names by the target group and naming of letter sounds and names by other students who experienced the instruction incidentally. Assessment was done with probes at the beginning of the instruction and at the end of the instruction. All students gained with later maintenance assessments indicating that all students maintained the ability to name their target letter sets. Incidentally learned letters also increased for these students. Thus, the study was able to demonstrate the effectiveness of SMART board technology combined with computer-assisted instruction for students with learning disabilities.

Kim, Vaughn, Klinger, Woodruff,

Reutebuch, and Kouzekanani (2006) investigated a software program called *Computer-Assisted Collaborative Strategic Reading* with students with disabilities. The study included 34 students with disabilities who used the software compared to a control group. The software taught the students to use a strategy for reading comprehension. Results of the assessments, a standardized reading comprehension test, a researcher-developed measure, and an opinion survey were positive.

Studies have demonstrated an improvement in reading skills when technology is used as a tool for students with mild disabilities. Assistive technology devices, multimedia projects, and text-to-speech synthesis proved to be a useful aide for students with disabilities to improve their reading skills.

2.3 Written Expression

Several studies have demonstrated the effectiveness of using technology to improve writing skills. Researchers looked at the inclusion of word processors with speech synthesis, graphic organizers, and word prediction programs to increase written expression skills for students with mild disabilities.

Word processing with speech synthesis was the focus of a study by MacArthur (1998). The study used five students, ages 9 and 10 with learning disabilities and found that both legibility and spelling improved in four of the five students. The spelling baseline measure of four students showed improvement from an array of 42% to 75% correctly spelled words to the 90%–100% range with the word processor.

MacArthur (1999) also studied the effects of word prediction in conjunction with use of speech synthesis on the readability and spelling of written samples from several students with learning disabilities. Results of this study showed no consistent effects on readability or spelling during the original study. A follow-up study confirmed an increase in spelling for two of the three students in the study (MacArthur, 1999).

Hetzroni and Shrieber (2004) also studied the effects of a word processor on the performance of three learning disabled junior high students with writing disabilities during general education classroom activities. The first phase of the study monitored the use of traditional paper-and-pencil materials and established a baseline. The second step of the study had the students using a computer. Next, computers were withdrawn from instruction, and students had to use only paper-and-pencil materials. Finally, computers were reintroduced for class work with structure of the writing, number of spelling errors, and number of words in the passages tallied. The results demonstrated a positive difference between handwritten products and computer generated writing (Hetzroni and Shrieber 2004).

Graphic organizers have been the focus of several studies with students with mild disabilities. Anderson-Inman, Knox-Quinn, and Horney (1996) studied students with learning disabilities in three high schools using *Inspiration*. After observation, students were divided into three groups based on their levels of using the computer. The researchers found that the most frequent users of *Inspiration* were usually those with higher intelligence measures.

Zhang conducted a qualitative study with 5 fifth grade students with learning disabilities in the area of written expression over a school year (Zhang, 2000). These students were reported to demonstrate trouble with the mechanics of written expression. A computer software program, *ROBO Writer* (Brooks & Zhang, 1992) had previously demonstrated good results in writing with students with learning disabilities (Brooks, Zhang, Frields, & Redelfs, 1994). In this study, a curriculum using *ROBO Writer* was designed, allowing the five students to generate written products. The aural feedback built into the program-helped students to recognize misspelled words and meaningless sentences. Results showed a positive effect on written expression (Zhang, 2000).

Mirenda, Turoldo, and McAvoy (2006) looked at the writing output of 24 students with mild disabilities, comparing handwriting with a word processor and a word processor using word prediction. Results demonstrated no significant differences in the number of words generated. However, the technologies led to a higher percentage of legible words, correctly spelled words, and acceptable word sequences.

Sturm and Rankin-Erickson (2002) studied the effects of concept mapping on the expository writing of middle students with reading disabilities, with some students identified as disabled and others identified as having reading difficulties. Twelve middle school students with learning disabilities were used for the repeated measures within-subject study. Researchers compared the use of no concept map, the use of hand mapping, and the use of *Inspiration* software. Measures of attitude toward writing were also taken. Assessment was done through essays that were scored based on the number of words, the syntactic maturity, the t-units or a main clause with its syntactical units, and a holistic rating given by the researcher and a second rater. Results using repeated ANOVAs on the quantitative elements demonstrated significance. Tukey pairwise comparisons on all three conditions using the number of words demonstrated that the writing sample was greater than the baseline sample, as were the t-unit results and the writing quality. Syntactic units failed to demonstrate significance. No significant results were obtained for syntactic complexity and writing attitude.

Quinlan (2004) studied the effects of speech recognition and advance planning on children's writing samples. They used both students with writing disabilities and students without writing disabilities. Students were trained to use graphic organizers and speech recognition. Written products were assessed for number of words, holistic quality, surface errors, and t-unit length. When comparing groups, results were varied with some measures favoring the fluent writers and other measures not significantly different. However, speech recognition did improve the quality, as determined by length and grammar measures. Thus, speech recognition and advanced planning proved to have a beneficial effect on both students without disabilities and students with disabilities.

Studies on the scaffolding of writing have shown the effectiveness of using technology with students with mild disabilities. Word processing and word prediction programs have demonstrated their usefulness with students with writing disabilities. Graphic organizers have assisted students to organize their written products. Technology has demonstrated that students with disabilities are benefited in written expression.

3. Future Directions

Recently, the field of technology for students with mild disabilities has looked at the effectiveness of instructional materials described as having universal design for learning (Anderson & Anderson, 2008). Universal design for learning (UDL) is described as providing instruction designed to meet the diverse learning needs of students with different backgrounds, abilities, and learning styles (CAST, 2003). UDL is characterized as instruction that incorporates many of the multimedia technologies that were previously researched, such as text-to-speech synthesis, graphic organizers, and word prediction, to create accessible instructional materials that will be successful with students with mild disabilities. Studies such as that done by Twyman & Tindal (2006) have begun to explore the effectiveness of these materials. Twyman and Tindal created accessible, conceptually based social studies materials (http://www.brtprojects.org/cyberschool/history/) from a U.S. history textbook. The researchers adapted a chapter with organizational and textual supports, including an overview of the chapter, a list of concepts and attribute tables, simplified text, a graphic organizer of concepts and attributes, and problem-solving assessments. The text could be read aloud and included an electronic dictionary.

Two mixed ability groups were chosen with students with learning disabilities randomly assigned to the groups and then treatment randomly assigned to the intact groups. Assessment measures included a vocabulary-matching probe, a concept maze task designed to measure content knowledge, and an extended-response essay (Twyman & Tindal, 2006, p. 8). Results failed to demonstrate a difference between the two groups on immediate pre-post assessments. However, "large effect size and power rating indicated that the computer provided students the opportunity to develop their problem-solving skills" (Twyman & Tindal, 2006, p. 13).

This type of research is beginning to explore the effectiveness of these UDL materials that are designed to allow access by all students with disabilities. As an early UDL study, Twyman & Tindal (2006) found some measure of success but the study included small numbers of students with disabilities and did not include a measure of how frequently these students with disabilities used the access features. Future studies should continue expand studies like this, using greater numbers of students with disabilities to investigate the effectiveness of these technologies.

4. Summary

This paper on the present situation of assistive technology use in the United States has explored the efficacy of using technology for students with mild disabilities. Studies have focused on the use of traditional computer-assisted-instruction use for students with disabilities and shown its success. Interactive video has shown promise for increasing problem-solving skills when used as the anchor for problem solving. Multimedia scaffolding features such as text-to-speech synthesis, built-in dictionaries, and graphic organizers have shown their usefulness in helping students with reading deficits. The same technologies, when used with word processors and word predictive processors, have demonstrated their ability to aid students who have writing disabilities. All these technologies hold the promise of increasing the learning for those students whose disabilities have prevented them success in the past. Assistive technology might be the key to learning for students with mild disabilities.

References

Anderson, C. L. & Anderson, K. M. (2008). Framing the research on accessible technology for students with mild disabilities. In Bell, L., Schrum, L., & Thompson, A., (Eds.). *Framing Research on Technology in*

Teacher Education. Washington, DC: National Technology Leadership Coalition.

Anderson-Inman, L., Knox-Quinn, C., Horney, M. A. (1996). Computer-based study strategies for students with learning disabilities: Individual differences associated with adoption level. *Journal of Learning Disabilities, 29*(5), 461–484.

Bahr, C. M. & Reith, H. J. (1989). The effects of instructional computer games and drill and practice software on learning disabled students' mathematical achievement. *Computers in the School, 6*(3/4), 87–101.

Blackhurst, A. E., & Lahm, E. A. (2000). Technology and exceptionality foundations. In J. D. Lindsey (Ed.) *Technology and exceptional individuals* (3rd. Ed., pp. 3–45). Austin, TX: ProEd.

Boone, R., & Higgins, K. (1993). Hypermedia basal readers: Three years of school–based research. *Journal of Special Education Technology, 7*(2), 86–106.

Bottge, B. A. (1999). Effects of contextualized math instruction on problem solving of average and below-average achieving students. *The Journal of Special Education, 33* (2), 81–92.

Bottge, B., & Hasselbring, T. (1993). Comparison of two approaches for teaching complex, authentic mathematics problems to adolescents in remedial math classes. *Exceptional Children, 59*(6), 556–566.

Bottge, B. A., Heinrichs, M., Chan, S., & Serlin, R. (2001). Anchoring adolescents' understanding of math concepts in rich problem-solving environments. *Remedial and Special Education, 22*(5), 299–314.

Bottge, B., Heinrichs, M., Mehta, Z. D., & Hung, Y. (2002) Weighing the benefits of anchored math instruction for students with disabilities in general education classes. *The Journal of Special Education, 35*(4), pp. 186–200.

Bottge, B., Heinrichs, M, Mehta, Z.D., Rueda, E., Hung, Y., Danneker, J. (2004). Teaching mathematical problem solving to middle school students in math, technology education, and special education classrooms. Retrieved June 23 from http://www.nmsa.org/Publications/RMLEOnline/Articles/Vol27No1Article1/tabid/529/Default.aspx.

Brooks, D. & Zhang, Y. (1992). ROBO–Writer [Computer software]. Lincoln: University of Nebraska.

Brooks, D. W.; Zhang, Y.; Frields, T.; Redelfs, M. (1994). ROBO-Writer. *The Computing Teacher, 22*(4), 49–51.

Campbell, M.L. & Mechling, L. C. (2009). Small group computer-assisted instruction with SMART board technology. *Remedial and Special Education, 30*(1), pp. 47–57.

CAST. (2003). Summary of universal design for learning concepts. Retrieved November 23,2007 from http://4.17.143.133/udl/SummaryofUDL Concepts7.cfm

Cognition and Technology Group at Vanderbilt. (1998). Designing environments to reveal, support, and expand our children's potentials. In S. A. Soraci & W. McIlvane (Eds.), *Perspectives on fundamental processes in intellectual functioning: A survey of research approaches, Vol. 1* (pp. 313–350). Stamford, CT: Ablex.

Cognition and Technology Group at Vanderbilt. (1997). The Jasper project: Lessons in curriculum, instruction, assessment, and professional development. Mahwah, NJ: Lawrence Erlbaum Associates.

Cognition and Technology Group at Vanderbilt. (1992). The Jasper Series as an example of anchored instruction: Theory, program description, and assessment data. *Educa-*

tional Psychologist, 27(3), 291–315.

Dawson, L., Venn, M., & Gunter, P. L. (2000). The effects of teacher versus computer reading models. *Behavioral Disorders, 25* (2), 105–113.

Edyburn, D. L.. (2000). Assistive technology and mild disabilities. Assistive technology and mild disabilities. *Focus on Exceptional Children, 32*(9), 1–24.

Elder-Hinshaw, R., Manset-Williamson, G., Nelson, J. M., & Dunn, M. W. (2006). Engaging older students with reading disabilities: Multimedia inquiry projects supported by reading assistive technology. *Teaching Exceptional Children, 39*, 6–11.

Elkind, J., Cohen, K., & Murray, C. (1993). Using computer-based readers to improve reading comprehension of students with dyslexia. *Annals of Dyslexia, 43*, 238–259.

Fuchs, L. S., Fuchs, D., Hamlet, C. L., Powell, S. R., Capizzi, A. M., & Seethaler, P. M. (2006). The effects of computer-assisted instruction on number combination skill in at -risk first graders. *Journal of Learning Disabilities, 39*(5), pp. 467–475.

Gleason, M., Carnine, D., & Boriero, D. (1990). Improving CAI effectiveness with attention to instructional design in teaching story problems to mildly handicapped students. *Journal of Special Education Technology, 10*(3), 129–136.

Hasselbring, T.S. & Goin, L. (2005). Research foundation and evidence of effectiveness for FASTT Math, Retrieved February 18, 2007 from http://www.tomsnyder.com/reports/.

Hebert, B. M., & Murdock, J. Y. (1994). Comparing three computer-aided instruction output modes to teach vocabulary words to students with learning disabilities. *Learning Disabilities Research & Practice, 9*(3), 136–141.

Hetzroni, O., Shrieber, B. (2004). Word Processing as an assistive technology tool for enhancing academic outcomes of students with writing disabilities in the general classroom. *Journal of Learning Disabilities, 37*(2), 143–154.

Irish, C. (2002). Using peg– and keyword mnemonics and computer-assisted instruction to enhance basic multiplication performance in elementary students with learning and cognitive disabilities. *Journal of Special Education Technology 12*(4). Retrieved November 23, 2007 from http://jset.unlv.edu/17.4/irish/first.html.

Kendall, W. (1978). Public Law 94–142: Implications for the classroom teacher, *Peabody Journal of Education, 55*(3), 226–230.

Kim. A., Vaughn. S., Klinger. A., Woodruff. A., Reutebuch. C. & Kouzekanani. K. (2006). Improving the reading comprehension of middle school students with disabilities through computer–assisted collaborative ctrategic reading. *Remedial and Special Education, 27*(4), 235–249.

Lance, A. A., McPhillips, M., Mulhern, G., & Wylie, J. (2006). Assistive software tools for secondary-level students with literacy difficulties. *Journal of Special Education Technology, 21*(3), 13–22.

MacArthur, C. A. (1999). Word prediction for students with severe spelling problems. *Learning Disability Quarterly, 22*(3), 158–172.

MacArthur, C. A.(1998).Word processing with speech synthesis and word prediction: Effects on the dialogue journal writing of students with learning disabilities. *Learning Disability Quarterly; 21*, 2, p 151–66.

Mirenda, P. / Turoldo, K. & McAvoy, C. (2006). The impact of word prediction software on the written output of students with physical disabilities. *Journal of Special Education Technology, 21*(3), 5–12.

National Center for Education Statistics. (2005). Children 3 through 21 years old served in federally supported programs for the disabled, by type of disability: Selected years, 1976–77 through 2003–04 [Data file]. Retrieved February 12,2007 from Digest of Education Statistics Web site, http://nces.ed.gov/programs/digest/d05/tables/dt05_050.asp.

National Center for Learning Disabilities (2007). IDEA Guide: Response to intervention. Retrieved November 17, 2007 from http://www.ncld.org/content/view/923/456087/.

Office of Special Education and Rehabilitative Services (1997). IDEA '97: The law. Retrieved November 17,2007 from http://www.ed.gov/offices/OSERS/Policy/IDEA/the_law.html.

Office of Special Education and Rehabilitation Services (2004). Disabilities that qualify infants, toddlers, children, and youth for services under IDEA 2004. Retrieved November 19 from http://www.ldonline.org/article/12399.

Quinlan, T. (2004). Speech recognition technology and students with writing difficulties: Improving fluency. *Journal of Educational Psychology, 96*(2), pp. 337–346.

Sturm, J. M. & Rankin-Erickson, J. L. (2002). Effects of hand-drawn and computer-generated concept mapping on the expository writing of middle school students with learning disabilities. *Learning Disabilities Research & Practice, 17*(2), 124–139.

Twyman, T. & Tindal, G. (2006). Using a computer–adapted, conceptually based history text to increase comprehension and problem-solving skills of students with disabilities. *Journal of Special Education Technology 21*(2), pp 5–16.

U. S. Department of Education. (2004a). Building the legacy: IDEA 2004. Retrieved November 23,2007 from http://idea.ed.gov/explore/view/p/%2Croot%2Cstatute%2CI%2CA%2C602%2C1%2C

U. S. Department of Education. (2004b). Building the legacy: IDEA 2004. Retrieved November 23,2007 from http://idea.ed.gov/explore/view/p/%2Croot%2Cstatute%2CI%2CA%2C602%2C2%2C

Woodward, J., & Gersten, R. (1992). Innovative technology for secondary learning disabled students: A multi-faceted study of implementation. *Exceptional Children, 58*(5), 407–421.

Zhang, Y. (2000). Technology and writing skills of LD students, *Journal of Research on Computing in Education, 32*(4) 467–478.

軽度発達障がい児のための支援技術の活用：米国の現状

シンディ　アンダーソン*・福島　健介**・生田　茂***

*ルーズベルト大学教育学部　**帝京大学教職センター　***大妻女子大学社会情報学部

要　　約

軽度発達障がい児のための支援技術の活用に関する米国の最近の論文を注意深く調査した。本研究では、数学や読解（Reading)、文章表現（Written expression）のための従来型のコンピュータを用いた支援技術の活用について注目した。インターラクティブなビデオ教材は、問題解決の最後の場面で用いられることで、問題を解決するスキルを高める可能性があること。テキストの読み上げ技術や組み込みの辞書、絵やスキットで表現する技術（Graphic organizers）は、文字の読み取りや認知の困難な児童には役に立つことが明らかにされている。最近の技術は、これまではうまくいかなかった障がい児の学びを確実に改善していることが分かる。今後、支援技術は、軽度発達障がい児の学習にとってキーになると考えられる。