Assistive Technology
Outcomes and Benefits

A joint publication of the Assistive Technology Industry Association (ATIA) and the Special Education Assistive Technology (SEAT) Center

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seat center
Illinois State University

Assistive Technology Outcomes and Benefits

Assistive Technology Outcomes and Benefits is a collaborative publication of the Assistive Technology Industry Association (ATIA) and the Special Education Assistive Technology (SEAT) Center at Illinois State University. This publication is provided at no-cost to readers. It is a peer-reviewed, cross-disability, transdisciplinary journal that publishes articles related to the *benefits* and *outcomes* of assistive technology (AT) across the lifespan. The journal's purposes are to (a) foster communication among vendors, AT Specialists, AT Consultants and other professionals that work in the field of AT, family members, and consumers with disabilities; (b) facilitate dialogue regarding effective AT practices; and (c) help practitioners, consumers, and family members advocate for effective AT practices.

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Assistive Technology Outcomes and Benefits

Editorial Policy

Assistive Technology Outcomes and Benefits is a peer-reviewed, cross-disability, transdisciplinary journal that publishes articles related to the *benefits* and *outcomes* of assistive technology (AT) across the lifespan. The journal's purposes are to (a) foster communication among vendors, AT Specialists, AT Consultants and other professionals that work in the field of AT, family members, and consumers with disabilities; (b) facilitate dialogue regarding effective AT practices; and (c) help practitioners, consumers, and family members advocate for effective AT practices.

Assistive Technology Outcomes and Benefits invites submission of manuscripts of original work for publication consideration. Only original papers that address *outcomes and benefits* related to AT devices and services will be accepted. These may include (a) findings of original scientific research, including group studies and single subject designs; (b) marketing research conducted relevant to specific devices having broad interest across disciplines and disabilities; (c) technical notes regarding AT product development findings; (d) qualitative studies, such as focus group and structured interview findings with consumers and their families regarding AT service delivery and associated outcomes and benefits; and (e) project/program descriptions in which AT outcomes and benefits have been documented.

ATOB will include a broad spectrum of papers on topics specifically dealing with AT outcomes and benefits issues, in (but NOT limited to) the following areas:

- Transitions
- Employment
- Outcomes Research
- Innovative Program Descriptions
- Government Policy
- Research and Development
- Low Incidence Populations

Submission Categories

Articles may be submitted under two categories—*Voices from the Field* and *Voices from the Industry*.

Voices from the Field

Articles submitted under this category should come from professionals who are involved in some aspect of AT service delivery with persons having disabilities, or from family members and/or consumers with disabilities.

Voices from the Industry

Articles submitted under this category should come from professionals involved in developing and marketing specific AT devices and services.

Within each of these two categories, authors have a range of options for the type of manuscript submitted. Regardless of the type of article submitted, primary consideration will be given by the journal to work that has *quantifiable results*.

Types of articles that are appropriate include:

Applied/Clinical Research. This category includes original work presented with careful attention to experimental design, objective data analysis, and reference to the literature.

Case Studies. This category includes studies that involve only one or a few subjects or an informal protocol. Publication is justified if the results are potentially significant and have broad appeal to a cross-disciplinary audience.

Design. This category includes descriptions of conceptual or physical design of new AT models, techniques, or devices.

Marketing Research. This category includes industry-based research related to specific AT devices and/or services.

Project/Program Description. This category includes descriptions of grant projects, private foundation activities, institutes, and centers having specific goals and objectives related to AT outcomes and benefits.

In all categories, authors MUST include a section titled *Outcomes and Benefits* containing a discussion related to outcomes and benefits of the AT devices/services addressed in the article.

For specific manuscript preparation guidelines, contributors should refer to the *Guidelines for Authors* at http://atia.org/

Outcomes and Benefits in Assistive Technology Service Delivery

Phil Parette
Editor

David Dikter
Associate Editor

In this issue of ATOB, a collaborative report by Cynthia Overton (National Center for Technology Innovation; NCTI); Cheryl Volkman (AbleNet®, Inc.); and Heidi Silver-Pacuilla and Tracy Gray (NCTI) is presented that discusses how existing AT market research can be leveraged to create 'new solutions' to reach wider markets. The article, 'Understanding Consumer Needs Through Market Research,' is a seminal scholarly contribution to the field in that it offers suggestions to assist organizations with little or no experience in conducting effective market research—information that to date has been relatively obscure in the professional literature. Of particular interest are recommendations for primary market research strategies, and information regarding accessible Consumer Guides to assist administrators involved in technology purchasing decisions, and educational technology vendors.

In the second article, Emily C. Bouck and Aman Yadav (Purdue University) present findings of a research study, 'Assessing Calculators as Assessment Accommodations for Students with Disabilities.' In light of both the accountability mandate of the No Child Left Behind Act of 2001 and the accommodations responsibilities of schools articulated in the Individuals with Disabilities Education Improvement Act of 2004, this investigation provides support for the utility of calculators for 75 seventh-grade students with and without disabilities in open-ended, problem-solving mathematics assessments. However, the investigators also note that calculators may not be a 'valid assessment accommodation' when using Elbaum's (2007) definition of a valid accommodation, i.e., it "should improve the performance of students with disabilities while having no effect on the performance of students without disabilities" (p. 219).

The third article, "Campus Community Partnerships with People Who Are Deaf or Hard of Hearing," describes a qualitative study designed to (a) engage doctoral students and AT end users in discussions regarding product development, (b) better understand how focus groups should be conducted with individuals who were deaf and hard-of-hearing, and (c) elicit feedback from end users regarding three specific devices that had been conceptualized to benefit individuals who were deaf and hard-of-hearing. Co-authored by Jamie Matteson, Christine K. Kha, Diane J. Hue, Chih-Chieh Cheng, Lawrence Saul, and Georgia Robins Sadler (University of California, San Diego), the article provides an insightful cross-discipline approach for working with persons who are deaf or hard of hearing using focus groups.

In the fourth article, "Sight Word Recognition Among Young Children At-Risk: Picture-Supported vs. Word-Only," a report is presented of the impact of Boardmaker™ Picture Communication Symbols on the development of word recognition skills among 31 at risk preschool children. Co-authored by Hedda Meadan, Julia B. Stoner, and Howard P. Parette (Illinois State University), the investigators found that previous research was supported regarding the use of pictures paired with words in the process of teaching word recognition, i.e., children learned and read Dolch words faster when they are taught without picture supports. However, in the fourth assessment of the study, it was found that the intervention group of children performed better than the control group. The authors suggested that practicing sight words with a picture and word might be best beneficial when testing occurs with a picture and word. During interviews with the intervention group children, all but one child reported that pictures helped learn the sight words

In the fifth article, "Technology (AT) Reutilization (Reuse): What We Know Today," Joy Kniskern, Carolyn P. Phillips, and Thomas Patterson (Pass It On Center, Georgia Department of Labor) describe both the value and limitations of current AT reuse data and outcomes. The authors present a summary of activities and data gathered from several national surveys culminating in a national classification system of AT reutilization. Interestingly, examples of both successful and damaging AT reutilization initiatives are described to facilitate decision making by groups committed to developing new or expanding existing AT reutilization initiatives. Limitations of existing research in this area are presented along with recommendations for future research on AT reutilization activities.

The sixth article, "Perspectives of Assistive Technology from Deaf Students at a Hearing University," Maribeth N. Lartz and Julia B. Stoner (Illinois State University), and La-Juan Stout (Valdosta State University) report a qualitative study of the AT perspectives of nine Deaf students enrolled in a large 'hearing' university. The investigators identified three categories of AT perspectives including: (a) self-reported use of AT and overall benefits, (b) barriers to AT use, and (c) facilitators to AT use. An insightful discussion follows which Discussion centers on the struggle to balance the triad of information that deaf students encounter in the university classroom and offers recommendations to assist deaf students in 'hearing' classrooms at the university level.

Finally, in the seventh article, "Assistive Technology and Emergent Literacy for Preschoolers: A Literature Review," a five-year review is presented of research articles that 'concurrently' addressed AT, emergent literacy, and early childhood. Co-authored by Kimberly Kris Floyd (Old Dominion University); Lora Lee Smith Canter and Tara Jeffs (East Carolina University); and Sharon A. Judge (Old Dominion University), the review employed a literature synthesis strategy previously reported by Edyburn (2002). The investigators reported only five peer reviewed articles meeting the search criteria. Given the lack of attention devoted to AT applications and their relationship to emergent literacy in the past decade, these findings are not surprising, and the authors focus on both the dearth of literature in this important area, as well as the need for targeted research to increase the knowledge base of the early childhood discipline.

We hope that these articles stimulate professional dialogue in the field and contribute to heightened awareness of the need for scientifically based practices. We also note that complementing this issue of the journal is a wide array of presentations scheduled at the ATIA 2008 Conference on January 28-31, 2009, in Orlando (see http://www.atia.org/i4a/pages/Index.cfm?pageID=3280 for Conference information). This meeting has become one of the foremost AT consumer and professional venues and presents a wide array of important program offerings to participants.

We also express appreciation to our talented Editorial Board members who were called upon to assist in the review processes for manuscripts submitted in 2008. Without their input and support, this publication would not be possible.

References

Edyburn, D. L. (2000). 1999 in review. A synthesis of the synthesis of the special education technology literature. *Journal of Special Education, 15*(1), 7-18.

Elbaum, B. (2007). Effects of an oral testing accommodation on the mathematics performance of secondary students with and without learning disabilities. *Journal of Special Education, 40,* 218-229.

Individuals with Disabilities Education Improvement Act, 20 U.S.C. § 1400 *et seq*. (2004)

No Child Left Behind Act, 20 U.S.C. § 6301 *et seq*. (2001)

Understanding Consumer Needs Through Market Research

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Abstract: The purpose of this article is to demonstrate how existing market research in the assistive technology (AT) field can be leveraged to create new solutions and to help those solutions reach wider markets. To do so, we discuss market research projects, focusing on seminal activities that have occurred in the assistive and learning technology field; present a collaborative market research activity involving the National Center for Technology Innovation and AbleNet®, Inc.; and offer suggestions for how an organization with little or no experience with market research can initiate such activities. As demonstrated in this article, findings deriving from market research activities can be used to benefit individual corporations responsible for conducting market research as well as the broader AT community.

Key Words: Market research, Collaboration, Assistive technology

Introduction

Market research is a critical component of conducting business in today's competitive environment. Information gathered from market research informs organizations of consumers' needs and expectations, which will, in turn, guide how businesses develop and market their products. This is especially important within the field of assistive technology (AT), given that many consumers have unique needs that may not necessarily be addressed by mainstream products or even those with a universal design. Collecting and integrating independent and objective market research as part of business practice is a recipe for success. The purpose of this article is to show how existing market research can be leveraged to create new solutions and to help those solutions reach wider markets. To do so, we discuss market research projects, focusing on seminal activities that have occurred in the AT and learning technology field; present a market research activity that was a collaboration between the National Center for Technology Innovation (NCTI) and AbleNet®, Inc. (hereafter referred to as AbleNet); and offer suggestions for how an organization with little or no experience with market research can initiate such activities.

An Overview of the Organizations

NCTI is a technical assistance center funded by the U.S. Department of Education, Office of Special Education Programs. The Center's mission is to advance learning opportunities for individuals with disabilities by fostering technology innovation. One approach for doing so is to enrich the field by generating knowledge through collaborative inquiry with technology professionals. AbleNet is an AT corporation that offers a broad spectrum of technology and curricular solutions to meet the learning needs of individuals who have severe to moderate disabilities worldwide. In addition to the organization's corporate structure, AbleNet operates the Ablenet Research Consortium (ARC; AbleNet, n.d.), which aims to increase the scientifically based research available on AbleNet curriculum, professional development, and AT.

NCTI and AbleNet have worked together on a number of initiatives over the past several years, including panel presentations and discussions about the increased pressure for scientifically based research in the AT and educational technology markets. The collaboration described in this paper was staffed and funded by both entities.

Market Research in the AT Field

Grigoriou (2000) distinguishes between the two types of market research and provides insight that crosses industry boundaries to have widespread implications for almost any emerging business. *Primary research* is described as first-hand research to solve a particular problem or seize a particular opportunity. This form of research is conducted by the party that is in need of specific information. Organizations and entrepreneurs not having the capacity to conduct their own research can enlist the services of a third-party market research firm to do so (sample education market research firms are found in the Resources section). *Secondary research* consists of information that has already been gathered by a third party, but nevertheless can provide significant benefit to industry leaders when made publicly available. One can turn to the Forrester Research (2003) study, for example, for secondary research to understand the needs of technology consumers who have special needs. Microsoft® commissioned this external research organization to conduct a study exploring the number of individuals who could potentially benefit from the use of accessibility features. Findings from the study showed that a need existed for more awareness and promotion of accessibility features to enable users to overcome physical and cognitive challenges when using computers.

The results of this study had a wide reaching impact for Microsoft® as well as the AT industry. Steve Bauer, Director of Rehabilitation Engineering Research Center on Technology Transfer (T^2RER), told AbleNet:

> These studies will help Microsoft® to develop accessible operating systems and software applications for computer users aging into retirement. Today's workers are pervasive users of technology. However, as they age there is a normal diminishment of sensory, physical and cognitive abilities. Products that individuals take for granted before retirement may subsequently become unusable. Innovative new hardware and software products will be needed. Market studies help Microsoft better understand the needs and abilities of today's elders, and the product preferences and usage of today's workers. (personal communication, April 15, 2008)

The Microsoft® AT Vendor Program assists more than 100 AT manufacturers. The AT products developed through this program help to make Microsoft® operating systems and applications accessible to individuals with and aging into disabilities. Microsoft® and AT manufacturers in the Vendor Program each derive obvious benefits from the collaboration. As part of the Vendor Program, the Microsoft® Accessibility Developer Center offers guidance, essential information, and tools for developing accessible applications and software code. Likewise, other major corporations such as IBM®, Apple®, and Intel® also have accessibility integration programs.

Unfortunately, the dearth of publicly available disability market data has historically led technology manufacturers to rely upon the experience and intuition of their colleagues to identify unmet needs and business opportunities. To help bridge this gap, T^2RERC has undertaken a project to conduct primary and secondary research for five AT industries. Information from this project is being compiled into 'Industry Profiles' that are publicly available through the T^2RERC website (T^2RERC, n.d.). To date, two such profiles have been completed: *Industry Profile on Education Technology: Learning Disabilities Technologies and Markets* and *Industry Profile on Visual Impairment*. Industry Profiles serve as excellent sources of secondary research for AT developers, providing overviews of the respective populations, demographic background information, existing technology devices, and insight on legislation and funding. Useful primary market data is also contained within these documents--with sufficient specificity to help identify business opportunities but not to design products. It is always important to recognize that secondary research should complement, rather than replace, targeted primary research. The remainder of this article describes a collaborative primary research activity conducted by AbleNet and NCTI, along with suggestions for launching primary research activity.

AbleNet/NCTI Collaboration

The purpose of the AbleNet/NCTI market research activity was to examine the changing roles and perspectives of district-wide administrators as they relate to the purchase and utilization of AT for their student populations. AbleNet's interest in understanding the needs of administrators stems from the organization's desire to serve the entire district with solutions that could best bring about improved student performance for those who have severe and profound to moderate disabilities. By better understanding administrative needs, AbleNet will be positioned to create solutions that solve these customers' challenges. As AbleNet began to focus on district-level consumers, it became clear that it needed to understand the needs of these people who were involved in the decision-making process for acquiring AT at all levels of the district. Prior to this, AbleNet focused on delivering solutions to teachers, therapists, and families, who are more often looking for individual and classroom solutions.

During this time, the No Child Left Behind Act of 2001 (NCLB) was dictating a new focus on accountability. It was obvious to AbleNet that this focus on accountability would affect AT utilization, purchasing, training, and so forth at all levels of special education. Furthermore, it became evident that solutions that achieved and demonstrated results at all levels of the district would be critical to AbleNet's future success. Therefore, AbleNet needed to capture and understand needs, desires, concerns, and motivation of district-level administrators nationwide.

AbleNet took a market research approach to understanding how the industry would shift. The company decided to devote marketing time to listening to its customers. AbleNet devised a semi-structured interview protocol with open-ended questions designed to elicit administrators' perspectives on the role of AT in school and district-wide technology purchases and achievement goals. Senior management and sales representatives called on districts around the country to hold conversations with administrators in various levels and departments. Interviews were documented in field notes and then shared in corporate meetings. The vocabulary and key concerns expressed in the interviews started to shape a corporate strategic response to the marketplace.

The learning was determined to be so powerful that the leadership felt compelled to find a way to share it with their AT colleagues. AbleNet approached NCTI to ask whether researchers at the Center could independently analyze the data and collaborate on sharing the findings. NCTI was enthusiastic about the potential of this rich data source to shed light on the changing needs of education administrators, the impact those needs have on special education, and the marketplace for AT companies. The Center agreed to analyze interview data and turn research findings into practitioner-friendly presentations and products to share widely with the researchers, developers, and entrepreneurs in the field.

The AbleNet/NCTI collaboration demonstrates how market research that has been traditionally reserved to inform corporations of their customers' expectations can be used to guide the field on the shifting needs of similar customer markets.

Doing the Research

AbleNet adopted an 'executive interview' model for conducting the basic research, based on the Delphi interview method (Linstone & Turnoff, 1975). The Delphi interview method represents an in-depth iterative research effort involving one-on-one executive interviews with a representative sample of experts or knowledgeable persons from selected target market businesses. In this case, AbleNet selected administrators from a variety of districts nationwide.

Four basic questions for the semi-structured interviews included: (a) What are your top three to five greatest needs today? (b) How do you think your superior would define his or her top three to five greatest needs today? (c) Why are these identified needs of such great importance? And (d) Have these needs shifted over the past 3 to 5 years?

Methods

Forty executive interviews were conducted between August, 2006, and November, 2007. A diverse pool of respondents was sought, representing various aspects of the body of potential purchasers at a district level. Potential respondents were identified through the existing AbleNet customer-base as well as cold-calling to districts that were not affiliated with AbleNet. The interviews were conducted with principals (5), superintendents (5), curriculum directors (5), special education directors (15), state-level AT leaders (3), and program directors (7). The interviews took place in person or on the phone and lasted 60–90 minutes. When possible, the interviews were held in the respondents' work environments. Respondents resided in Arizona, California, Florida, Kansas, Maryland Minnesota, North Carolina, New York, and Pennsylvania. Interviews were recorded through field notes taken by the AbleNet interviewers. Interviews were facilitated by AbleNet corporate executives, who have long been trained by third party market research companies on conducting effective market research strategies such as interviews, focus groups, and surveys. However, the project was initiated as a way to gauge current practices employed by a sampling of respondents representing education administrators who make purchasing decisions involving AT. Given this less formal approach, interviews were conducted with no mechanism to ascertain inter-interview reliability.

Upon completion of interviews, field notes were forwarded to two NCTI researchers. These notes were analyzed using Atlas.ti©, a qualitative data analysis software application

Table 1
Qualitative Data Analysis Software

Qualitative Data Analysis Software	
A number of software applications to support qualitative data analysis are commercially available. These applications enable users to identify, code, and annotate findings; determine the importance of data; and draw relationships between data within and across sources. Examples of qualitative data software include are included below.	
Software Title	**URL**
Atlas.ti©	http://www.atlasti.com/
NVivo©	http://www.qsrinternational.com/products_nvivo.aspx
HyperResearch©	http://www.researchware.com/

(Atals.ti Scientific Software Development, 2002-2008) (see Table 1 for more information on this type of analytic software). Notes were analyzed for key words and phrases that identified the most pressing issues relevant to administrators. These key issues were then interpreted by NCTI researchers in collaboration with AbleNet to determine how administrator data revealed challenges faced by vendors as they market their products to these practitioners. In doing so, NCTI compared data to its own ongoing study of trends in the field and dialogues with thought leaders and stakeholders. *The Moving Toward Solutions* report (NCTI, 2005) derived from a series of dialogue events in which NCTI asked key thought leaders from education and technology fields, "What will it take for assistive and learning technology to be considered a critical component of education to help more students learn, achieve, and reach their potential?" The report provides a framework within which to identify emerging trends and key areas for advancing technology as a solution in school improvement.

Findings

Five themes emerged from the interview data as key issues for administrators as they discussed technology purchasing decisions, including: (a) curriculum alignment, (b) implementation, (c) scientifically based research, (d) funding, and (e) legislative mandates. Each is explored in more detail below.

Curriculum alignment. Administrators demonstrated knowledge of aligning curriculum to state standards and expressed a strong interest in drawing links between curriculum materials and the standards on which students would be assessed. As expressed by one superintendent, "Everything must align with standards. AT will not be used unless this alignment is clearly understood." However, many of those interviewed were not as familiar with the plethora of technology devices on the market that could support this effort. Consequently, they were faced with making decisions about new and innovative technology that appeared appealing at the surface level. Nevertheless, in many cases, the relationship between the products' role within the curriculum and the connection to state standards was not made explicit by vendors. Without this critical piece of information, administrators expressed reluctance to invest in products without a clear understanding of how such devices would interface with the curriculum to help facilitate instruction aligned with state standards.

Implementation. Administrators expressed great interest in drawing on technology as a resource to help improve student performance and enhance instruction. Acquiring technologies with a universal design was of particular interest to meet the needs of a range of students. However, administrators found that, after investing significant financial resources in assistive and learning technologies that they believed would be helpful, technology was not being utilized to the greatest extent possible.

This was largely due to teachers' lack of knowledge on how to implement technology in lessons to support teaching and learning. Administrators found that many times, technology purchases were made without an implementation plan or the support needed to ensure effective implementation in the learning environment. One special education director reported, "The biggest disappointment is investment in AT that never gets used."

Scientifically based research. NCLB mandates that instructional materials and tools should be supported by scientifically based research to prove what works. Administrators made several comments reflecting the importance of this requirement. For example, one county AT administrator stated, "[Technology] must be research-based for even classroom-level purchases. Some companies have gotten to be very good at presenting research first and then introducing curriculum, software, or AT in alignment with the research." In response, administrators frequently ask vendors to provide documentation of evidence to demonstrate the efficacy of product utilization. Although administrators inquired about scientifically based research, many acknowledged that they did not know how to identify and evaluate whether the research was appropriate to support their decisions. This is because many parallel organizations have different definitions of evidence-based research, and criteria to evaluate objective results vary.

Funding. Administrators reported that they experienced challenges financing technology due to changes in Medicare support and general budget cuts while meeting the ever-expanding needs of their student population. These expanding needs include English language learner students, students in need of response to intervention services, and students on the autism spectrum, to name just a few. The Individuals with Disabilities Education Improvement Act of 2004 (IDEIA 2004) dictates that AT be considered and, if deemed necessary, provided for individuals when the need is identified in an individual education program (IEP). However, administrators expressed concerns about financial factors associated with these devices. For example, one state AT administrator reported, "[I'm] worried the perceived high cost of products gets in the way of viewing [AT] as a tool to be used in differentiated learning." Current funding realities encourage teams to identify technology solutions that are designed for use by multiple students whenever possible. Purchasers must make decisions for long-term value, so often a less-expensive 'one of a kind' solution may not be cost effective in the long run. The complexity of issues and needs has led to a complex purchase process as a result. Consequently, the number of school and district personnel involved in the technology acquisition process has increased to ensure that classroom as well as district needs are considered.

Legislative mandates. Overall, findings from the data demonstrate that NCLB has been the single most influential factor in creating the shift AbleNet identified initially: that more AT purchases are being made based on district-level technology considerations. For example, one special education director stated, "[I] am increasingly concerned with how the special education students are meeting general education requirements." Provisions found in the legislation, such as the requirement that purchases be supported by scientifically based research of effectiveness and the additional focus brought to the achievement of specific student populations, have had a profound effect on administrators' priorities and district purchasing policies. Administrators reported identifying and implementing instructional practices and curriculum materials based on scientific evidence, increased attention to standardized testing to meet adequate yearly progress, and changing education practices to satisfy the requirements of both NCLB and IDEIA. To address the needs of NCLB, administrators have become more resourceful in how they utilize education materials. For example, educational materials with a universal design have become more appealing because they meet a broad range of needs for students with and without disabilities. This allows for cost-effective purchasing practices and helps align technology solutions with general education standards. Furthermore, in addition to relying on support from school professionals, administrators have high expectations for technology solutions to ensure the best educational opportunities for the students that they serve.

Outcomes and Benefits

As stated previously, AbleNet conducted market research to (a) enhance service to district-level administrators in order to support a broader segment of special education than the company had in the past; (b) increase product offerings that meet the needs of district administrators seeking district-wide solutions while continuing to support individuals on the educational team, and (c) determine whether the existing AT solutions that it offered met system-wide district-level needs. This section addresses how AbleNet's market research initiative informed each of these areas.

Broadening Marketing Efforts/Customer Base

For 15 years, AbleNet's primary clientele consisted of school-based educators and parents who made purchasing decisions based on the individual needs of students. However, with the centralization of purchasing decisions and other changing market trends, AbleNet realized there were new challenges for special education that could affect the organization's marketing strategy. AbleNet specifically understood that administrators were going to be a bigger part of the purchasing decision and knew that it did not understand the needs of these administrators the way it had understood its core customer group. In an effort to help AbleNet better understand the needs and motivations of these individuals, plus factors that would influence purchasing decisions in their districts, AbleNet employed market research tactics. The results of the research produced key information that guided business practices that are used today. For example, one finding demonstrated that NCLB mandated that educational materials be supported by scientifically based research and mandated that they be aligned with state standards to help students meet their annual yearly progress requirements. AbleNet concluded that purchasing decisions would be made on being able deliver these standards of excellence. Although AbleNet was delivering some level of these standards at the time of the research, it felt it needed to move very quickly to bring all of its solutions into alignment with district-level needs. Therefore, AbleNet began to develop partnerships with general education solution providers who already had scientifically based research and offered products aligned with state standards. AbleNet knew it could trust the talent of its employees, who have many years of experience as educators in the field and years of work with top researchers, to be able to create and align other curriculum in addition to creating their own. The first effort to align current curriculum started with a partnership with *Weekly Reader* that allowed AbleNet to take the long-standing *Weekly Reader* curriculum and align/adapt it for students who have severe and profound to moderate disabilities. AbleNet provided additional strength to the programs by integrating proven teaching strategies and AT utilization so all students could participate. It is also actively seeking its own scientifically based evidence to be able to track its success with student performance over time.

Increasing Product Offerings for District Administrators

For AbleNet to continue to be considered a thought leader in the area of new products and solutions for the U.S. schools market, the organization needed the research conducted to guide research and development teams for both AT products as well as content for students with moderate to severe disabilities. The market research discussed in this article helped both AbleNet's research team and sales team better understand the needs of the district and what questions to ask to determine the most critical of issues and to ultimately work jointly to create solutions that would best serve the needs districts across the country. The findings led to a search for new curricula and technology so that AbleNet could create the type of solutions needed for these customers. Since conducting market research and applying the various findings to the direct sales channel, AbleNet has found strong receptivity to new solutions.

Determining Appropriateness of Existing Assistive Technology Solutions

General feedback from school-based clients suggested that AbleNet was providing many of the right solutions for classroom-level sales. However, the organization had limited details of how solutions met the needs of its district-level clients. AbleNet executives wanted to know whether the organization supported districts appropriately, whether it was targeting the right consumers, and whether the solutions that it offered were seen as top priority in the list of priorities that districts deal with. Findings from the market research demonstrated that AbleNet was missing certain pieces of the solution for clients at the district level. The organization learned that it needed ways to help districts support accountability efforts as they measured student performance. AbleNet also recognized that the organization had a gap in solutions for secondary and transition students. As discussed previously, market research also revealed that AbleNet needed additional scientifically based research to support its products. As a result, AbleNet was able to adjust its product development and district development plans. In doing so, it developed the NEXT™ transition skills system (AbleNet Inc., 2007) to support secondary and transition students. NEXT™ was launched in January 2008 and specifically incorporated learning from the themes of alignment and legislative mandates. This transition skills system is a solution that simplifies the process of identifying, teaching, and tracking essential transition skills over multiple years, while meeting state standards and federal guidelines for providing transition education to students who have autism spectrum disorders and mild, moderate, and severe disabilities. In addition to partnering with other research-oriented organizations, AbleNet (n.d.) initiated the ARC to meet consumers' needs for products supported by scientifically based research. ARC offers a stipend and free product/curriculum for research efforts that are chosen by a team of internal and external reviewers based on a published set of criteria. In exchange for the research support, AbleNet expects the research team to seek publication of the results in a peer-reviewed journal. There is no corporate oversight over the publication of findings. AbleNet's goal is to learn from objective research so it can improve its solutions and utilize the results to help guide more effective implementation of its solutions with its customers worldwide.

As a result of market research, AbleNet is in a better position to meet the needs of district-level administrators by offering a more complete system of products that are research-based and aligned with state standards. This has led to a notable increase in sales. In addition to informing AbleNet's business practices, the research findings were

	HELP!	GETTING STARTED	QUESTIONS TO ASK CLIENTS
Alignment	I'm hearing from educators that they are under increasing pressure to align curriculum with state standards. How can I address the curricular standards of my clients?	• Assess your products to determine how they help students achieve the state standards/alternate standards in regions in which you do business. Consider explicit alignment with standards or other published core curricula as a database feature. • Clearly demonstrate/specify the links between your products and your clients' curriculum standards at all levels of the school/district. Administrators and teachers have very different information needs. • Publish information about the efficacy of your products on your company's Web site to demonstrate how particular products have successfully helped students meet standards.	• Which standards are most challenging for your students to meet? • What strategies have you implemented to help students meet these standards? What is working and what is not? • What features/benefits in technology products are you looking for to help your students meet standards? • Will you require ongoing support to help your staff understand how technology provides access to achieving the standards for specific students?
Implementation	In follow-up conversations with clients, I'm learning that some clients do not integrate products into the classroom effectively. How can I help clients maximize my company's products?	• Make your clients' local education agency (LEA) assistive technology (AT) resource center aware that your company's products have been acquired by a school or district. Offer guidance for effective implementation. • Ensure that the LEA understands the needs that your products fill and knows how to get the best results with them. • Provide clients with case studies and multiple scenarios to demonstrate how your products have been appropriately integrated into the classroom setting.	• What type of individualized and group training has your staff received in the past? What approaches have been effective, and in which instances have you experienced challenges? • What type of support do you feel that you need to integrate our products into the classroom? • Does your LEA have designated staff to offer training and disseminate information throughout the district?
Scientifically Based Research	Since the implementation of NCLB, I have noticed an increase in requests for scientifically based research (SBR) to support the efficacy of my company's products. Where can I find examples of SBR and what are some strategies for conducting SBR with our products?	• Refer to resources for guidance, such as the www.TechMatrix.com and journals including the Journal of Special Education Technology, Closing the Gap, Special Education Technology Practice, and Teaching Exceptional Children. • Partner with reputable researchers to design and execute studies to test the effectiveness of your products. Consider the NCTI Tech in the Works competition for support. • Engage potential clients in research activities to test your products' effectiveness.	• How is SBR used to inform your purchasing decisions? • In what format is SBR best received by you and your colleagues (journal articles, white papers, presentations)? • Would your district be willing to partner with our organization to engage in ongoing research activities? Note: It is critical for your organization to have qualified research capacity in place before partnering with schools or districts.

Figure 1. Excerpt of sample questions posed by educational technology vendors to support marketing of assistive and learning technologies. Source: National Center for Technology Innovation, Center for Implementing Technology in Education, and AbleNet, Inc. (n.d.a). *Consumer guide. Ed tech vendors.* Retrieved September 17, 2008, from http://www.techmatrix.org/consumerGuides.aspx. Used with permission.

used by NCTI as the foundation for creating products and presentations to spark further discussion in the AT field. Two products are described below.

Consumer Guide. A Consumer Guide (NCTI, Center for Implementing Technology in Education, and Ablenet, Inc., n.d.a, b) is a decision-support tool presented as a matrix of themes, advice, and questions to help facilitate appropriate and responsible technology marketing and purchasing decisions. This resource was created as a two-part document to speak to *both* school administrators and technology vendors. This design illustrates the parallel and shared vocabularies of these two target audiences and suggests bridges to improved communication and collaboration. The *Consumer Guide* assures that the most appropriate information is gathered and utilized during the technology acquisition decision-making process for both the purchaser and the technology vendor. In doing so, the *Consumer Guide* helps facilitate a dialogue that addresses key issues that were identified through this collaboration. The guide is promoted through the following four Web sites: (a) hwww.NationalTechCenter.org, (b) www.TechMatrix.org, (c) www.AbleNetInc.com, and (d) www.CITEd.org. Excerpts from the Consumer Guide for School Administrators and Consumer Guide for Ed Tech Vendors are presented in Figures 1 and 2.

	HELP!	GETTING STARTED	QUESTIONS TO ASK VENDORS
Alignment	We are aligning our entire curriculum to the state standards. How can I determine which technology products will support these efforts?	• Ask the standards leaders in your state whether they have any guidance on aligning technology products and classroom curriculum. • Consult your curriculum coordinator for guidance on aligning standards to technology products. • Consult with colleagues about how they have aligned standards to particular products.	• Do you provide ongoing support in aligning products to curriculum standards? If so, what does this support consist of? • Can you provide me with references to clients who have aligned your product to curriculum standards? • Can you give me a specific list of the topics that your product addresses so that I can create the alignment to specific standards for my agency?
Implementation	With so many technologies on the market, selecting the right products and integrating them into the classroom can be a mystery. Plus, each time our department acquires new technologies, the staff needs to be trained.	• Contact your local education agency (LEA) assistive technology (AT) resource center for guidance. • Contact your LEA curriculum department for a list of technology products that address state and agency standards. • Request training from your LEA AT resource center to help teachers use devices and integrate them into the existing curriculum.	• What types of individualized and group training do you offer to help teachers and students use your products? • What types of support do you offer for integrating your products into the classroom? • Do you offer an extended support plan that will provide technical assistance to our school after the products have been purchased?
Scientifically Based Research	Because of NCLB, our district is emphasizing the need for products that are supported by scientifically based research (SBR). How can I ensure that legitimate SBR exists to support the efficacy of products that our district is interested in purchasing?	• Refer to technology-focused resources for guidance, such as www.TechMatrix.org and journals including Journal of Special Education Technology, Closing the Gap, Special Education Technology Practice, Teaching Exceptional Children, and ATIA Outcomes and Benefits Journal. • Refer to curriculum development resources for guidance, such as ACLD, subject area journals, and literature on differentiated instruction. • Make certain that the research you use to make decisions has been conducted by unbiased investigators. • Consider initiating or participating in studies that test a product's effectiveness.	• Can you provide SBR that supports the efficacy of your products? • Can you provide research that guides the implementation of your products to maximize student outcomes? • Who conducted the research to test your products? • In what setting was the research conducted? • Which journals have published findings about your products? • What current research activities are you engaged in and for what purpose regarding the technology we are considering?

Figure 2. Excerpt of sample questions posed to school administrators to support the purchase of assistive and learning technologies. Source: National Center for Technology Innovation, Center for Implementing Technology in Education, and AbleNet, Inc. (n.d.b). *Consumer guide. School Administrators*. Retrieved September 17, 2008, from http://www.techmatrix.org/consumerGuides.aspx. Used with permission.

Presentations. The AbleNet/NCTI collaboration also has resulted in several presentations at conferences where it is used to spark a dialogue among participants. Readers can experience one of these presentations in an archived Webinar (see Volkman & Overton, 2008). Sessions were hosted by the Center for Implementing Technology in Education (CITEd) and Don Johnston, Inc. In this session, the background questions, research methods, and key findings were shared and discussed with online participants.

Deepening the dialogue in the AT field about current realities at the district level as well as articulated concerns of administrators is critical for vendors and developers of technology tools to remain competitive and relevant. The *Consumer Guide* and live conference presentations can play a role in strengthening the utilization of technology as a solution for all students.

Implications for the Field

As described earlier, the AbleNet/NCTI collaboration provided AbleNet with useful insight on their effective corporate practices along with opportunities to better serve the needs of their existing and prospective clients. However, the implications from this collaboration reach beyond AbleNet and into the broader professional field. For example, the collaboration demonstrates how policy and legislative mandates have the potential to shift who the customers/purchasers are and then also influence the priorities that drive spending decisions. This suggests that it is prudent for the field to stay abreast of policy and legislative shifts to predict and explore the changing needs of their consumers. Furthermore, it implies that the industry would benefit from conducting studies to validate and monitor the shifts that are predicted. The project also shows that results from a market research initiative can have practical application, as reflected through the *Consumer Guides*, Webinars, this article, and the development of NEXT™ transition skills system. The first three are made available for widespread use among the field to inform professional practices, while the later demonstrates how market research leads to product development. Finally, the AbleNet/NCTI partnership demonstrates how industry leaders can collaborate with other entities to inform their own professional practices, as well as those of industry leaders throughout the field.

Market Research Options

Conducting primary research has great promise for helping to best understand the needs and expectations of a manufacturer's target audience. Many well-established AT companies are experienced in market research, whereas younger companies may just be starting the process. The following section identifies options for those companies beginning the process of conducting market research and refining their business approaches as a result.

Identify missing information. Understanding what the manufacturer knows and what is needed to be known about the target audience is an important first step in conducting market research. Neglecting this initial step could result in duplicating efforts (that is, collecting information that already available) and overlooking information that is vital to product development and marketing.

Utilize secondary research. Manufacturers should draw on secondary research to establish information in the field that has already been uncovered. For example, T2RERC has released exhaustive market research reports addressing needs among users who have visual impairments and learning disabilities. Colleagues at other organizations or professional organizations (e.g., Assistive Technology Industry Association) should be contacted to see whether they have market research available for public consumption.

Identify support for primary research. Financial constraints serve as a leading barrier to technology innovation. Many novice developers have innovative ideas but little capital to engage in research and development steps that are critical for successful technology innovation. Small Business Innovation Research (SBIR) Program grants, administered by the U.S. Small Business Administration, encourage commercialization to ensure that good ideas are brought to market, based on good research processes that are required in the proof of concept phase (Phase 1) of the grant.

Make use of low-cost Web tools. Manufacturers should consider low-cost media tools such as blogs, consumer forums, electronic surveys, and discussion boards to generate input from consumers in their target field. Web 2.0 features and capabilities are giving consumers a voice in product development and marketing strategies. By actively soliciting input through a company's own Web site as well as participating on public sites where consumers gather, allows the manufacturer to reach new audiences and build awareness of the potential of their products. Readers may examine more in *The Power of Social Media to Promote Assistive and Learning Technologies* (NCTI, 2008).

Develop a method to collect and analyze data. As discussed previously, Microsoft® enlisted an external research firm to conduct a study exploring the number of individuals who could potentially benefit from the use of AT. However, smaller organizations may lack the financial resources needed to enlist this type of support. In such instances, draw on references such as books, journal articles, market research organizations, and technical

Table 2
Education Market Research Resources

Education Market Research Resources		
Resource	**URL**	**Description**
America's Digital Schools, 2006	http://ads2006.net/ads2006/	This study explores the future of educational technology from the perspective of superintendents, curriculum directors, and technology directors. Key findings are available at no charge, and the full report may be ordered for a fee.
Education Market Research	http://www.ed-market.com	Education Market Research publishes market research data collected from original studies conducted by the organization. Areas include textbooks, supplemental materials, computer hardware, software, video, and online.
Education TURNKEY	http://www.edturnkey.com/	TURNKEY conducts niche market research in K–12 educational technology, specializing in special education, state technology grants, E-rate discounts and refunds, and other areas.
Grunwald Associates	http://www.grunwald.com	Grunwald Associates provides industry research on technology, children, families, and the education market.
Harvard Case Studies	http://www.hbsp.harvard.edu/hbsp/case_studies.jsp	Provides cases on best practices in research or on interviews; the cases are usually fairly inexpensive to purchase and can help you build a case or use examples.
Quirks	http://www.quirks.com/	This Web site helps users identify "research on research," best practices, and appropriate research methodologies. A free membership is offered, which includes a magazine and Webinars.
Survey Sampling	http://myssi.surveysampling.com/08/02/USEN/index.html	This resource offers sampling solutions, best practices, and trends.

assistance centers such as NCTI to develop an approach to collecting and analyzing primary data. A number of software applications to support qualitative data analysis are commercially available. These applications enable users to identify, code, and annotate findings; determine the importance of data; and draw relationships between data within and across sources (examples of qualitative data software are found in the Resources section). Once the manufacturer develops and implements a data collection and analysis plan, findings to support the business strategy may be utilized.

Limitations

The partnership between AbleNet and NCTI demonstrates how market research can be leveraged to create new solutions that reach broad markets. This initial collaborative effort was aimed to identify, formalize, and disseminate strategies to inform the field on leveraging market research. AbleNet and NCTI accomplished this through their collaboration; however, limitations existed within the process and should be acknowledged and considered during future endeavors. First, the initiative began as an information gathering process. No formal research design was established prior to the start of data collection, and NCTI entered into this project with AbleNet after data were collected and ready for analysis. While interviewers were trained by third party market research companies on conducting effective market research interviews, interviews were conducted with no mechanism to ascertain inter-interview reliability. Furthermore, this endeavor differed from other traditional qualitative research approaches because during the data analysis phase, NCTI researchers contacted AbleNet staff involved with conducting interviews for clarification on the data (e.g., interpretation, context). Although findings from this project highlighted AT over educational and instructional technologies for learning, AbleNet's original purpose for conducting the research was broad enough to consider curriculum and professional services in the company's special education category. The findings shared in this paper should be seen as guideposts to further research and collaborative efforts that inform the field in an effort to better meet the needs of educational professionals and the students that they serve.

Conclusion

Market research has served as a valuable resource in understanding the needs, desires, and concerns of consumers and purchasers within the AT field. Although this important business strategy has been utilized in the AT field, opportunity exists to improve the gathering and use of market research to enhance the products and services offered to a changing and diverse set of customers worldwide. Drawing on secondary research (data that have been collected by a third party on consumers) is a good first step to getting a better understanding of a manufacturer's audience. Microsoft® and T2RERC have made market research reports available for broad use that serve as excellent starting points. However, this approach should be followed up with primary market research that is customized to provide specific insight on a

Table 3
Demographic Information Resources

Demographic Information Resources		
Title	**URL**	**Description**
Bureau of Labor Statistics	http://www.bls.gov	The Bureau of Labor Statistics is the principal fact-finding agency for the federal government in the broad field of labor economics and statistics.
Child Trends and Child Trends Data Bank	http://www.childtrendsdatabank.org	This site offers up-to-date national trends and research on more than 100 key indicators of child and youth well-being.
Disability Statistics: An Online Resource for U.S. Disability Statistics	http://www.disabilitystatistics.org	This site features disability statistics and related demographic information.
Twenty-Seventh Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act	http://www.ed.gov/about/reports/annual/osep/2005/parts-b-c/index.html	Report provides annual progress made toward the provision of a free appropriate public education to all children with disabilities and the provision of early intervention services to infants and toddlers with disabilities.
National Center for Education Statistics	http://nces.ed.gov	The National Center for Education Statistics (NCES) is the primary federal entity for collecting and analyzing data related to education.

company's client base. This article provided an example of one such market research activity involving a collaborative activity between AbleNet and NCTI. Additional resources on initial steps to conducting market research can be found in Tables 2 and 3.

References

AbleNet Inc. (2007). Next: Transition Skills Software (version 1.0) [Computer software/hosting services]. Roseville, MN: Computer Business Solutions.

AbleNet. (n.d.). *AbleNet research consortium*. Retrieved September 16, 2008, from http://www.ablenetinc.com/home/research/ablenetresearchconsortium/tabid/109/default.aspx

Atlas.ti Scientific Software Development. (2002-2008). Atlas.ti (Version 5.5) [Computer software]. Berlin, Germany: Author.

Forrester Research. (2003). *The wide range of abilities and its impact on computer technology*. Cambridge, MA: Author. Retrieved May 29, 2008, from http://download.microsoft.com/download/0/1/f/01f506eb-2d1e-42a6-bc7b-1f33d25fd40f/ResearchReport.pdf

Grigoriou, N. (2000). The role of marketing in an organisation. *Businessdate, 8*, 4–7.

Individuals with Disabilities Education Improvement Act, 20 U.S.C. § 1400 *et seq*. (2004)

Linstone, H. A., & Turnoff, M., (Eds.). (1975). *The Delphi method: Techniques and applications*. Reading, MA: Addison Wesley.

National Center for Technology Innovation. (2008). *The power of social media to promote assistive and learning technologies*. Washington, DC: American Institutes for Research, National Center for Technology Innovation. Retrieved May 5, 2008, from http://www.nationaltechcenter.org/index.php/2008/01/29/power-of-social-media-final/

National Center for Technology Innovation. (2005). *Moving toward solutions: Assistive and learning technologies for all students*. Washington, DC: American Institutes for Research, National Center for Technology Innovation. Retrieved May 5, 2008, from http://www.nationaltechcenter.org/index.php/2007/03/04/moving-toward-solutions-assistive-and-learning-technology-for-all-students/

National Center for Technology Innovation, Center for Implementing Technology in Education, and Ablenet, Inc. (n.d.a). *Consumer guide. Ed tech vendors*. Retrieved September 17, 2008, from http://www.techmatrix.org/consumerguides.aspx.

National Center for Technology Innovation, Center for Implementing Technology in Education, and Ablenet, Inc. (n.d.b). *Consumer guide. School administrators*. Retrieved September 17, 2008, from http://www.techmatrix.org/consumerguides.aspx..

No Child Left Behind Act, 115 Stat. 1425 (2002)

Rehabilitation Engineering Research Center on Technology Transfer. (n.d.). *Industry-profile project: Facilitating A/T industry innovation through focused market research*. Retrieved May 29, 2008, from http://t2rerc.buffalo.edu/research/industry-profile/index.htm

Strobel, W., Arthanat, S., Fossa, J., Mistrett, S., & Brace, J. (2006). *Industry profile on education technology: Learning disability technology and markets*. Buffalo, NY: Rehabilitation Engineering Research Center on Technology Transfer. Retrieved on May 29, 2008, from http://t2rerc.buffalo.edu/pubs/ip/index.htm

Strobel, W., Fossa, J., Panchura, C., Beaver, K., & Westbrook, J. (2003). *Industry profile on visual impairment*. Buffalo, NY: Rehabilitation Engineering Research Center on Technology Transfer. Retrieved on May 29, 2008, from http://t2rerc.buffalo.edu/pubs/ip/index.

htm

Volkman, C., & Overton, C., (2008) *Technology decision-makers hold the keys to implementation* [Webinar]. Retrieved September 16, 2008, from http://www.cited.org/index.aspx?page_id=126.

Assessing Calculators as Assessment Accommodations for Students with Disabilities

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Abstract: This study explored the performance of 75 seventh-grade students with and without disabilities, educated in inclusive mathematics classes, on open-ended, problem-solving mathematics assessments. In the study, approximately half of the students used a graphing calculator on the first assessment and not on the second assessment (*n* = 35; 46.7%), whereas the other half used it on the second assessment and not on the first (*n* = 40; 53.3%). The results indicate that all students did better when using a graphing calculator, regardless of the order of calculator use (i.e., Assessment 1 or 2). The results also suggest that calculators may not be a valid accommodation for some students with disabilities on assessments. This study has implications for providing calculators as accommodations on mathematics assessments.

Keywords: Mathematics, Calculators, High incidence disabilities

Accountability is at the forefront of education and so is its 'sidekick'- assessment. Federal policy requires that all students be tested yearly in literacy and mathematics in grades 3 through 8 and once again between grades 10 and 12 (No Child Left Behind Act of 2001 [NCLB]). Although all students are to be tested, students are not all the same. Students with disabilities, for example, often struggle with content areas, such as mathematics, and therefore perform worse on assessments (Fuchs, Fuchs, & Capizzi, 2005). One way to better measure the performance of students with disabilities on assessments is to provide an accommodation or set of accommodations.

Accommodations are a right of students with disabilities on assessments and in daily class activities (Individuals with Disabilities Education Improvement Act of 2004 [IDEIA]; Koening & Bachman, 2004). A valid accommodation does not alter the construct of an assessment, but rather alters the presentation, type of response, setting, timing, or the provision of technology or other supports, according to a student's individual needs (Fuchs et al., 2005; Ysseldyke, Thurlow, McGrew, & Shriner, 1994). Accommodations help 'level the playing field' for students with a disability (Fuchs & Fuchs, 1999). Examples of common accommodations for students with disabilities, particularly students with a high incidence disability, include: tests read aloud, allowing oral responses, calculators, individual administrations, and extended time (Thurlow, Elliott, & Ysseldyke, 2003).

While accommodations for students with disabilities are varied and can be expansive, not every accommodation is a valid accommodation for assessments. Elbaum (2007) defined a valid accommodation as one that results in the performance of students with disabilities increasing to a greater extent than the performance of students without disabilities when provided with the same accommodation on the same assessment. Given the proliferation of assessing students in the era of accountability, research exploring the validity of accommodations has increased. Yet, even with this increased attention, there is still a dearth of research. Additional studies are needed to understand the validity of different accommodations, specifically on mathematics assessments, and calculators are a natural option given their frequent appearance as accommodations on individual education programs (IEPs; Maccini & Gagnon, 2000; Thurlow, Lazarus, Thompson, & Morse, 2005; Tindal & Ketterlin-Geller, 2004).

Accommodations for Mathematics Assessments

Researchers have studied the validity of particular accommodations relevant to mathematics assessments, such as extended time, oral presentation, and calculators. The research on extended time has shown to be mixed and dependent on the type of mathematics problems being assessed (Fuchs, Fuchs, Eaton, Hamlett, & Karns, 2000). Fuchs and colleagues found that extended time is not a valid accommodation on computation mathematics assessments or those involving application problems, as students with disabilities did not benefit on Curriculum-Based Measurement assessments more than students without disabilities when provided with this accommodation (i.e., did not improve scores more). However, the researchers did find statistically significant benefits for extended time when students with and without disabilities took a problem-solving assessment, favoring students with disabilities. (Note: This suggests that extended time is a valid accommodation for problem-solving assessments.)

Researchers also have found mixed results for the oral presentation of mathematics assessments as an accommodation for students with disabilities. Similar to the extended time accommodation, Fuchs et al. (2000) found no benefit in the area of mathematics for students with disabilities on application assessments, but did find statistically significant benefits for this accommodation on the problem-solving assessments. Tindal, Heath, Hollenbeck, Almond, and Harniss (1998) found that students with disabilities benefited when a mathematics assessment was read aloud by a teacher as opposed to students with disabilities themselves reading the test but this was not the case for students without disabilities, making oral presentation an appropriate accommodation.

Finally, and similar to the other accommodations examined with respect to mathematics assessments, inconsistent results have been found for calculators as an accommodation. Fuchs et al. (2000) examined the use of a calculator as an accommodation for fourth- and fifth-grade students with learning disabilities on curriculum-based measurements (CBMs). Their research involved 181 students without disabilities and 192 students with learning disabilities. Students were given computation, concepts and applications, and problem-solving CBMs. The researchers found that students with learning disabilities benefited more than their peers without disabilities when using a calculator on problem-solving CBMs. However, the students with disabilities did not benefit more than students without disabilities on the concepts and application CBMs. (Note: Fuchs et al. study examined several different types of accommodations and the overarching study was to compare teacher-alone vs. data-support accommodation decisions.)

Shaftel, Belton-Kocher, Glasnapp, and Poggio (2003) also studied the impact of calculators as an accommodation for students with and without disabilities. Specifically, they studied 570 fourth graders with disabilities and 244 sixth graders without disabilities. Shaftel and colleagues found the use of a calculator benefited students with disabilities but not students without disabilities and concluded that calculators were an appropriate accommodation for students with disabilities. However, the results were not conclusive as the assessments used for students with disabilities in the study were presented in simpler English in addition to students being provided a calculator. Furthermore, students with and without disabilities were not tested at the same grade levels.

Recent research has explored calculators–both four-function and graphing calculators–as an accommodation on open-ended problem-solving assessments. Bouck and Bouck (2008) studied four-function calculators as a mathematics assessment accommodation. The research involved 89 sixth graders with and without disabilities on open-ended, problem-solving, number and operation, time-limited assessments. They found that the use of a standard four-function calculator resulted in both students with and without disabilities answering more questions correctly when they had access to the calculator on the assessment than when not. However, students with disabilities did not benefit more than students without disabilities when provided with this accommodation.

Similar results were found by Bouck (in press) in examining graphing calculators as an assessment accommodation by students with and without disabilities. This study analyzed the performance of 47 seventh-grade students with and without disabilities, in inclusive mathematics classes, on an open-ended, problem-solving, number and operation, time-limited mathematics assessment. While the data showed that on the problem-solving assessments, students with disabilities answered more problems correctly when given access to a graphing calculator, these gains were not statistically significant when compared to students without disabilities.

This specific research project sought to continue and extend the research on calculators as an accommodation on assessments. It focused on graphing calculators and the order in which students were allowed access to a calculator (first assessment or second assessment). In particular, it sought to answer the following question: Does the use of a graphing calculator result in performance differences on standards-based, open-ended, problem-solving assessments for students with and without disabilities?

Method

Participants

Seventy-five seventh-grade students participated in this study. All participants came from two schools in one large rural district in a midwestern state. The district was selected because it had been using a problem-centered mathematics curriculum which encouraged calculator use for over a decade. It also educated the majority of its students with a disability in inclusive mathematics classes. The two schools had a combined student population of 2,577 students, an average rate of 93.1% Caucasian students, an average rate of 78% passing the state mathematics assessment, and an average rate of 88.3% passing the state reading assessment (School Matters, 2006). The district as a whole had a 28% economically disadvantaged rate and 13.8% of its students identified with disabilities (School Matters).

Four inclusive classes and two teachers (both general education mathematics teachers) participated in this study. Fifty-three percent of the students had Teacher A ($n = 40$) and 47% Teacher B ($n = 35$). The students were relatively evenly dispersed across the four classes. Of the 75 students who completed both assessments, 74.7% ($n = 56$) were students without disabilities and 25.3% ($n = 19$) were students with high incidence disabilities. The majority of the students with disabilities were diagnosed with a learning disability (*n* = 13; 68.4%) (NOTE: The schools did not indicate the type of learning disability students had, such as a learning disability related to reading, writing, mathematics, and other subject areas); however, others included students with Attention Deficit Hyperactivity Disorder (ADHD; *n* = 5; 26.3%) and students with behavior disorders/emotional impairments (*n* = 2; 10.5%). Slightly more than half of all the students were female (*n* = 40; 53.3%), yet only 31.6% (*n* = 6) of the students with disabilities were female.

Materials

All students in the study completed the same two assessments in the same order (instruments available upon request from the author) as well as used the same type of calculator (a TI-82 graphing calculator), which was the standard calculator for these students and all students were familiar with it and had used it previously. The two assessments were similar but not identical. Both assessments consisted of 28 open-response, problem-solving questions that focused on the number and operation strand from the National Council of Teachers of Mathematics (2000) *Principles and Standards for School Mathematics*. The number and operation strand was chosen for both assessments because the majority of the standards for sixth grade students in this midwestern state came from this strand. The state's sixth-grade standards were chosen as students were tested at the beginning of their seventh-grade year and testing students on the sixth grade standards would reflect what students were suppose to have learned following the completion of their previous year of schooling. The assessment questions represented adaptations of released items from the state's general large-scale assessment (Michigan Department of Education, 2006) and released items from the National Assessment of Educational Progress (n.d.).The assessments were reviewed by well-known mathematics education specialists in the state for clarity, appropriateness, and alignment to state standards.

Procedure

The study involved two assessments taken about four weeks apart. Both assessments were timed, in that students had one class period to complete the assessment (50 minutes across all classes). About half of the students (*n* = 35; 46.7%) were assigned to Condition 1, meaning that they had access to a graphing calculator on the first assessment (Assessment 1) but not the second. The other students (*n* = 40; 53.3%) were assigned to Condition 2, in which they had access to a graphing calculator on the second assessment (Assessment 2) and not on the first. The students were randomly assigned to a condition (i.e., order of calculator use) at the level of teacher, which means that students themselves were not randomly assigned to use a calculator or not, but a class was assigned to use a calculator or not on the assessment (see Figure 1 for graphical depiction of conditions).

Data Analysis

The mathematics assessment data were analyzed multiple ways. First, the data was analyzed using a 2 × 2 ANOVA (Ability status × Condition). The dependent variable was students' raw change score from Assessment 1 to Assessment 2 and was computed by subtracting the number of questions students answered correctly on the first assessment (out of 28) from the number students answered correctly on the second assessment (out of 28). The change score was selected as the dependent variable following Richards's (1975) argument that change scores representing the difference between pretest and posttest are appropriate, easier to compute, and have greater meaning to non-researchers. Ability status (students with

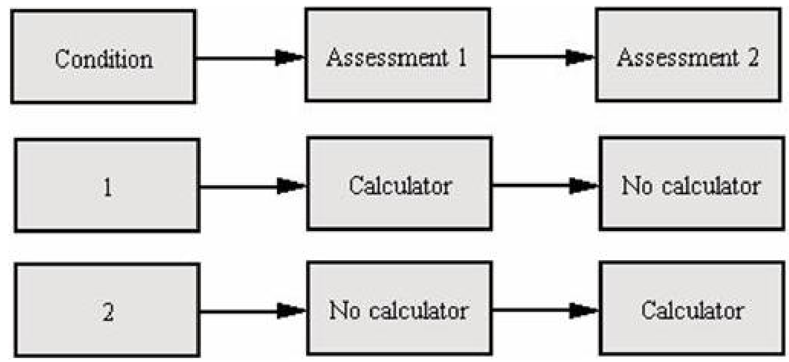

Figure 1: Graphical representation of study conditions.

disabilities and students without disabilities) and condition (calculator use on Assessment 1 or calculator use on Assessment 2) were the two factors in the ANOVA.

Independent t-tests were also completed for each condition with ability status as a factor. For Condition 1 (access to a calculator on Assessment 1), the dependent measure was students' scores on the first assessment when the graphing calculator was used. For Condition 2, the dependent measure was scores on the second assessment when students had access to a graphing calculator. The mathematics assessments data also were analyzed using frequency distributions.

Results

Analyzing students' change scores on the mathematics assessments from the first assessment to the second assessment revealed no statistically significant interaction for ability status and condition, $F_{(1,71)} = .573$, $p = .452$. However, a main effect for condition (graphing calculator use on Assessment 1 vs. graphing calculator use on Assessment 2) was found, $F_{(1,71)} = 26.118$, $p < .000$, $\eta_p^2 = .269$; $\beta = .999$. This suggests that students who had access to a graphing calculator on the second but not the first assessment showed greater gains (from Assessment 1 to Assessment 2) than students who had access to a graphing calculator on the first assessment but not the second. A main effect for students' gain scores was not found for ability status (students with disabilities vs. students without disabilities), $F_{(1,55)} = .904$, $p = .345$, suggesting that students with disabilities did not differ from students without disabilities on their change scores from the first assessment to the second assessment.

Figure 2 depicts the graphical representation of the data of change scores for students with and without disabilities by condition. The graph indicates illustrates the change in scores from Assessment 1 to Assessment 2 for the two groups of students (students with and without disabilities) via the two conditions (calculator and then no calculator and no calculator and then calculator). It indicates that students who had a calculator on Assessment 2 had positive change scores – they did better on Assessment 2 than Assessment 1, regardless of ability (although students with a disability were slightly higher), whereas students who had a calculator on Assessment 1 had a negative change score, meaning they did better on Assessment 1 than Assessment 2.

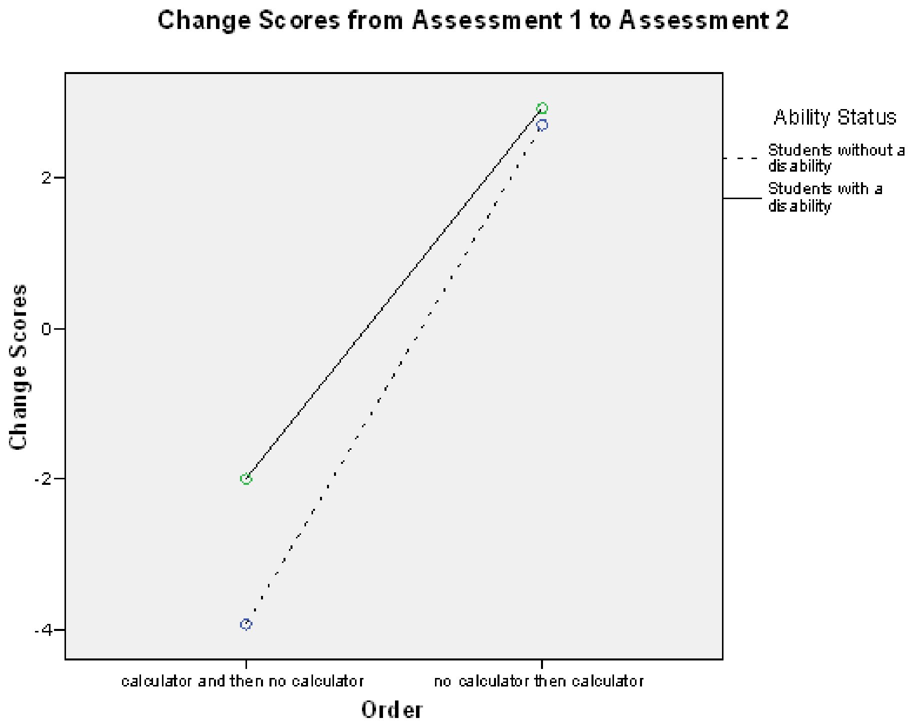

Figure 2: Change score from first assessment to second assessment across condition and ability.

All students, regardless of ability, answered more problems correctly on the mathematics assessment when they had access to a graphing calculator. For those who had access to a graphing calculator on Assessment 1, students with disabilities answered an average of 3.17 questions correctly and students without disabilities answered an average of 8 questions correctly (see 1 for means). This is in contrast to students who did not have access to a graphing calculator on the first assessment, in which students with disabilities averaged 2.31 correct responses and students without disabilities averaged 5.93 correct responses. Similarly on Assessment 2, students with disabilities who had access to a graphing calculator answered an average of 5.23 questions correctly and students without disabilities answered an average of 8.63 correctly, as opposed to students who did not have access to a graphing calculator (average of 1.17 correct for students with disabilities and 4.07 for students without disabilities). The change score in Condition 1 for students with a disability was a -2.0 and -3.93 for students without disabilities. However, in Condition 2 the change score for students with disabilities was +2.92 as compared to +2.7 for students without disabilities (refer to Table 1).

The *t*-tests for each condition with ability status (students with disabilities and students

Table 1
Means for Scores by Ability Status and Condition

	Condition 1		Condition 2	
	SWD (6)	SWOD (29)	SWD (13)	SWOD (27)
Assessment 1	3.17	8	2.31	5.93
Assessment 2	1.17	4.07	5.23	8.63
Change score	-2.0	-3.93	+2.92	+2.7

Note: SWD refers to students with disabilities; SWOD refers to students without disabilities without disabilities) as a factor suggest that graphing calculators are not a valid accommodation. The independent *t*-test for Condition 1, with the dependent variable of scores on Assessment 1 and ability as a factor, was significant, $t_{(33)} = 2.453$, $p = .02$, favoring students without disabilities. The independent t-test for Condition 2, with the dependent variable of scores on Assessment 2 and ability as a factor, was significant, $t_{(38)} = 2.508$, $p = .017$, also favoring students without disabilities. The significant *t*-tests suggest that students with disabilities did not benefit more than students without disabilities when given access to a graphing calculator as an accommodation; in fact, students without disabilities benefited more.

Discussion

This study sought to answer the question: Does the use of a graphing calculator result in performance differences on standards-based, open-ended, problem-solving assessments for students with and without disabilities? The results indicate that both students with and without disabilities answered more open-ended, problem-solving questions correctly with access to a graphing calculator than without. However, the results further suggest that graphing calculators are not a valid assessment accommodation, given the definition of a valid accommodation, as one in which students with disabilities benefit to a greater extent than students without disabilities (Elbaum, 2007).

The findings of this study indicate that both students with and without disabilities performed better on standards-based, open-ended, problem-solving mathematics assessments when they had access to a graphing calculator. This is not necessarily surprising given that a calculator can reduce students' mental math mistakes. These findings both support and extend previous research regarding calculator use on mathematics assessments and students with disabilities (Bouck, in press; Bouck & Bouck, 2008; Fuchs et al., 2000; Shaftel et al., 2003). The results support previous research by replicating that access to a calculator can result in performance gains by students with and without disabilities; yet do not support calculators as a valid accommodation on mathematics assessments. The lack of students with disabilities benefiting more from a calculator might suggest that, while calculators help minimize the mental math mistakes of these students, they do not compensate for lower conceptual understanding. Lower conceptual understanding by some students with disabilities as compared to some students without disabilities might explain the statistically significant benefit to students without a disability when given a calculator. However, this interpretation from this limited research is not intended to be used as a rationale for denial of services to students with disabilities or a dismissal of calculator use by either population.

Outcomes and Benefits

Students with disabilities have historically performed worse in mathematics than students without disabilities. For example, students with disabilities often struggle with automaticity of basic facts, computation problems, and problem-solving (Cawley, Parmar, Fley, Salmon, & Roy, 2001; Jitendra, DiPipi, & Perron-Jones, 2002; Montague, 1992; Woodward & Montague, 2002). The data from this study suggest that calculators as an assistive technology tool cannot solve all the mathematical challenges faced by students with disabilities. A lack of conceptual understanding of a mathematical idea cannot be overcome through the use of a calculator. While calculators can reduce mental mistakes or students' struggle with basic facts, which is a positive result, they cannot generate an understanding of a mathematical concept if a student does not possess it.

Hence, a need exists to increase the mathematical conceptual understanding of students with disabilities. Additional instruction focused on making sense and understanding mathematical ideas rather than efficiency with procedures is needed for students with disabilities. This is not to say that students with disabilities should not be given access to a calculator, as clearly these students benefited from having access (i.e., answered more correctly with a calculator than without). Allowing students with disabilities access to a calculator has the potential to give teachers greater insight into students' true mathematical knowledge bases when they are not hung-up by mental math or basic facts mistakes.

In conclusion, the data from this study on calculators as an assistive technology accommodation on mathematical assessments suggested all students, regardless of ability status, performed better on the open-ended, problem-solving assessments aligned to state standards when they had access to a graphing calculator. Yet, the data also suggested that graphing calculators are not a valid accommodation when using Elbaum's (2007) definition of a valid assessments accommodation, as students with disabilities did not benefit to a greater extent than students without disabilities from access to this tool. This is of particular importance given that 14 states within the United States of America allow calculators as accommodations on large-scale assessments, 14 allow them under certain circumstances, 1 allows them but with implications for scoring, 7 allow them under specific circumstances and with implications for scoring, and 5 consider them a non-standard accommodation but with no implications for scoring (Lazarus, Thurlow, Lail, Eisenbraun, & Kato, 2006). Educators and policymakers need to consider the research when deciding if and/or when calculators are a valid accommodation and should be allowed on assessments (Fuchs et al., 2005).

Limitations

This study has a few limitations in that only one school district was involved. It was conducted with a limited number of students in total and specifically students with disabilities. Another limitation involved missing data, which was a result of the length of the assessments. Twenty-eight open-response, problem-solving questions were too many for students with and without disabilities to complete in one class period. Students who did not finish either assessment employed different test-taking strategies, such as starting at the beginning and finishing as much as one could or skipping around and answering questions the student thought s/he knew. Finally, data was not analyzed at the level of type of disability, rather disability classifications were aggregated together. Data also was not aggregated for students with disabilities who were indicated to need a calculator as an accommodation versus those students whose IEP did not specify as such. While accommodations are meant to be determined on an individual student level given a student's strengths and challenges, this study sought to begin to examine calculators as assessment accommodations. Future research should address the limitations of this study.

Future Directions

Additional research is needed regarding mathematics assessment accommodations, particularly for standardized tests following mandates under NCLB. Specifically, additional research is needed to examine graphing calculators as valid accommodations–both in the classroom for daily use and on assessments. Future research should replicate studies like this as well as extend the ages examined (i.e., elementary and high school). Finally, research should explore calculators as accommodations on a range of assessment types, such as computation problem, problem-solving questions, and in situations simulating standardized testing situations as well as other mathematics strands (i.e., geometry).

References

Bouck, E. C. (in press). Calculating the value of graphing calculators for seventh grade students with and without disabilities: A pilot study. *Remedial and Special Education.*

Bouck, E. C., & Bouck, M. K. (2008). Does it add up? Calculators as accommodations for sixth grade students with disabilities. *Journal of Special Education Technology, 23*(2), 17-32.

Cawley, J., Parmar, R., Fley, T. E., Salmon, S., & Roy, S. (2001). Arithmetic performance of students: Implications for standards and programming. *Exceptional Children, 67*, 311-328.

Elbaum, B. (2007). Effects of an oral testing accommodation on the mathematics performance of secondary students with and without learning disabilities. *Journal of Special Education, 40*, 218-229.

Fuchs, L. S., & Fuchs, D. (1999). Fair and unfair testing accommodations. *School Administrator, 10*(56), 24-29.

Fuchs, L. S., Fuchs, D., & Capizzi, A. (2005). Identifying appropriate test accommodations for students with learning disabilities. *Focus on Exceptional Children, 37*(6), 1-8.

Fuchs, L. S., Fuchs, D., Eaton, S. B., Hamlett, C. L., & Karns, K. M. (2000). Supplementing teacher judgments of mathematics test accommodations with objective data sources. *School Psychology Review, 29*, 3-24.

Individuals with Disabilities Education Improvement Act, 20 U.S.C. § 1400 *et seq.* (2004)

Jitendra, A., DiPipi, C. M., & Perron-Jones, N. (2002). An exploratory study of schema-based word – problem - solving instruction for middle school students with learning disabilities: An emphasis on conceptual and procedural understanding. *Journal of Special Education, 36*, 23-38.

Koenig, J. A., & Bachman, L. F. (Eds.). (2004). *Keeping score for all: The effects of inclusion and accommodation policies on large-scale educational assessments.* Washington, DC: National Academies Press.

Lazarus, S. S., Thurlow, M. L., Lail, K. E., Eisenbraun, K. D., & Kato, K. (2006). *2005 state policies on assessment participation and accommodations for students with disabilities* (Synthesis Report 64). Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes. Retrieved March 5, 2006, from http://education.umn.edu/NCEO/OnlinePubs/Synthesis64.

Maccini, P., & Gagnon, J. C. (2000). Best practices for teaching mathematics to secondary students with special needs. *Focus on Exceptional Children, 32*(5), 1-22.

Michigan Department of Education. (2006). *Mathematics grade level content expectations* v.12.05. Lansing, MI: Author. Retrieved February 12, 2006, from http://www.michigan.gov/documents/MathGLCE_140486_7.pdf.

Montague, M. (1992). The effects of cognitive and metacognitive strategy instruction on the mathematical problem-solving of middle school students with learning disabilities. *Journal of Learning Disabilities, 25,* 230-248.

National Assessment of Educational Progress. (n.d.). NAEP questions. *IES National Center for Educational Statistics.* Retrieved February 8, 2008, from http://nces.ed.gov/nationalreportcard/ITMRLS/startsearech.asp

National Council of Teachers of Mathematics. (2000). *Principles and NCTM standards for school mathematics.* Reston, VA: Author.

No Child Left Behind Act, 20 U.S.C. 6301 *et seq*. (2001)

Richards, J. M. (1975). A simulation study of the use of change measures to compare educational programs. *American Educational Research Journal, 12*, 299-311.

School Matters. (n.d.). *Welcome to School Matters*. Retrieved February 11, 2008, from http://www.schoolmatters.com/

Shaftel, J., Belton-Kocher, E., Glasnapp, D. R., & Poggio, J. P. (2003). *The differential impact of accommodations in statewide assessment: Research summary*. Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes. Retrieved March 5, 2006, from http://education.umn.edu/NCEO/TopicAreas/Accommodations/Kansas.htm.

Thurlow, M. L., Elliott, J. L., & Ysseldyke, J. E. (2003). *Testing students with disabilities: Practical strategies for complying with district and state requirements*. Thousand Oaks, CA: Corwin Press.

Thurlow, M. L., Lazarus, S. S., Thompson, S. J., & Morse, A. B. (2005). State policies on assessment participation and accommodations for students with disabilities. *Journal of Special Education, 38*, 232-240.

Tindal, G., Heath, B., Hollenbeck, K., Almond, P., & Harniss, M. (1998). Accommodating students with disabilities on large-scale tests: An experimental study. *Exceptional Children, 64*, 439-450.

Tindal, G., & Ketterlin-Geller, L. R. (2004, January). *Research on mathematics test accommodations relevant to NAEP testing*. Washington, DC: National Assessment Governing Board. Retrieved June 20, 2006, from http://www.nagb.org/pubs/conferences/tindal.pdf.

Woodward, J., & Montague, M. (2002). Meeting the challenge of mathematics reform for students with LD. *Journal of Special Education, 36*, 89-101.

Ysseldyke, J. M., Thurlow, M. L., McGrew. K. S., & Shriner, J. G. (1994). *Recommendations for making decisions about participation of students with disabilities in statewide assessment programs* (Synthesis Report 15). Minneapolis: University of Minnesota National Center on Educational Outcomes. Retrieved March 5, 2006, from http://cehd.umn.edu/nceo/OnlinePubs/SynthesisReport015.pdf

Campus Community Partnerships with People Who Are Deaf or Hard-of-Hearing

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Abstract: In 1997, the Moores University of California, San Diego (UCSD) Cancer Center and advocacy groups for people who are deaf and hard of hearing launched a highly successful cancer control collaborative. In 2006, faculty from the Computer Science Department at UCSD invited the collaborative to help develop a new track in their doctoral program. This track would train computer scientists to be culturally competent when working with people who have hearing and visual challenges, with the ultimate goal of developing assistive living devices that would be welcomed by, and useful to, the anticipated end users. Faculty and students began developing ideas for technological advances that were anticipated to benefit people who are deaf and hard-of-hearing. Computer science graduate students and faculty worked with the medical school faculty, staff, and undergraduates to design culturally competent focus groups for people who were deaf and hard-of-hearing. The focus groups were designed to gather opinions of these presumed end users about three, very promising ideas for assistive listening devices. The result was a productive interchange between the computer science team and focus group members. The insights garnered have subsequently been used to refine the three devices. This paper provides an overview of how computer science students were trained to present their technological innovations to people who are deaf and hard-of-hearing and to gain feedback on how their devices might best serve them.

Keywords: Deaf and hard-of-hearing, Assistive technology, Computer science, Focus groups

In 2006, computer science faculty at the University of California, San Diego (UCSD) recognized the need to develop a cadre of doctoral level-trained computer science graduates who were interested in developing technological devices to improve the quality of life of people who had visual or hearing challenges. While they had the necessary faculty to provide the scientific training, they lacked faculty who could assist their students to develop the cultural competency needed to work with people who were visually or hearing challenged.

In their search for colleagues to help them work with each of these groups, they discovered colleagues at the Moores UCSD Cancer Center who had been successfully collaborating with deaf and hard-of-hearing advocacy groups since 1997 to create cancer control education programs for people with hearing challenges. Thus, the computer science faculty had found not only faculty colleagues, but through them, access to the nationwide network of deaf and hard-of-hearing advocacy groups that the Cancer

Center had found to help them achieve their educational vision.

Meanwhile, the Moores' faculty and staff and their colleagues from the community-based advocacy groups for people who are deaf or hard-of-hearing had been searching for other UCSD researchers who might be interested in working with them to expand the research on behalf of people with hearing challenges. The core research team that resulted from this new collaboration included faculty members from Computer Science, Bioengineering, and Public Health, doctoral students in Computer Science, and undergraduates with prior experience with the Moores UCSD Cancer Education for people who are deaf and hard of hearing.

Hearing loss is the 6th most common chronic condition in the United States, and affects between two and four of every 1,000 people in the United States (Barnett, 2002; Pleis & Lethbridge-Cejku, 2006). These individuals offer computer science researchers many opportunities to create devices that will further their pursuit of innovation, while discovering ways to improve people's immediate quality of living.

The aim of this study was to conceptualize assistive listening devices that might be feasible and beneficial to people who are deaf and hard-of-hearing. Focus groups were conducted to assemble people who were deaf and hard-of-hearing together with laboratory-based researchers in order to exchange ideas about the assistive listening devices and to determine which would be of greatest value for deaf and hard-of-hearing people. This paper offers readers an introduction to understanding the differences in groups along the spectrum of deafness and describes the focus group structure, which the team tested and found to be very useful in gathering data from the people who were intended to derive greatest gain from the technological innovations being developed.

Method

Review the Literature

For the first step in the process of preparing students to collaborate effectively with people who are deaf or hard-of-hearing, faculty gave students a collection of articles to help them understand the many subtle distinctions that exist among people with audiological differences (Eckhardt & Anastas, 2006; Iezzoni, O'Day, Killeen, & Harker, 2004; Lane, 2002, 2005; Levy, 2002; Padden, & Humphries, 1988; Phelan, & Parkman, 1995; Pollard, 1992; Stebnicki & Coeling, 1999). The reading material was intended to help the students learn how to interact in a culturally competent manner with people who are deaf and hard-of-hearing. These articles were derived from a larger collection of articles that were being used to create a cadre of physicians who would help people with hearing challenges gain better access to health information and care (Farber, Nakaji, & Sadler, 2004).

Distinctions in terminology. The students learned that the spectrum of people with hearing deficits range from those who are hard-of-hearing to people who are deaf. Generally, people who are *hard-of-hearing* will have been educated in standard classroom settings and provided with accommodations when possible. Their hearing loss may have occurred early in life or later, as an accompaniment of the aging process. This subgroup can also include people who are deaf. They will only rarely have learned sign language and will culturally align themselves with the other members of their ethnic group. They communicate with speech and use either one or a combination of oral, lip reading, and signing methods (Stebnicki & Coeling, 1999).

People who are *culturally deaf* will likely have had very different education and social experiences from people who are hard-of-hearing. Distinctions among these individuals are influenced by whether the person became deaf before or after the full acquisition of speech and whether they were educated in schools for the deaf or mainstream schools with accommodations. Deaf with a capital 'D' refers to a cultural group as opposed to deaf with a lower case 'd' which refers to people with a hearing loss (Padden & Humphries, 1988; Stebnicki & Coeling, 1999). Members of the Deaf community share a common language (i.e., American Sign Language [ASL] in the U.S.) and a culture (i.e., Deaf culture). The Deaf community is rooted in a rich culture, having their own clubs, social networks, and traditions. The Deaf community may include individuals who have been deaf or hard-of-hearing since birth or those who have acquired hearing loss later in life, but gaining membership requires the use of ASL, an important quality of Deafness (Padden & Humphries, 1988).

Approval of Study

Institutional Review Board (IRB) approval was secured for this study, since the opinions and ideas of human participation were to be gathered. IRB approved the recruitment flyers, consent forms, and focus group scripts prior to use. The consent documents were written with the recognition that a portion of the study participants would have learned English as a second language and as a result, would have limited English proficiency. Since some participants were likely to have no English language literacy, and there is no written form of ASL, an interpreter or staff member fluent in ASL was always available to provide an ASL interpretation of the consent document (Meador & Zazove, 2005).

Brainstorming of Assistive Devices

The program faculty asked several of their community collaborators to review their ideas for a small collection of devices that the faculty and students thought might be both useful and feasible to develop. From that group, they were asked to select the two or three ideas that they perceived would most benefit people with hearing loss. The devices selected for exploration were a dialogue facilitator, an audio event detector, and a volume detector.

The first assistive listening device, the *Dialogue Facilitator*, would build upon the rapidly expanding field of voice recognition software. It converts the hearing user's speech into text, which the person with hearing loss can read on a computer screen and print out for immediate and later review. By including medical vocabulary, the dialogue facilitator could help deaf or hard-of-hearing patients communicate in a physician's office. It was envisioned that at the doctor's office, both the doctor and patient will sit near a computer. The physician will speak into a microphone, and the words that are said will be displayed on the computer screen. The patient can read from the computer screen to catch words or phrases that were missed. In the end, a full copy of the conversation can be printed out for the patient to keep. Such a device would be most helpful to people who are deaf or hard-of-hearing with relatively high literacy rates in the spoken language.

The second assistive listening device, the *Audio Event Detector*, would recognize and notify users of selected words, prompts, and sounds from the user's environment. Example sounds include the call of the user's name, an emergency alarm, a phone ring, and keywords for social activities, such as 'Bingo.' The user can program five to ten target sounds onto the device, which is designed to be small and wearable.

The third assistive listening device, the *Volume Detector*, would provide users who were hard-of-hearing with immediate feedback on the level of their vocal projections. People who suffer from hearing loss often have difficulties with modulating their own voice levels against the surrounding environment. This device simultaneously measures the level of surrounding noise and the level of the individual's speech. If a significant discrepancy is detected between these two levels, the device will notify the individual to either increase or decrease his or her volume level.

The Computer Science team members then began developing prototypes of these devices. The Cancer Center team members began recruiting potential participants for focus group discussions about the usefulness of those devices for people who are deaf or hard-of-hearing.

Developing the Focus Groups

Eligibility requirements. Eligibility requirements for study participation included: (a) self-identification as a person who is deaf or hard-of-hearing, (b) being at least 18 years of age, and (c) having the competency to understand and sign a consent document. Based on prior experience in conducting focus groups, the Cancer Center researchers anticipated that for every three people who said they would agree to attend a focus group, one could be expected to arrive.

Recruitment of focus group participants. The Cancer Center team members initiated a person-to-person recruitment strategy to populate the focus groups. Known members of the Deaf community were contacted using multiple communication strategies, including face-to-face conversations, emails, instant messaging, direct phone and calls through videophone, and posting of IRB-approved flyers at affinity organizations in San Diego (e.g., Deaf Community Services [DCS], Association of Late Deafened Adults [ALDA], and the Hearing Loss Association of California). Additional recruitment was done through community venues that attracted people who are deaf or hard-of-hearing, such as ministries that provide accommodations for people who are deaf and hard-of-hearing and social gatherings (e.g., pizza nights, coffee nights, and health seminars that are specifically for people who are deaf and hard-of-hearing). Potential participants were given a copy of the IRB-approved flyer to help them retain the information they were given by the study recruiter, to serve as a reminder of the focus group schedule and location, and to share with others who might be interested (Merrell, Kinsella, Murphy, Philpin, & Ali, 2006). The recruiter explained that focus group participants would receive a $15 gift card to a local grocery store chain in appreciation for their participation, as well as healthy refreshments at the focus group.

The study recruiter also asked if potential participants would be willing to share the names and contact information of other people who might be interested in learning about the study (i.e., snowball sampling; Wasserman, Pattison, & Steinley, 2005). These methods of recruiting make it difficult to determine an accurate refusal rate since the denominator (those invited) is unknown. This is compounded by the fact that some people may have been willing to participate, but were unavailable during the times that the focus groups were scheduled.

Preparations for conducting focus groups. When researchers work with people outside of their own community or cultural group, it is essential that they seek guidance on how to cooperate with the group in a culturally competent manner (Munoz-Baell & Ruiz, 2000; Stebnicki & Coeling, 1999). Before conducting the first focus group, the research team held a three-hour practice session with two staff members from the Cancer Center who were members of the Deaf community and had experience in conducting focus groups with people who are deaf and hard-of-hearing. Two hearing undergraduates were also part of this research team. They had been working on the Cancer Center's Deaf community cancer education program and had been trained in cultural sensitivity for the Deaf community. They assisted with the set-up of cameras and lighting for the recording of the focus groups.

Four interpreters were hired to provide additional advice on the optimal logistical configuration of the focus groups' participants and presenters. The practice session also gave the computer science graduate students their first opportunity to work with ASL interpreters. In addition, the practice session gave the students the chance to learn how best to employ their visual aids and helped them to learn the best way to pace and organize the presentation of their materials. The principle investigator (Sadler) for the Cancer Center's Deaf community cancer-related research projects assumed the role of overseeing the practice session and providing the doctoral students with additional immediate feedback on ways to improve the effectiveness of their presentations and their cultural competency.

Developing the optimal room configuration was a key logistical consideration during the practice session. The first goal was to provide optimal light without creating glare. The second goal was to provide strong enough lighting to enable participants to make accurate distinctions among the subtle differences in various signs and the rapid finger spelling of ASL. Lighting and video camera considerations had to take into account that all members of the focus group had to be in direct visual contact with each other to communicate in ASL. Placement of the cameras also influenced the room's configuration because it was essential to produce quality video tapes that would capture not only the video of the interpreters' and participants' signing, but also the interactive aspects of the focus groups' dynamics. Since there were considerable costs incurred in conducting each focus group, and since the recording of the focus group was central to the success of the project, an extra video camera was always available in case one of the other two cameras malfunctioned.

Additional considerations involved keeping the expense of conducting the focus groups within the projected budget that was partially funded through the University's Chancellor's Interdisciplinary Collaboratories grants. (Note: These are small, innovation grants that are anticipated to promote interdisciplinary collaborations and yield the experience and data needed to secure subsequent funding.) When working with focus groups, the planned budget should allow for expected costs such as stipends and tuition remission for students, hourly wages for interpreters, recording equipment, participant incentives, and refreshments for the focus groups.

When calculating interpreters' cost, it is important to remember that for sessions that will last longer than 45 minutes, a second interpreter must also be hired so that the interpreters can relieve each other. This is not only essential for the well being of each interpreter, but also to avoid interpreter fatigue that will lead to diminished quality of communication. In the focus groups, a team of two interpreters is needed for translating the presenter's information into ASL and one additional pair of interpreters is needed for up to 10 members of the focus group so that their communications in ASL can be translated into English for the presenter's understanding. In addition, for people who are hard-of-hearing and do not sign, a real-time captionist must be available to convert the spoken words into written format. Again, depending on the duration and the size of the focus group, more than one person may be required.

A final consideration that can increase the quality of the focus groups is the pre-event preparation of the interpreters. Providing a written summary of the content of the presentation planned, a glossary of technical terms, and time for the interpreter to ask questions of the presenter can significantly improve the quality of the interpreter's transmission of the information.

Protocol for Focus Groups

All three, two-hour-long focus groups were scheduled to be conducted at the Moores UCSD Cancer Center because it was a familiar location to most participants due to the Center's long-term educational collaboration with people who are deaf and hard-of-hearing. Each focus group was designated for a particular group of people in order to better address the needs of that group; the first two focus groups were planned primarily for deaf individuals, and the last one was intended primarily for people who were hard-of-hearing.

The students were told to exactly follow the IRB-approved focus group protocol, which included individually greeting and welcoming the participants as they arrived and inviting them to partake in the refreshments. Once all expected participants had arrived, the students were to give a formal introduction of the entire research team and fully explain the goals of the focus group. They would then take the participants through the full IRB-approved consenting process with documents in written English and presented in ASL. Video release consent forms were also included to ask for participants' permission for the video tapes to be used for research, training, and presentations at scientific and

Table 1
Focus Group Discussion Guide

Device 1: Volume Detector
Will this device be useful for people who are deaf or hard-of-hearing?
Would you use a device like this? In what situations??
How would you like to wear it? Attached like a pager? In a pocket? Other?
How would this device notify you? Vibrations? Lights? Other?
What else? How can it best serve you?

Device 2: Dialogue Facilitator
Will this device be useful for people who are Deaf or hard-of-hearing? How would it be useful for you?
Is there anything about this device that you would like to modify?
Will this device be useful in other scenarios besides a doctor's office?
How important is it to you that this device is mobile? How small would this device have to be?
How often do you visit the doctor? What is usually the format of these visits?
Do you ever have trouble communicating with your doctor? Do you communicate with your doctor using an interpreter?

Device 3: Sound Detector
Will this device be useful for people who are deaf or hard-of-hearing? How would it be useful for you?
Is there anything about this device that you would like to modify?
What are some useful sounds or words that you would program onto this device?
How would you like to wear this device?
How would you like this device to alert you?
Which of the three devices presented would you be most interested in using?

educational conferences.

The computer science student was to remind the participants of her name and then give a thorough explanation of the device being presented. She would then lead the focus group discussion about the device with the help of a Cancer Center staff member who was deaf and proficient in ASL. Table 1 lists the questions that were to be used for each device to guide the discussions throughout the focus groups. The questions were developed by the computer science students and project faculty and approved by IRB. They focused on gaining an understanding of how the potential end-user might employ the device, how the prototype of the originally conceived device should be modified to make it more user friendly, and whether there were other potential uses for the device that had not been identified. As the focus groups were approaching completion, the computer science students were to ask the participants if they would like to be notified if any of the devices reached the point of readiness for (beta) testing. Finally, to further strengthen the students' and focus group members' comfort working across language and culture barriers, the computer science students were to encourage the focus group participants to stay a little longer for social exchange and refreshments after the focus group.

Field Notes and Transcription

During the practice session, the placement of an audio tape was also tested along with the best position for the undergraduate students to sit when they were gathering field notes. The undergrads needed to be unobtrusive recorders of key observations and also able to periodically check to assure the proper functioning of the video and audio recording equipment. The audio tape recording was made because it is easier to transcribe from an audio tape than a video tape, and these audiotapes served as a back-up strategy in case the video equipment failed or parts of the videotaped discussion were inaudible. A back up audio recording device is, therefore, also a wise investment.

The transcription of the audio tape would be done as soon as possible after each focus group. That transcription would then be compared with the dialogue on the video tape as a double check for accuracy. The relevant transcription of the focus groups would then be coded into thematic clusters, the frequency data would be determined, and conclusions would be developed.

Participants

The participants ranged in age from 24 to 75 yrs (see Table 2). For females, the average age of the participants was 53; for males, 43. The group included 12 deaf participants and three hard-of-hearing participants (one did not answer the question) and had diverse modes of communication. One of the group members had completed high school, 11 had attended some college, and four had completed college or beyond. While the participants' ethnic diversity was not representative of the region's racial/ethnic characteristics, it was the need to assure a diversity of hearing-related characteristics that primarily drove the recruitment efforts in the area of attaining sample diversity.

Results

Impact of the Practice Session on Data Gathering in the Focus Groups

Comparing the students' experiences in the practice focus group session to the consistent and high quality results of the three focus group sessions, there could be no doubt of the demonstrable benefits that were gained from the single practice session. The room configuration was changed multiple times during the practice session to address issues

Table 2
Focus Group Participant Demographics (n=16)

Category		Total
Gender		
	Male	10
	Female	6
Race/Ethnicity		
	Black/African American	1
	White/Caucasian	15
Age		
	18-30	4
	31-40	2
	41-50	2
	51-60	4
	61+	4
Identity†		
	Prelingually deafened (Became deaf before speech acquisition)	12
	Postlingually deafened (Became deaf after speech acquisition)	0
	Late deafened	0
	Hard-of-Hearing	3
Primary Mode of Communication††		
	ASL	13
	Pidgin Sign English (PSE)	2
	Sign Exact English (SEE)	0
	Total Communication (sign, speech, lip-read, etc.)	3
	Oral	2
	Cued Speech (hand movement paired with visual signs that represent phonetics)	0

†One participant did not answer this question.
‡Some participants chose two primary modes of communication

related to (a) achieving optimal lighting; (b) filming to include all participants; (c) ensuring clear audio pick-up; (d) maintaining direct visual access among all parties involved in the focus groups; (e) providing interpreter accommodations; and (f) seeing the presenter, interpreter, and slides simultaneously.

Following the practice session, the three focus group sessions preceded extremely smoothly, the recordings were of sufficient clarity and entirely audible, and the data gathered was of very high quality and directly addressed the students' information needs. Figure 1 presents the final room configuration used for all three focus groups and is the one which would be selected for all future focus groups of comparable size.

Students' Acquisition of Cultural Competency

The reading materials combined with the practice session were sufficient to help the students gain an appropriate level of cultural competency in their presentations and interactions with the members of the focus groups. Following each focus group session, the participants: (a) volunteered comments expressing their appreciation of the students' clear efforts to be deaf-friendly; (b)expressed excitement about the devices; (c) stayed after the focus groups to talk to the individual presenters and staff members; (d) volunteered to participate in future focus groups; and (e) unanimously agreed to be notified of the overall progress of the study, as well as future opportunities to participate in research.

The computer science students gained valuable experience working with the interpreters and an appreciation of the importance of taking the time to learn culturally competent ways to work with people who are deaf and hard-of-hearing. By having a highly interactive practice session, the doctoral students were able to hone their skills as they received real-time feedback from their computer and behavioral science faculty, deaf team members, and interpreters. By giving the students suggestions throughout their presentation, the students had the opportunity to practice each lesson learned during the remainder of their presentation, thus reinforcing the lessons. At the end of each presentation, the students received a written summary of the key points they would

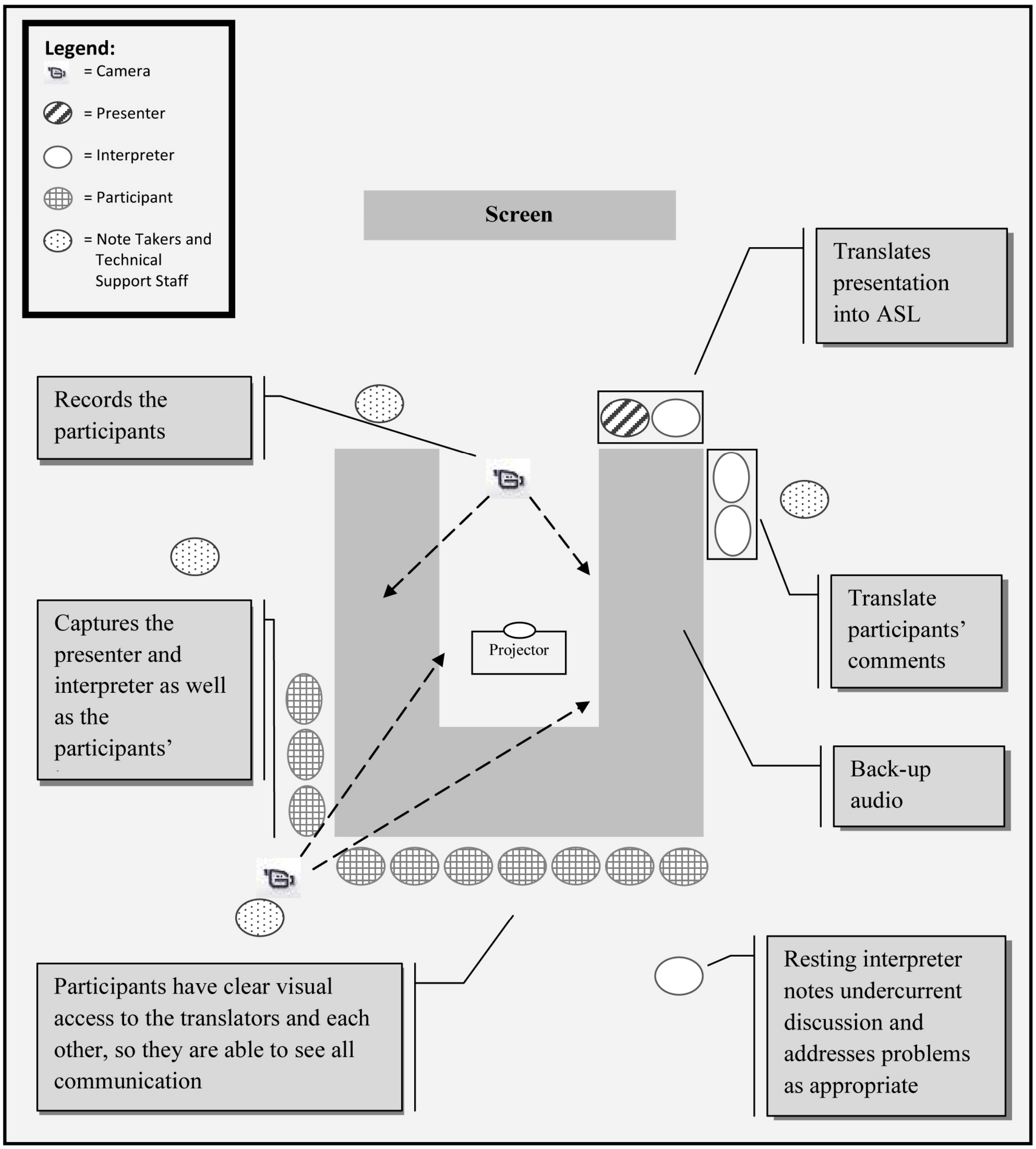

Figure 1. Optimal room configuration for up to 10 focus group participants.

Table 3
Culturally Competent Techniques for Conducting Focus Groups with People Who Are Deaf or Hard-of-Hearing

- Present visual information sequentially with oral presentation to allow participants to follow along.
- Recognize the difference between Deaf and hard-of-hearing subgroups, and how this may affect their application of devices.

Allow participants the opportunity to read the presenter's lips by avoiding the following:

- Turning face away from audience.
- Talking behind hands.
- Talking while the participants' attention is diverted (eating food, taking a break, etc.).

Display competency working with interpreters, including:

- Giving eye contact to the participant, rather than the interpreter.
- Allowing time for the interpreter to translate, by speaking slowly or pausing between statements.
- Using more common and less technical terms.
- Taking breaks to allow interpreters to rest.
- Bringing the group to order by waving arms or flicking lights on and off.
- Providing visual components that are easily accessed:
- Using a PowerPoint™ presentation with diagrams and pictures to illustrate the physical devices.
- Incorporating key terms, and avoid unnecessary details.
- Accommodating color-blind participants, by avoiding red and green colors.
- Choosing fonts that are easier to read, rather than those that are more aesthetically appealing.

need to practice and remember to do correctly during the actual focus groups.

Table 3 includes examples of the lessons students learned about cultural competency during the practice focus group session. For example, they learned that one culturally acceptable way of gaining attention from an audience of deaf and hard-of-hearing people is to flick the room's lights off and on quickly. Another example they learned is that they must first explain the visual aid they will be showing to the audience. Then they show the audience the visual aid without further accompanying conversation. Finally, they recapture the audience's attention by entering into the audience's visual field and signaling the start of conversation before actually initiating the conversation. Students learned that additional graphics and hands-on exhibits would increase the accuracy and speed the transmission of information to their focus group participants.

They also learned the value of adding slides with keywords and pictures as a visual supplement to the presentation. Equally important, students learned that their slides should only include colors that are accessible to people who are color blind to assure optimal accuracy of the transmitted information (Cole, 2004). As a result of the practice focus group session, each student developed a more detailed slide presentation that better forecasted the order of the topics to be presented and enhanced the ease of understanding the complex information being shared. Giving this depth of attention to the cultural competency of the students' presentations coincidentally disclosed other ways to enhance the students' likelihood of research success. The focus group setting is an unfamiliar one for most computer science students. This practice session made it easy for the Moores behavioral science staff and faculty to identify ways to help the students employ the social skills that are routinely used to put participants at ease in focus groups (see Table 4).

Table 4
General Interpersonal and Presentation Skills

- Personally greet participants upon arrival.
- Help participants get comfortable and access amenities.
- Gain the attention of the entire audience before beginning the presentation.
- Begin the presentation with a thorough introduction and overview.
- To reduce disruptions, have the participants collect all refreshments and bring them to the table before the session begins
- Allow participants to retrieve more refreshments between breaks in the presentation to assure their comfort.
- Elicit feedback from the participants frequently.
- Elicit responses from participants in random order.
- Bring relevant sidebar discussion into mainstream discussion.

Evaluation of Budget Projections

The practice session was also useful in helping the faculty assess if they had correctly projected the funds that would be required to conduct the three focus groups planned or whether adjustments would be needed to the budget or methodology. Since the faculty members were preparing subsequent research proposals, this practice session also gave them a more accurate assessment of the actual costs of conducting focus groups with people who are deaf or hard-of-hearing. Table 5 illustrates the approximate budget for a two-hour focus group for up to 10 participants.

A total of four interpreters were used for the two focus groups with participants who were deaf (two oral and two signers). Two interpreters (one oral and one signer more English-language geared) were sufficient for the hard-of-hearing focus groups. None of the participants indicated a need for a real-time captionist to provide simultaneous transcription of the focus group dialogue. Hence, this cost is not included in the budget, but should be a consideration when planning budget expenses for focus groups with people

Table 5
Estimated Costs for One Two-Hour Focus Group of 10 Participants

Item	Price/Unit	Qty.	Total
One-Time Costs			
LCD Projector	$1000	1	$1000
Cameras	$ 600	3	$1800
Light Kit	$ 100	2	$ 200
Audio Recorder	$ 35	1-2	$ 35 - $70
Total Start-Up Costs			$3,035 - $3,070
Per-Session Costs			
Video Tapes	$4	6	$24
Audio Tapes + batteries	$5	1	$5
Interpreters (costs vary by city)	$130/2 hour minimum	4	$520 for 2 hours
Participant Incentives	$15 - $100	10	$150 - $1,000
Healthy Refreshments	$8 per person	20	$160
Total Per-Session Costs			$859 -$1,709

Table 6
Insights Gained from Focus Groups

Theme Area	Focus Group Advice and Changes Recommended
General (across all three devices	• Integrate devices with already owned gadgets, such as a PDAs, cell phones, or laptops • Need to be financially feasible.
Device 1: Volume Detector	*Advice:* • Needs to be small and portable. • More suitable to the hard-of-hearing community, because Deaf community does not typically use their voice. • Should have options for signal of volume, such as blinking lights and vibrations. *Changes Recommended:* • Add variation in intensity of signal to denote degrees of volume.
Device 2: Dialogue Facilitator	*Advice:* • Technology should not be a replacement for human interpreters; instead, it should supplement interpreting or be an alternative option. • Institutions (i.e. doctors and hospitals) should not control the use of this device; rather, the patients should be able to own this device and use it at their own discretion. • The device should be portable. • There are other scenarios (besides the doctor's office) where the device would be useful, including at school, court, or a restaurant. • To interact back with the doctor, people preferred to type. *Changes Recommended:* • Make the screen very large so that the patient can more easily see the doctor and the screen at the same time.
Device 3: Sound Detector	*Advice:* • It should be easy for the user to record new 'events' that he or she wants to detect. • Must be small enough that the user can carry it around effortlessly. *Changes Recommended:* • Add an indicator to tell how close a certain sound is, perhaps a light that flashes at greater frequency when the sound is closer. • Add a timestamp to record when a certain sound occurs. • Add an indicator to show directionality of the origin of the sound. • Have the ability to record certain sounds so that they can be replayed to hearing friends to ask exactly what that sound was.

who are hard-of-hearing or deaf.

While it was possible to attract participants with the $15 gift card incentive, this low amount was insufficient to attract participants quickly. It is also likely that the people who did participate were more attracted to the novelty of the experience, the chance to socialize with other deaf or hard-of-hearing people, or the opportunity to do a community service than the incentive and this may have biased the sample to attract a more affluent group of participants. Given the amount of time ultimately requested of the participants, an incentive in the range of $50 to $100 would have been more appropriate.

Insights Gained Related to Device Development from the Focus Groups

The audio and visual recordings were successfully transcribed, coded, clustered, and interpreted into meaningful findings. All three focus groups' participants expressed unique needs for, and applications of, the three identified devices. The participants were insightful regarding the physical design, overall concept, and commercial markets for the devices, both identifying and nullifying ideas within these areas. The research team found several common themes that were identified throughout all of the focus groups. See Table 6 for examples of the identified themes, advice, and changes recommended by focus group participants.

Most importantly, these insights would have been difficult to derive without the input from the focus group participants. The three sessions provided achieved consensus on several key points, while also producing several new insights and ideas. Had fewer focus groups been held, important information would have been missed. Since the three focus groups never reached the point where new information was not provided, the additional focus groups scheduled for the next stage of developmental feedback will likely yield further new ideas.

The audio portion of the recording allowed for good transcription of the interpreters' oral translations. While the visual recordings were not of the highest quality, they were sufficient to supplement the audio recordings, to observe interactions and dynamics among the focus group participants, and to permit the participants' signs to be deciphered and the overall messages to be understood. Better lighting, however, would have ensured better accuracy and better teaching materials.

Outcomes and Benefits

This study has been successful in meeting our goal of teaching doctoral students how to overcome language and cultural barriers in order to engage the anticipated end users of their discoveries in meaningful discussions. Computer science students learned to communicate with, and reach out to, people from different cultural backgrounds. The students created an environment in which deaf and hard-of-hearing participants felt comfortable and where their collaboration was genuinely appreciated. The participants' understanding of the material and acceptance of the research team was demonstrated by the overwhelming amount of feedback given and the sincere interest shown for helping the students to develop their devices. The students now have the confidence needed to work with people across communication, language, and cultural barriers. They also have learned the value of finding people who can help them make a good first impression through cultural competency, how to create bridges to overcome interpersonal barriers, and the value of good prior planning. The insights they gained from the focus group session expanded the students' awareness of the value of collaborating with the presumed end-users of their devices to gain insights that will better focus their work.

Throughout the course of this study, the research team has accumulated valuable experiences for working with people who are deaf or hard-of-hearing in a focus group setting. The most important recommendations include the following.

1. *Contact leaders who advocate on behalf of people who are deaf and hard-of-hearing.* They are a valuable resource for recruitment, knowledge about the

people to be served, and interpreting needs and services. Having the support of a community leader for a scientist's research can be essential in acquiring the trust of other individuals who have had limited experience with research. For this study, the majority of contacts established were gained through DCS, which has peer associations nationwide.

2. *Become familiar with the people to be served and their culture*. This knowledge allowed this study's researchers to establish better communication and trust with their study participants who were deaf or heard of hearing as well as future collaboration opportunities.
3. *Use professional interpreters when attempting to communicate in the absence of a common language*. For many deaf people, ASL is their primary language. Local advocacy organizations can put researchers in contact with interpreting services and advise the researcher on determining the appropriate level of interpreting expertise to request, so that the interpreters' skills will match the interpreting needs.
4. *Recognize that people who are deaf and hard-of-hearing rely upon more than one form of communication*. It is appropriate to inquire which methods should be provided to accommodate each person best. Since interpreters must be scheduled at least a week in advance, it is essential to inquire about participants' preferred mode of communication well before their arrival at the focus group. This is a critical step since clear communication is federally mandated for the consenting process.
5. *Value a practice session*. In our study, this was the most valuable resource for planning the room layout, interpreter accommodations, positions of recording equipment, and the budget. The practice session also provided the students' with exposure to real life examples of language and cultural considerations before the students gave their presentations.
6. *Invest in good video and audio recording devices*. A high quality audio recording and a high-resolution camera make clear transcriptions possible, a particularly important concern when the fine hand and finger movements of ASL must be understood. Having a person take field notes can also enrich the interpretation of the transcription.
7. *Have a deaf or hard of hearing person assist with focus group facilitation*. This will help participants feel more comfortable and be more willing to share their ideas and opinions.
8. *Recognize the many characteristics among people who are deaf or hard-of-hearing*. Such characteristics can create diverse communication accommodation needs, as well as diverse opinions. One option is to group together participants with like accommodation needs to facilitate intra-group communication. Alternatively, since people with different hearing challenges might think of different applications for the same device, bringing people with diverse characteristics together is likely to expand the ideas raised for discussion. Having more diversity within this study's focus groups allowed participants to gain insights from each other, as one group recognized a value in an aspect of a device that the others had not considered.

Conclusion

Teaching tomorrow's computer science researchers how to work across communication, language, and cultural barriers to reach the intended end-users of their discoveries enriches students' learning, while helping them to create devices that will better serve their end-users. When the intended end-user is a person who is deaf or hard-of-hearing, special accommodations must be considered. This study demonstrates the value of collaborating with intended end-users and prior preparation for doing so. It offers specific strategies that all researchers who seek to improve the well-being and quality of life of people who are deaf or hard-of-hearing can employ.

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References

Barnett, S. (2002). Communication with deaf and hard-of-hearing people: A guide for medical education. *Academic Medicine: Journal of the Association of American Medical Colleges, 77*, 694-700.

Cole, B. L. (2004). The handicap of abnormal colour vision. Clinical & Experimental Optometry: *Journal of the Australian Optometrical Association, 87*, 258-275.

Eckhardt, E., & Anastas, J. (2006). Research methods with disabled populations. *Journal of Social Work in Disability & Rehabilitation, 6*, 233-249.

Farber, J. H., Nakaji, M. C., & Sadler, G. R. (2004). Medical students, deaf patients and cancer. *Medical Education, 38*, 1201.

Gray, P. (2002). *Psychology* (4th ed.). New York: Worth.

Iezzoni, L., O'Day, B., Killeen, M., & Harker, H. (2004). Communicating about health care: observations from persons who are deaf or hard-of-hearing. *Annals of Internal Medicine, 140*, 356-362.

Kaskowitz, S. R., Nakaji, M., Clark, K., Gunsauls, D., & Sadler, G. (2006). Bringing prostate cancer education to deaf men. *Cancer Detection and Prevention, 30*, 439-448.

Lane, H. (2002). Do deaf people have a disability? *Sign Language Studies, 2*, 356-379.

Lane, H. (2005). Ethnicity, ethics, and the deaf-world. *Journal of Deaf Studies and Deaf Education, 10*, 291-310.

Levy, N. (2002). Deafness, culture, and choice. *Journal of Medical Ethics, 28*, 284-285.

Meador, H., & Zazove, P. (2005). Health care interactions with deaf culture. *The Journal of the American Board of Family Practice, 18*, 218-222.

Merrell, J., Kinsella, F., Murphy, F., Philpin, S., & Ali, A. (2006). Accessibility and equity of health and social care services: Exploring the views and experiences of Bangladeshi carers in South Wales, UK. *Health & Social Care in the Community, 14,* 197-205.

Munoz-Baell, I., & Ruiz, M. (2000). Empowering the deaf. Let the deaf be deaf. *Journal of Epidemiology and Community Health, 54*(1), 40-44.

Padden, C., & Humphries, T. (1988). *Deaf in America: Voices from a culture*. Cambridge, MA: Harvard University Press.

Phelan, M., & Parkman, S. (1995). How to work with an interpreter. *British Medical Journal, 311*, 555-557.

Pleis, J. R., & Lethbridge-Cejku, M. (2006). *Summary health statistics for U.S. adults: National health interview survey, 2005*. Washington, DC: U.S. Department of Health and Human Services. (Vital Health Statistics, Series 10). Retrieved July 31, 2008, from http://www.cdc.gov/nchs/

data/series/sr_10/sr10_232.pdf

Pollard, R. (1992). 100 years in psychology and deafness: A centennial retrospective. *Journal of the American Deafness and Rehabilitation Association, 26*(3), 32-46.

Stebnicki, J. A., & Coeling, H. V. (1999). The culture of the deaf. *Journal of Transcultural Nursing: Official Journal of the Transcultural Nursing Society, 10*, 350-357.

Wasserman, S., Pattison, P., & Steinley, D. (2005). Social networks. *Encyclopedia of Statistics in Behavioral Science, 3*, 1866-1871.

Sight Word Recognition Among Young Children At-Risk: Picture-Supported vs. Word-Only

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Abstract: A quasi-experimental design was used to investigate the impact of Picture Communication Symbols (PCS) on sight word recognition by young children identified as 'at risk' for academic and social-behavior difficulties. Ten pre-primer and 10 primer Dolch words were presented to 23 students in the intervention group and 8 students in the control group during interactive games. Assessments occurred at four points and results indicated that children in the control group learned sight words faster under similar conditions of activities and time. These findings are consistent with previous literature and offer further insight into the learning of sight words by this population. Interactive games proved effective with children; they learned quickly over a relatively short time exposure. In the last assessment (word and picture) the intervention group performed better than the control group, indicating that pictures assisted young children to identify and learn new words in a relatively short period of time.

Key Words: Early intervention, Emergent literacy, Assistive technology, Picture communication symbols, Sight word recognition

A number of emergent literacy skills have been deemed to be of importance for future reading development (Clay, 1975; National Reading Panel, 2000; Teale & Sulzby, 1986). These include phonemic awareness, alphabetic principle, fluency, concepts about print, vocabulary development, and comprehension (. Collectively, these skills provide the foundation for the development of reading which is fundamental for independence in our society (International Reading Association [IRA] & National Association for the Education of Young Children [NAEYC], 1996).

According to Karchmer, Mallette, and Leu (2003) traditional understanding of emergent literacy skill development and effective strategies for teaching these skills must continually be examined from a comprehensive perspective (Kamil, Intrator, & Kim, 2000; Lankshear & Knobel, 2003; Neuman & Dickinson, 2001). Such a perspective must, of necessity, consider that young children are exposed to and use an array of technologies in their daily lives (Loveless & Dore, 2002; McGee & Richgels, 2006; Stephen & Plowman, 2003), and that their experiences with technologies transform the very nature of literacy (Anderson, Grant, & Speck, 2008; Jonassen, Howland, Moore, & Marra, 2003; Turbill & Murray, 2006). More specifically, the multimodal demands of interacting with technologies, even at an early age, require education professionals to rethink how emergent literacy skills are developed (Jewitt, 2006; Turbill & Murray).

A comprehensive perspective that embraces the idea that young children are already learning about the world around them and developing understandings of the importance of print must also give credence to the evidence supporting the use of particular technologies used by teachers with young children (Campbell, Milbourne, Dugan, &

Wilcox, 2006; Dunst, Trivette, & Cutspec, 2002; Justice & Pullen, 2003; Lankshear & Knobel, 2003; Odom et al., 2005; Parette, Peterson-Karlan, Wojcik, & Bardi, 2007). That is, the question must be asked, "Does the technology tool have an impact on children's acquisition of targeted emergent literacy skills that are important for later reading success?"

Admittedly, technology applications for typical, 'at-risk' young children, and those with disabilities, have drawn increasing attention from professionals world-wide (Casey, 2000; Jewitt, 2006; Loveless & Dore, 2002; Mistrett, 2004; Mistrett, Lane, & Ruffino, 2005; Siraj-Blatchford, 2004). Such applications hold great potential to facilitate the development of an array of developmental skills, particularly in the area of emergent literacy (Anderson et al., 2008; Bowes & Wepner, 2004; Casey, 2000; Hutinger, Bell, Daytner, & Johanson, 2006; Karchmer et al., 2003; Siraj-Blatchford & Whitebread, 2003). Specific technology applications have been developed, marketed, and routinely used in preschool settings both in the U.S. and abroad for supporting emergent literacy skill development (e.g., Boardmaker™ with Speaking Dynamically Pro®; Judge, 2006; Karemaker, Pitchford, & O'Malley, 2008; Parette, Watts, & Stoner, 2005-2007), though little is known about the effectiveness of such tools to mediate children's emergent literacy learning. Typically, these tools require multimodal involvement of the learner (i.e., images, color, and other elements are often presented in tandem with text; Jewitt, 2006), and education professionals currently have limited understanding of how the learning of emergent literacy skills (e.g., word recognition) is affected by the current presence and use of technologies in young children's daily lives.

Symbol Usage in Emergent Literacy Classroom Practices

Graphic symbols such as those in Boardmaker™ (Mayer-Johnson, 2006) are frequently used in early childhood education settings in tandem with strategies for teaching emergent literacy skills (Antonius & Zeijdel, 2007; Giovanetti, 2006; Spencer, 2002). Work conducted in the field regarding the use of symbols has focused primarily on an analysis of symbol learnability and complexity (Fuller & Lloyd, 1987; Soto, Cassidy, & Madanat, 1996). Essentially, a symbol is something "that stands for or represents something else" (Vanderheiden & Yoder, 1986, p. 15). The *something else* is the symbol's 'referent.' Early work examining symbols and their referents has suggested a continuum of symbols that range from *transparent* (i.e., easily guessed in the absence of a referent) to *translucent* (i.e., the referent's meaning may or may not be obvious but the relationship can be perceived once the meaning is provided) to *opaque* (i.e., no relationship is evident even when the symbol's meaning is known; Fuller & Lloyd; Lloyd, Fuller, & Arvidson, 1997; Soto et al.; Schlosser, 1997a, b). Picture Communication Symbols (PCS) found in Boardmaker™ (Antonius & Zeijdel, 2007; de Graft-Hanson, 2006; Judge, 2006) have been found to be easily learned when transparent or translucent relationships between symbol and referent exist (Fuller & Lloyd; Mizuko, 1987; Soto et al.). These symbols are a set of color and black and white drawings developed by Mayer-Johnson, LLC for use in augmentative and alternative communication (AAC) systems (Mayer-Johnson, 2008).

Sight Word Reading and Technology Applications

Of particular importance in developing early reading foundation skills is the development of 'sight word' reading competencies. Reading sight words is necessary for young children's independence, safety, and more mature reading experiences as they grow older and progress in the public school curriculum (Carnine, Silbert, Kame'enui, & Tarver, 2004; Ehri, 2005; National Reading Panel, 2000; Rivera, Koorland, & Fueyo, 2002). Browder and D'Huyvetters (1988) defined sight word reading as a discrete, observable response that is controlled by a printed stimulus. Sight words are lists of words that (a) are recognized without mediation or phonetic analysis (Browder & Lalli, 1991); (b) can be read from memory; and (c) include not only high-frequency words but any words that can be "read from memory" (Ehri, p. 169).

Early work by Samuels (1967) suggested that in teaching sight words to beginning readers, less efficient learning occurs when a new word to be learned is accompanied by related pictures. Samuels argued that this could be detrimental to learning new words since the child would depend on the extra cues to anticipate an unknown word. Thus, as Hill (1995) noted, appropriate responses to the graphic features of the word might not be acquired, or 'blocked' (Didden, Prinsen, & Sigafoos, 2000; Fossett & Mirenda, 2006) and incorrect responses may occur, particularly if the child depends on the 'extra cues' to anticipate the unknown word.

Singer, Samuels, and Spiroff (1973) compared three procedures for introducing new words, including words (a) in isolation; (b) in sentences (context); and (c) with pictures. Typically comparing two groups--one in which a picture appeared with each word and one without pictures--the investigators found that context and picture cues slowed acquisition of new word acquisition. When pictures accompanied the words, students required longer to reach criterion and made more errors than when pictures were not present. Later reports confirmed these findings (Center for Literacy and Disability Studies, n.d.; Fossett & Mirenda, 2006; Saunders & Solman, 1984; Singh & Solman, 1990).

Such findings are interesting, however, when we recognize that most young children are immersed in interactions with technology every day that present multimodal learning opportunities (e.g., large screen televisions and programming that is language-based; computer programs available in home settings; play with electronic toys and games; Bowman & Beyer, 1994; Jewitt, 2006; Loveless & Dore, 2002). This is sometimes true with Boardmaker™ when learning activities are designed for presentation on computer screens or projected onto large screens using LCD projectors (Blum, Watts, & Parette, 2008; Parette, Blum, Boeckmann, & Watts, in press; Parette, Hourcade, Boeckmann, & Blum, in press). Thus, another perspective to understand how children learn sight words is that learning is enhanced when pictures, such as those provided using Boardmaker™, are paired with words to be learned (Goodman, 1965). Using this reasoning, Denberg (1976-1977) commented,

> pictures are introduced, not to supplant print but to provide one additional source of information from which the beginner can sample as he reads. Increasing the amount of available information through the medium of pictures is shown to have a strong facilitative effect on word identification in context and a smaller, though significant, facilitative effect on word learning. (p. 176)

Limited support for this position has been reported in the professional literature (Elman, 1973; Montare, Elman, & Cohen, 1978).

Hill (1995) recommends that Samuel's (1967) theory appears to be preferable as a model for teaching non-readers of normal ability new words. In comparing typical children to those with Down syndrome and learning disabilities, sight vocabulary was observed to be learned most efficiently by all participants when the target word was presented in isolation (Hill). Similar findings have been reported in studies conducted with children with disabilities to teach sight words (Burns, 2007; Conley, Derby, Roberts-Gwinn, Weber, & McLaughlin, 2004; Didden, de Graaff, Nelemans, & Vooren, 2006; Fossett & Mirenda, 2006).

Dolch sight words in the preschool classroom. For young children identified as being 'at-risk,' teaching sight word recognition may require explicit skill instruction on the part of education professionals (Ehri, 2005; Lee & Vail, 2005; Stahl, McKena, & Pagnucco, 1994). Boardmaker™ can be used to develop materials used for the teaching of sight words. The National Reading Panel (2000) has recommended that vocabulary "be taught both directly and indirectly" and that "dependence on a single vocabulary instruction method will not result in optimal learning" (p. 14). Even more importantly, the National Reading Panel observed that there was a paucity of research regarding effective instructional methods for vocabulary instruction and subsequent measurement of vocabulary growth.

The most frequently used list to teach sight words is the Dolch List (Dolch, 1936; Rivera et al., 2002). The original Dolch list contained 220 words and if one can read all of those words, one can read at a third grade level (Dolch, 1948). These vocabulary words continue to be prevalent in curricula materials used in early childhood education settings nationally (Rivera et al.; Squidoo, LLC, 2008), and are often paired with pictures when teaching young children, both with and without disabilities. However, there is a recurring finding of a lack of consistent positive effects of images on learning (Answers.com, 2007), which is influenced markedly by the kind of image that is used. A review of studies examining type of image usage (i.e., decorative or conceptually relevant) reported that 'decorative illustrations' were found to lead to the smallest improvements and sometimes negative effects in learning (Levin, Anglin, & Carney, 1987). Such 'decorative' illustrations are found in frequently used technology applications such as Boardmaker™ with Speaking Dynamically Pro® (Duffie & McGinn, 2005) which may be used to teach sight words.

Since classrooms across the country often use technologies such as Boardmaker™ with Speaking Dynamically Pro® to develop classroom instructional materials and teach emergent literacy skills (Antonius & Zeijdel, 2007; Judge, 2006), it begs the following research questions:

1. What is the impact of use of PCS found in Boardmaker™ on sight word recognition by young children 'at risk'?
2. Will providing the written word and a PCS of a sight word compared to providing only the written word increase children identifications of a set of sight words?

Method

Participants

Children participating in the study were from a Midwestern city, were aged 4-5 years, and attended seven different preschool classrooms for children 'at risk.' Children were identified as being at risk based on a three-pronged process including administrations of (a) the Developmental Indicators for Assessment for Learning-3 (DIAL-3; Mardell-Czudnowski & Goldenberg, 1998); (b) the Preschool Phonological Screening section of the Hodson Assessment of Phonological Patterns-3 (HAPP-3; Hodson, 2004); and (c) a

Table 1
Participant Assessment Data

Group	Gender *n* Male	*n* Female	ROWPVT *Avg* Standard Score	EOWPVT *Avg* Standard Score
Control	4	4	98	94
Intervention	19	7	96	90

screening checklist that is a composite of common risk factors (i.e., exposure to drugs or alcohol during pregnancy, premature birth, violence in the home, frequent hospitalizations, low income family, and other factors). Children identified as being at risk performed at least one standard deviation below the norm in two domains of the DIAL-3, or satisfied any two of the following criteria: (a) score of one standard deviation below the norm in a domain on the DIAL-3; (b) exhibit at least four risk factors on the screening checklist; or (c) perform one standard deviation below the norm on the Preschool Phonological Screening of the HAPP-3. All students were participating in the Making A Difference Using Assistive Technology (MDAT) project, a three-year grant funded by the Illinois Children's Healthcare Foundation (Parette, Watts, & Stoner, 2005-2007). This project provided AT toolkits (Edyburn, 2000) to 10 classrooms to help develop children's emergent literacy skills, though project activities did not specifically focus on teaching the children sight words. The toolkit contained a (a) Dell™ personal computer and keyboard, (b) microphone, (c) scanner, (d) digital camera, and (e) ceiling-mounted projection system with Bluetooth keyboard and wireless mouse. Software included in the AT toolkit included Office 2003 (Microsoft®, 2003); Intellitools® Classroom Suite (Cambium Learning Technologies, 2006); Boardmaker™ with Speaking Dynamically Pro® (Mayer-Johnson, 2006); Writing with Symbols 2000 (Widget Software ltd., 2007); and Clicker® 5 (Crick Software, 2007).

As part of the larger MDAT project, all participants had completed the Expressive One Word Picture Vocabulary Test (EOWPVT; Academic Therapy Publiscations, 2000a), and the Receptive One Word Picture Vocabulary Test (ROWPVT; Academic Therapy Publications, 2000b). Participants' demographic information and assessment data are provided in Table 1. Children were randomly assigned to either a control (n = 8) or intervention (n = 23) group. EOWPVT and ROWPVT assessments indicated that control and intervention groups had similar expressive and receptive vocabulary ability at the beginning of the study.

Setting and Materials

All assessments and training sessions were conducted in a quiet place outside of the classroom. Since the participants ranged in age from 4 to 5 years, 10 pre-primer and 10 primer Dolch words were selected to be presented to the participants during each session. See Table 2 for the complete list of the 20 words.

Two sets of stimuli cards were developed for presentation to the participants. One set consisted of the printed Dolch word, in 12-point font, on a 2 x 2 in laminated card. The other set consisted of the printed Dolch word, in 12-point font, with a corresponding picture created from Boardmaker™. Pictures were chosen from the picture communication (PCS) symbols generated by Boardmaker™ based on 'concreteness' of the symbol. The control group played games that used only the

Table 2
Percentage of Correctly Read Words Across Assessments

Intervention					Control			
Word	% Baseline	% Mid	% Post-Word	% Post-Picture	% Baseline	% Mid	% Post-Word	% Post-Picture
A	30.4	68.4	65	70	37.5	87.5	87.5	87.5
He	0	0	0	56.5	12.5	25	25	42.9
His	0	5.2	0	30.4	0	25	0	0
I	39.1	42.1	60	65.2	12.5	100	87.5	100
In	0	5.2	0	43.5	25	12.5	25	57.1
On	0	0	10	43.5	0	12.5	12.5	14.3
Said	4.3	10.5	5	47.8	0	0	25	28.6
She	0	0	20	65.2	12.5	12.5	12.5	85.7
They	0	0	0	69.6	0	0	0	14.3
You	0	5.2	15	73.9	0	25	25	42.9
To	0	0	5	52.5	12.5	12.5	37.5	28.6
And	4.3	5.2	0	35	12.5	12.5	12.5	28.6
But	4.3	5.2	35	91.3	0	0	25	57.1
For	0	0	5	78.3	12.5	12.5	12.5	42.9
Had	0	0	0	43.5	0	0	0	71.4
It	4.3	0	0	35	0	0	0	14.3
Of	4.3	0	5	21.7	0	12.5	0	14.3
That	0	0	0	17.4	0	0	12.5	14.3
The	0	5.2	0	8.7	0	0	0	0
Was	4.3	5.2	5	21.7	0	12.5	12.5	14.3
Total	5	8.2	11.5	48.5	6.9	16.9	20.6	37.8

written words and the intervention groups used the same games; however, in addition to the written word a corresponding picture created from Boardmaker™ was included. Two games--*Bingo* and *Shake, Drop, and Roll*--were played during the training sessions. Sessions lasting 15 min were conducted twice a week with each group.

Experimental Design

A quasi-experimental, non-equivalent control group pretest-posttest design was used (Campbell & Stanley, 1966). Dependent measures were correct oral reading of the targeted Dolch words. Four assessments were conducted during the study for both intervention and control groups. In each assessment children were asked, individually, to read the 20 sight words. Each word was typed on a separate 2 x 2 in laminated card. The assessments were administered at (a) baseline; (b) mid intervention (i.e., two wks after beginning the study); (c) post assessment using the written word only with both groups (i.e., four wks after the beginning of the study); and (d) post assessment using the written word and the corresponding picture (i.e., four wks after the beginning of the study) with both groups. All assessments were audio-taped.

Procedure

Each control and intervention group was further divided into smaller groups of two or three children. Six graduate student clinicians from the Department of Communication Sciences and Disorders were trained in the procedures and conducted all assessment and intervention sessions twice a week. Supervision was provided by a certified speech and language pathologist who is also a faculty member in the Department of Special Education. Intervention sessions consisted of playing either *Bingo* or *Shake, Roll, and Find* with the 20 targeted Dolch reading words. All reading words were used during each session.

Before each game, the clinician would read each card to the students and have each student repeat the word. The games played during each training session were the same for the entire week and then alternated the following weeks. *Bingo* was played by providing each small group with a *Bingo* card that had either the word paired with picture printed (intervention groups) or only the printed word (control groups). The clinician conducting the training session shook the cards in a large plastic jar, allowed each student to select one, and asked the student to read it. If the child could not read the word the clinician said the word and asked the child to repeat. The procedure continued until all 20 Dolch words were read.

Shake, Drop, and Roll was played by providing each small group with a game card that consisted of one row of six spaces with corresponding die pictures and one row with blank spaces. The clinician randomly laid the reading cards face down (with pictures for the intervention groups and without pictures for the control groups) and the student rolled the die. The clinician would then turn over the corresponding reading word and ask the student to read the word. If the child could not read the word the clinician said the word and asked the child to repeat. Before the next student's turn the card would be replaced with another. This procedure continued until all 20 words had been read.

Fidelity and Reliability

To ensure fidelity of treatment graduate students were trained on all procedures prior to the beginning of the study. In addition, graduate students checked each step of the protocol (i.e., procedural checklist) as it was completed for integrity of procedures per session; 100% of procedure steps were completed. In addition, 50% of all sessions across groups and graduate student clinicians were randomly chosen for fidelity of treatment checks. A faculty member from the Department of Special Education completed the procedural checklist and checked for agreements. Procedural fidelity across groups and clinicians was 97%.

Social Validation

All students were interviewed at the end of the study. Students in the control group were asked : (a) Did you like the games that we played? (b) What did you like about them? (c) Which one did you like the most? and (d) Do you think the games helped you to learn the words on the cards? All but one student in the control group responded positively when asked if he or she liked the games and an equal number of students identified *Bingo* and *Shake, Drop, and Roll* as their favorites. When asked if the games helped them learn the words on the cards, all students responded 'yes.'

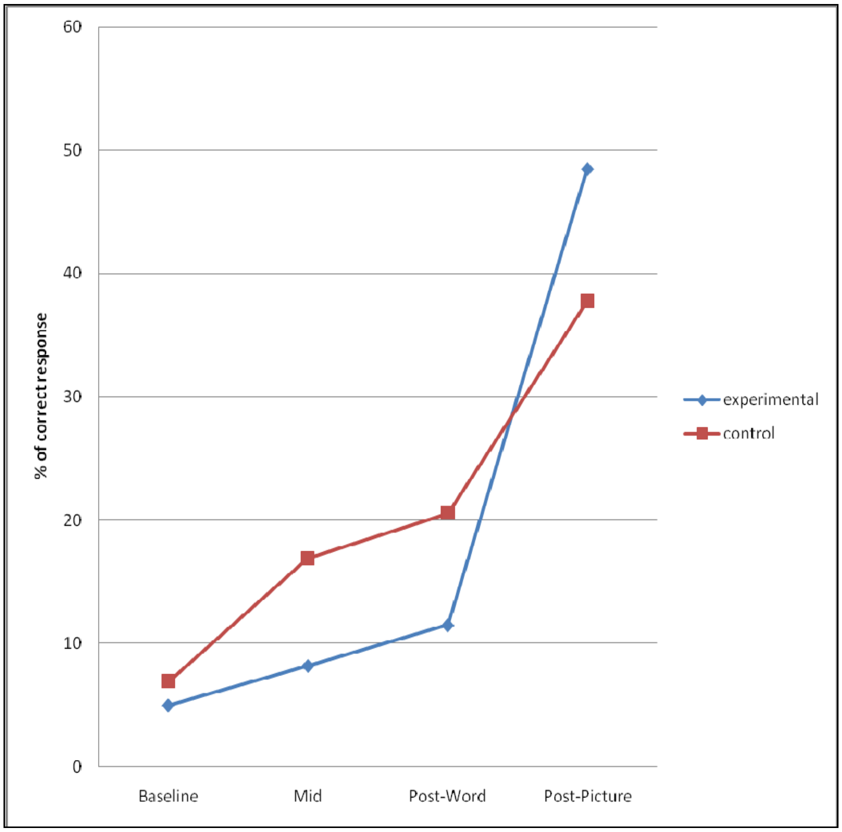

Figure 1. Percentage of correct words across treatment conditions.

Students in the intervention group were asked: (a) Did you like the games that we played? (b) What did you like about them? (c) Which one did you like the most? (d) Do you think the games helped you to learn the words on the cards? (e) Did you like having pictures with the words? and (f) Did the pictures help you learn the words? Why?

Twenty-two students in the intervention group reported liking the games and three stated they did not. *Shake, Drop, and Roll* appeared to be the favorite game of the intervention group, due primarily to the engagement of children in the task of rolling a die. All but 2 students thought the games helped them learn the words and all but 1 student reported liking the pictures with the words. When asked if the pictures helped them learn the words all but one student said 'yes.' One student comment, "because the pictures made me smarter," illustrated the student perspective that pictures assisted with reading the words. Regardless of the condition (intervention or control), the children were engaged in playing games with the clinicians and appeared to enjoy their interactions.

Responses to questions about social validity were audio-taped and hand written by the clinicians who were working with each group of students; the audio-taped responses were transcribed by a graduate student not involved in the acquisition of the data and compared to the hand-written transcripts of the clinicians. Reliability was 100%.

Results

The number and percentage of correct responses (reading Dolch words) in each of the four assessments (baseline, mid intervention, post intervention, and post intervention with pictures) for each of the 20 Dolch words is presented in Table 2. Figure 1 presents the

percentage of correct answers across all Dolch words. During baseline, children in the control group on average correctly read 6.9% of the words and children in the intervention group correctly read 5% of the words. In the mid intervention assessment the control group read 16.9% and the intervention group read 8.2% of the words. In the first post assessment (only written words) the control group read 20.6% and the intervention group read 11.5% of the words. In the final assessment (written word and its corresponding picture) the control group read 37.8% and intervention group read 48.5% of the words. Overall, the control group participants learned faster and read more words in assessment 3 (post with only words). During assessment 4 (words + picture) the intervention group read more words correctly.

Outcomes and Benefits

The finding that children in the control group learned selected Dolch sight words faster under similar conditions of activities and time is consistent with previous literature investigating the influence of pictures when learning sight words (Center for Literacy and Disability Studies, n.d.; Fossett & Mirenda, 2006; Saunders & Solman, 1984; Singer, Samuels, & Spiroff, 1973; Singh & Solman, 1990). However, despite these findings, some research supports the practice of pairing sight word learning with pictures (Arlin, Scott, & Webster, 1978; Elman, 1973). When working with students who have disabilities, in particular, pictures do appear to support sight word learning when used in conjunction with specific instructional strategies (Browder & Lalli, 1991). It may be that this recognition underpins ongoing classroom practices nationwide that reflect the use of pictures in teaching sight words (cf. abcteach, 2001-2008; About, Inc., 2007; Squidoo, LLC, 2008). To some extent it may also be that the gap between evidence-based research and practice remains quite wide, and findings in the field continue to be ignored or poorly disseminated to practitioners (Peterson-Karlan & Parette, 2007).

However, this study offers further insight into the learning of sight words with a specific population, i.e., young children identified as being 'at risk.' In this study, all children did learn during interactive games and reported enjoyment with participation. The interactive games used with these children who are at risk for academic and social-behavior difficulties proved effective for learning sight words and students in the current study learned quickly over a relatively short exposure time (i.e., four wks).

Additionally, in the last assessment (word and picture) the intervention group performed better than the control group. This appears to indicate that the pictures did help the young children to identify and learn new words in a relatively short period of time; however, the results suggest that practicing sight words with a picture and word might be best beneficial when testing occurs with a picture and word. Interestingly, all the children but one in the intervention group reported that pictures helped them learn the sight words. It is possible that the children became dependent on the pictures and therefore identified more words correctly in the fourth assessment (i.e., word and picture) compared to the third assessment (i.e., word only). However, the intervention period was very short. In addition to the short period of intervention, the limitations of this study include the relatively small number of participants, the unbalanced number of participants in the control and intervention groups, and the absence of a fading phase for the pictures. Future outcomes research should be conducted to determine if a fading phase for the picture component would facilitate learning. Alternatively, the question should be asked by early childhood education professionals, "Do we really want to fade the pictures at this point with this group of children?" It may be that the next step is to teach these words in the context of a sentence and only at a later point fade the pictures. More research in this area is needed.

In discussing the implications of research involving students with disabilities, Browder and Lalli (1991) observed that education professionals should "consider simplicity, as well as effectiveness" (p. 226). Some early childhood teachers are 'early adopters,' i.e., they will embrace the use of technology early in their careers and utilize these important learning support tools routinely in their classrooms (Parette & Stoner, 2008). Other teachers will be 'later adopters,' i.e., they will use technology less willingly, if at all (Parette & Stoner). Since studies have shown that sight word learning occurs *both* with and without the use of pictures, and in light of the widespread development of technology applications marketed to early childhood professionals and used in classrooms nationwide, it remains important for early childhood professionals to continually examine outcomes of their classroom practices on the development of emergent literacy skills among children.

Also, as Flynn (1994) has observed, changes in general intelligence have occurred over time, suggesting "the continuing capacity of the human brain to respond to increasing novelty and complexity in the environment" (Siraj-Blatchford & Whitebread, 2004, p. 18). Given that children in today's society are exposed to and use technology in very different ways than in generations past, it is especially critical that we continue to question whether past knowledge about child learning continues to hold true in the technology-rich world in which they live.

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References

abcteach. (2001-2008). *Dolch word cards.* Retrieved July 18, 2008, from http://abcteach.com/directory/basics/abc_activities/dolch_word_cards/

About, Inc. (2007). *Top nine ways to develop early sight words at home.* Retrieved July 31, 2008, from http://learningdisabilities.about.com/od/infancyandearlychildhood/tp/earlysightword.ht

Academic Therapy Publications. (2000a). *Expressive One-Word Picture Vocabulary Test.* Novato, CA: Author.

Academic Therapy Publications. (2000b). *Receptive One-Word Picture Vocabulary Test.* Novato, CA: Author.

Anderson, R. S., Grant, M. M., & Speck, B. W. (2008). *Technology to teach literacy. A resource for K-8 teachers* (2nd ed.). Upper Saddle River, NJ: Pearson Merrill/Prentice Hall.

Answers.com. (2007). *Literacy: Learning from multimedia sources* [Electronic Version]. Retrieved October 9, 2007, from http://www.answers.com/topic/literacy-learning-from-multimedia-sources

Antonius, K., & Zeijdel, C. (2007). Supporting active participation in literacy using Boardmaker Plus. *Closing the Gap, 25*(5), 12-14.

Arlin, M., Scott, M., & Webster, J. (1978). The effects of pictures on rate of learning sight words: a critique of the focal attention hypothesis. *Reading Research Quarterly, 14*, 645-660.

Blum, C., Watts, E. H., & Parette, H. P. (2008). *Teaching phonological awareness to at risk preschool children: An initial evaluation of* *outcomes for a Microsoft® PowerPoint TM-based curriculum with a LCD projection system*. Manuscript submitted for publication.

Bowes, K. A., & Wepner, S. B. (2004). Issues in technology. Using assistive technology for literacy development. *Reading and Writing Quarterly, 20*, 219-223.

Bowman, B. T., & Beyer, E. R. (1994).Thoughts on technology and early childhood education. In J. L. Wright & D. D. Shade (Eds.), *Young children: Active learners in a technological age*. Washington, DC: National Association for the Education of Young Children.

Browder, D. M., & D'Huyvetters, K. K. (1988). An evaluation of transfer of stimulus control and of comprehension in sight word reading for children with mental retardation and emotional disturbance. *School Psychology Review, 17*, 331-342

Browder, D., & Lalli, J. (1991). Review of research on sight word instruction. *Research in Developmental Disabilities, 12*, 203–228.

Burns, M. K. (2007). Comparison of opportunities to respond within a drill model when rehearsing sight words with a child with mental retardation. *School Psychology Quarterly, 22*, 250-263.

Cambium Learning Technologies. (2006). *Intellitools classroom suite* [Computer software]. Petaluma, CA: Intellitools.

Campbell, P. H., Milbourne, S., Dugan, L. M., & Wilcox, M. J. (2006). A review of evidence on practices for teaching young children to use assistive technology devices. *Topics in Early Childhood Special Education, 26*(1), 3-13.

Carnine, D. W., Silbert, J., Kame'enui, E., & Tarver, S. G. (2004). *Direct instruction reading* (4th ed.). Upper Saddle River, NJ: Pearson.

Casey, J. M. (Ed.). (2000). *Early literacy. The empowerment of technology*. Englewood, CO: Greenwood Publishing Group.

Center for Literacy and Disability Studies. (n.d.). *The use of pictures in early reading instruction* (Research to Practice Brief). Chapel Hill, NC: Author.

Clay, M. M. (1975). *What did I write?* Auckland, New Zealand: Heinemann.

Conley, C. M., Derby, K., Roberts-Gwinn, M., Weber, K. P., & McLaughlin, T. (2004). An analysis of initial acquisition and maintenance of sight words following picture matching and copy, cover, and compare teaching methods. *Journal of Applied Behavior Analysis, 37,* 339-350.

Crick Software. (2007). *Clicker 5* [Computer software]. Westport, CT: Author.

de Graft-Hanson, C. (2006). Supporting speech and language development with technology. *Closing the Gap, 25*(4), 9-10.

Denberg, S. D. (1976-1977). The interaction of picture and print in reading instruction. *Reading Research Quarterly, 12*, 176-189.

Didden, R., de Graaff, S., Nelemans, M., & Vooren, M. (2006). Teaching Sight Words to Children With Moderate to Mild Mental Retardation: Comparison Between Instructional Procedures. *American Journal on Mental Retardation, 111*, 357-365.

Didden, R., Prinsen, H., & Sigafoos, J. (2000). The blocking effect of pictorial prompts on sight-word reading. *Journal of Applied Behavior Analysis, 33*, 317-320.

Dolch, E. W. (1936). A basic sight vocabulary. *Elementary School Journal, 36*, 456-460.

Dolch, E. W. (1948). *Problems in reading.* Champaign, IL: Garrard Press.

Duffie, P., & McGinn, M. (2005). Hooray for the USA: Integrating technology into the curriculum. *Closing The Gap, 24*(1), 16-17.

Dunst, C. J., Trivette, C. M., & Cutspec, P. A. (2002). Toward an operational definition of evidence-based practices. *Centerscope, 1*(1), 1-10.

Edyburn, D. L. (2000). Assistive technology and students with mild disabilities. *Focus on Exceptional Children, 32*(9), 1-23.

Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading, 9*, 167-188.

Elman, E. (1973). *The effect of pictures on the acquisition and retention of sight words.*

Unpublished Master's thesis, Rutgers University, The State University of New Jersey, Camden.

Fossett, B., & Mirenda, P. (2006). Sight word reading in children with developmental disabilities: A comparison of paired associate and picture-to-text matching instruction. *Research in Developmental Disabilities: A Multidisciplinary Journal, 27*, 411-429.

Fuller, D. R., & Lloyd, L. L. (1987). A study of physical and semantic characteristics of a graphic symbol system as predictors of perceived complexity. *Augmentative and Alternative Communication, 3*, 26-35.

Giovanetti, L. (2006). Literacy supports for children on the autism spectrum. *Closing the Gap, 25*(2), 1, 10-12.

Goodman, K. S. (1965). A linguistic study of cues and miscues in reading. *Elementary English, 42*, 639-643.

Hill, L. (1995). An exploratory study to investigate different methods for teaching sight vocabulary to people with learning disabilities of differing aetiologies. Down Syndrome *Research and Practice, 3*(1), 23-28.

Hodson, B. W. (2004). *Hodson Assessment of Phonological Patterns* (3rd ed.). Greeville, SC: Super Duper® Publications.

Hutinger, P. L., Bell, C., Daytner, G., & Johanson, J. (2006). Establishing and maintaining an early childhood emergent literacy curriculum. *Journal of Special Education Technology, 21*(4), 39-54.

Illinois State Board of Education. (2004). *Illinois prekindergarten program for children at risk of academic failure FY 2003 Evaluation report*. Springfield, IL: Author. Retrieved July 31, 2008, from http://isbe.state.il.us/research/pdfs/prek_evaluation.pdf

Illinois State Board of Education. (2007). *Fiscal year 2006 income eligibility guidelines*. Retrieved September 4, 2007, from http://www.isbe.state.il.us/nutrition/pdf/income_guidelines_06.pdf

International Reading Association and the National Association of Education for Young Children. (1998). Learning to read and write: Developmentally appropriate practices for young children. *The Reading Teacher, 52*, 193-216.

Jewitt, C. (2006). *Technology, literacy and learning. A multimodal approach*. New York: Routledge.

Jonassen, D. H., Howland, J., Moore, J., & Marra, R. M. (2003). *Learning to solve problems with technology. A constructivist approach*. Upper Saddle River, NJ: Merrill Prentice Hall.

Judge, S. (2006). Constructing an assistive technology toolkit for young children: Views from the field. *Journal of Special Education Technology, 21*(4), 17-24.

Justice, L. M., & Pullen, P. C. (2003). Promising interventions for promoting emergent literacy skills: Three evidence-based approaches. *Topics in Early Childhood Special Education, 23*(3), 99-113.

Kamil, M. L., Intrator, S. M., & Kim, H. S. (2000). The effects of other technologies on literacy and literacy learning. In M. H. Kamil, P. B. Mosenthal, P. D. Pearson & R. Barr (Eds.), *Handbook of reading research* (Vol. III, pp. 771-787). Mahwah, NJ: Earlbaum.

Karchmer, R. A., Mallette, M. H., & Leu, D. J. (2003). Early literacy in a digital age. Moving from a singular book literacy to the multiple literacies of networked information and communication technologies. In D. M. Barone & L. M. Morrow (Eds.), *Literacy and young children. Research-based practices* (pp. 175-194). New York: Guilford.

Karemaker, A., Pitchford, N. J., & O'Malley, C. (2008). Using whole-word multimedia software to support literacy acquisition: A comparison with traditional books. Educational and *Child Psychology, 25, 97-118*.

Lee, Y., & Vail, C. O. (2005). Computer-based reading instruction for young children with disabilities. *Journal of Special Education Technology, 20*, 5–18.

Lankshear, C., & Knobel, M. (2003). New technologies in early childhood research:

A review of research. *Journal of Early Childhood Literacy, 3*(1), 59-82.

Levin, J. R., Anglin, G. J., & Carney, R. N. (1987). On empirically validating functions of pictures in prose. In D. M. Willows & H. A. Houghton (Eds.), *The Psychology of Illustration* (Vol. 1, pp. 51-86). New York: Springer.

Lloyd, L. L., Fuller, D. R., & Arvidson, H. H. (Eds.). (1997). *Augmentative and alternative communication. A handbook of principles and practices*. Boston: Allyn and Bacon.

Loveless, A., & Dore, B. (Eds.). (2002). *ICT in the primary school.* Buckingham, England: Open University Press.

Mardell-Czudnowski, C., & Goldenberg, D. S. (1998). *DIAL-3: Developmental Indicators for the Assessment of Learning* -Third Edition. Circle Pines, MN: American Guidance Service.

Mayer-Johnson. (2006). *Boardmaker® with Speaking Dynamically Pro®* [Computer software]. San Diego, CA: Author.

McGee, L. M., & Richgels, D. J. (2006). Can technology support emergent reading and writing? Directions for the future. In M. C. McKenna, L. D. Labbo, R. D. Kieffer & D. Reinking (Eds.), *International handbook of literacy and technology* (Vol. 2, pp. 369-377). Mahwah, NJ: Lawrence Earlbaum Associates.

Microsoft®. (2003). *Office 2003* [Computer software]. Redmond, WA: Author.

Mistrett, S. (2004). Assistive technology helps young children with disabilities participate in daily activities. *Technology in Action, 1*(4), 1-9.

Mistrett, S. G., Lane, S. J., & Ruffino, A. G. (2005). Growing and learning through technology: Birth to five. In D. Edyburn, K. Higgins & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 273-308). Whitefish Bay, WI: Knowledge by Design.

Mizuko, M. I. (1987). Transparency and ease of learning symbols represented by Blissymbols, PCS, and Picsyms. *Augmentative and Alternative Communication, 3*, 129-136.

Montare, A., Elman, E., & Cohen, J. (1978). Words and pictures: A test of Samuels' findings. *Journal of Reading Behaviour, 9*, 269-285.

National Reading Panel. (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction.* Retrieved October 8, 2007, from http://www.nichd.nih.gov/publications/nrp/upload/smallbook_pdf.pdf

Neuman, S. B., & Dickinson, D. K. (Eds.). (2001). *Handbook of early literacy research.* New York: Guilford.

Odom, S. L., Brantlinger, E., Gersten, R., Horner, R. H., Thompson, B., & Harris, K. R. (2005). Research in special education: Scientific methods and evidence-based practices. *Exceptional Children, 71*, 137-148.

Parette, H. P., Blum, C., Boeckmann, C., & Watts, E. H. (in press). Teaching word recognition to young children using Microsoft® PowerPoint™ coupled with direct instruction. *Early Childhood Education Journal.*

Parette, H. P., Hourcade, J. J., Boeckmann, N. M., & Blum, C. (in press). Using Microsoft® PowerPoint™ to support emergent literacy skill development for young children at-risk or who have disabilities. *Early Childhood Education Journal.*

Parette, H. P., Peterson-Karlan, G. R., Wojcik, B. W., & Bardi, N. (2007). Monitor that progress! Monitor that progress! Interpreting data trends for assistive technology decision-making. *Teaching Exceptional Children, 40*(1), 22-29.

Parette, H. P., & Stoner, J. B. (2008). Benefits of assistive technology user groups for early childhood education professionals. *Early Childhood Education Journal, 35*, 313-319.

Parette, H. P., Watts, E. M., & Stoner, J. (2005-2007). *Making a difference using assistive technology (MDAT) project.* Grant funded by the Illinois Children's Healthcare Foundation.

Peterson-Karlan, G. R., & Parette, H. P. (2007). Evidence-based practice and consideration of assistive technology effectiveness and outcomes. *Assistive Technology Outcomes and Benefits, 4*, 130-139.

Rivera, M. O., Koorland, M. A., & Fueyo, V. (2002). Pupil-made pictorial prompts and fading for teaching sight words to a student with learning disabilities. *Education and Treatment of Children, 25*, 197-207.

Samuels, S. J. (1967). Attentional processes in reading: The effects of pictures on the acquisition of reading responses. *Journal of Educational Psychology, 58*, 337-342.

Saunders, R. J., & Solman, R. T. (1984). The effect of pictures on the acquisition of a small vocabulary of similar sight-words. *British Journal of Educational Psychology, 54*, 265-275.

Schlosser, R. W. (1997a). Nomenclature and category levels in graphic AAC symbols. Part I: Is a flower a flower a flower? *Augmentative and Alternative Communication, 13*, 4-13.

Schlosser, R. W. (1997b). Nomenclature and category levels in graphic AAC symbols. Part II: Role of similarity in categorization. *Augmentative and Alternative Communication, 13*, 14-19.

Singer, H., Samuels, S. J., & Spiroff, J. (1973). The effects of pictures and contextual conditions on learning responses to printed words. *Reading Research Quarterly, 9*, 555-567.

Singh, N. N., & Solman, R. T. (1990). A stimulus control analysis of the picture-word problem in children who are mentally retarded: The blocking effect. *Journal of Applied Behavior Analysis, 23*, 525-532.

Siraj-Blatchford, J. (Ed.). (2004). *Developing new technologies for young children*. London: Trentham Books.

Siraj-Blatchford, J., & Whitebread, D. (2003). *Supporting ICT in the early years*. Buckingham, England: Open University Press.

Soto, G., Cassidy, M. J., & Madanat, S. M. (1996). Application of ordered probit techniques to analyze ratings of blissymbol complexity. *Augmentative & Alternative Communication, 12*, 122-126.

Spencer, L. G. (2002). *Comparing the effectiveness of static pictures vs. video modeling on teaching requesting skills to elementary children with autism*. Unpublished doctoral dissertation, Georgia State University, Atlanta, GA.

Squidoo, LLC. (2008). *Teaching the Dolch sight words*. Retrieved July 17, 2008, from http://www.squidoo.com/dolch-sight-words

Stahl, S. A., McKenna, M. C., & Pagnucco, J. R. (1994). The effects of whole-language instruction: An update and a reappraisal. *Educational Psychologist, 29*, 175-185.

Stephen, C., & Plowman, L. (2003). Information and communication technologies in pre-school settings: A review of the literature. *International Journal of Early Years Education, 11*, 223-234.

Teale, W. H., & Sulzby, E. (1986). *Emergent literacy: Writing and reading*. Norwood, NJ: Ablex.

Turbill, J., & Murray, J. (2006). Early literacy and new technologies in Australian schools: Policy, research, and practice. In M. C. McKenna, L. D. Labbo, R. D. Kieffer & D. Reinking (Eds.), *International handbook of literacy and technology* (Vol. 2, pp. 93-108). Mahwah, NJ: Lawrence Earlbaum Associates.

Vanderheiden, G., & Yoder, D. (1986). Overview. In S. Blackstone (Ed.), *Augmentative communication: An introduction* (pp. 1-28). Rockville, MD: American Speech-Language-Hearing Association.

Widget Software Ltd. (2007.). *Writing with Symbols 2000* [Computer software]. Solano Beach, CA: Author.

Technology (AT) Reutilization (Reuse): What We Know Today

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Abstract: The history, scope, and evolving definitions of assistive technology reutilization activities, from both grassroots and legislative perspective, are discussed. A national classification system of AT reuse activities and data gathered from several national surveys of AT reutilization programs using this classification approach are presented. The rationale, benefits, and potential perils of AT reuse are discussed from the viewpoint of suppliers, consumers, agencies, and organizations engaged in AT reutilization activities. Examples of both successful and damaging AT reutilization initiatives are cited with cautionary recommendations to organizations interested in establishing or expanding AT reutilization initiatives. The role of the National Assistive Technology Reutilization and Coordination Technical Assistance Center (Pass It On Center) is shared. The value and limitations of the current AT reuse data and outcomes are discussed and recommendations for future research on AT reutilization activities and outcomes are offered.

Keywords: Assistive technology reutilization, Assistive technology reuse

The Beginnings of Assistive Technology Reutilization

The reutilization, or 'reuse,' of assistive technology (AT) is a service born of need. In today's world of increasing demand and shrinking resources for AT, individuals with disabilities, their family members and caregivers, and disability service organizations often consider reutilized AT as an affordable, and, for some, the only solution to overcoming insurmountable financial barriers. From local grassroots efforts in the 1980s, reutilization (hereafter referred to as reuse) has grown to become a nationally-recognized response for providing AT to those people who would otherwise 'go without.'

One of the earliest known reuse organizations, National Cristina Foundation, was established in 1984 to put technologically obsolete but usable computers into the hands of people with disabilities (National Cristina Foundation, 2000-2008). Another nationally renowned non-profit organization, Friends of Disabled Adults & Children, Too (FODAC, 2007), began in one person's basement that was essentially a storage space for a few wheelchairs. The organization has since refurbished over 20,000 wheelchairs, 5,500 hospital beds and many other types of durable medical equipment (DME) since 1986. Undoubtedly, there were many more local groups collecting and redistributing DME through various organizations (e.g., Easter Seals, United Cerebral Palsy, and the Muscular Dystrophy Association) but there was no unifying voice around AT reuse at the time.

Legislative Catalyst for Expansion of AT Reuse Programs

In 1988, Congress passed the Technology-Related Assistance for Individuals with Disabilities Act (Tech Act) to give states funds a catalyst to develop creative strategies to reduce AT access barriers. The Tech Act was the first federal legislation to define both AT devices and services. The Tech Act of 1998 defines an AT device as "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" [§3(a)(3)]

AT services are defined as "any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device" [§3(a)(4)] and the purposes of the act such as "purchasing, leasing or otherwise providing for the acquisition of assistive technology devices by people with disabilities" and "selecting, designing, fitting, customizing, adapting, applying, maintaining, repairing, or replacing of assistive technology devices" [§3(a)(4)(B)], set the stage for states to devise many creative strategies one including AT reuse.

Equipment exchange and 'recycling' services began to flourish in the 1990's and early 2000's to address intractable systemic funding barriers and the consumer-driven demand for AT (National Assistive Technology Technical Assistance Partnership, 2000). Some states established both print and electronic equipment exchange services that allow sellers and buyers to exchange equipment; other states launched new programs or supported the expansion of existing programs for simple redistribution of usable AT; and still others incorporated refurbishing services to restore and repair equipment otherwise unusable. A variety of program models emerged, all focused primarily on addressing unmet needs of persons with disabilities who, for many different reasons, were not obtaining AT devices and services needed for living, working, learning or playing, inclusively or independently. In addition, many other private, community-based organizations initiated or expanded existing reutilization services to respond to these unmet consumer needs.

Rapid innovation in electronics accelerated the replacement rate of technologies such as computers and lead to a surplus of outdated, yet reusable, equipment (National Safety Council, 1999). This abundance of equipment and unmet consumer needs for computer technology led to the proliferation of computer refurbishing programs, often spurred on by the lively dialogue and technical assistance of Yvette Marin, the Executive Director of the National Cristina Foundation, who sought to encourage donations of surplus computers from corporate partners for use by people with disabilities (National Cristina Foundation, 2000-2008).

The 1994 amendments to the Tech Act allowed states to develop model systems that would "support activities to increase access to, and funding for, assistive technology" [§101(b)(1)]. Further, the 1994 Act set the stage for inclusion of public and private sector collaboration around "development, demonstration and dissemination of assistive technology devices, and the ongoing provision of information about new products to assist individuals with disabilities" [§101b(11)(A)(B)].

In the 1998 reauthorization, reuse is identified in the statute as a formal (though discretionary) activity. State AT Act Programs could develop systems for the "maintenance of information about, and recycling centers for, the redistribution of assistive technology devices and services" [§101(b)(3)(A)(i)(I)(iii)]. With the Tech Act reauthorization in 2004, AT reutilization is specifically identified as a quasi–mandatory activity [§4(e)(2)(B)] whether the reuse activity was funded under AT Act funds to the state or through other state or non-federal funds[§4(f)(2)(B)(iv)]. The AT Act of 2004 allows the state to:

> directly, or in collaboration with public or private entities, carry out assistive technology device programs that provide for the exchange, repair, recycling, or other reutilization of assistive technology devices, which may include redistribution through device sales, loans, rental or donations. [§4(e)(2)(B)]

This evolution in the Act is significant because private entities such as manufacturers and suppliers are critical to the success of AT reuse programs. They offer standards and guidelines for the sanitization and repair of specific types of equipment, can clarify when equipment or equipment parts are no longer usable, and sometimes perform repairs or reuse services under fees-for-services contracts.

As more programs of this kind developed and expanded, the Rehabilitation Services Administration (RSA) launched its AT reuse initiative designed to promote *safe, appropriate* and *effective* AT reuse described later in the manuscript. Leading up to RSA's initiative were a number of early, national efforts designed to bring together public, private and even international AT reutilizers, consumers, manufacturers, and state AT programs to look at operational strategies and issues which will be discussed in the next section.

Early National Efforts to Forge a Unified, Collaborative Vision for AT Reuse

In March, 1999, the RESNA Technical Assistance Project and the Assistive Technology in New Hampshire program hosted the first national conference, 'Discovering Hidden Resources: AT Recycling, Refurbishing and Redistribution,' to (a) address emergent needs of AT reuse programs; (b) facilitate sharing of information; and (c) forge a vision of a national system that would support procurement, distribution, and reassignment of reutilized AT by these programs. This conference resulted in an informative monograph that included a first attempt at definitions used in recycling AT equipment; identification of the benefits of recycled AT for suppliers, students and individuals with disabilities; descriptions of models for AT reutilization programs and the components of computer recycling programs; an overview of international AT recycling efforts; and, a first attempt to clarify issues of national importance pertaining to reutilized AT (National Assistive Technology Technical Assistance Partnership, 2000). This conference and monograph set the stage for future policy and programmatic developments in the emerging AT service delivery field and was a catalyst to move forward the notion of promulgating safe, appropriate, and effective reutilization of AT as a 'hidden resource' to address intractable AT funding barriers.

AT Reuse: Finding Partners for Successful Practices

In May, 2000, the RESNA Technical Assistance Project and Tools for Life (2008) hosted the second national conference on AT reuse in Decatur, Georgia. More than 45 representatives of state AT programs, manufacturers, AT recycling organizations, and third-party organizations participated (National Assistive Technology Technical Assistance Partnership, 2000). This conference stressed the need for continuing conversations among existing and potential partners, the need to identify best practices, costs and benefits, and the need to develop sustainable AT reuse services that support consumers, manufacturer/suppliers, and organizations involved in these initiatives. Two reutilization programs in Georgia—FODAC (2007) and the ReBoot computer reutilization program (Touch the Future, Inc., n.d.)--were toured to give participants a closer look at how successful reuse can enhance partnerships among suppliers, manufacturers and end-users. The conference also spotlighted how several reuse programs offer job skills training, industry certification, and employment as computer and durable medical equipment repair technicians to individuals with disabilities.

Early Definitions of Reused/Reutilized AT

One issue that confounds research is nomenclature. Without clear definitions of the types of AT reuse activities, definitive research is not possible. Early AT reuse activities were often referred to as "recycling" activities. The RESNA TA Project defined reused AT equipment as follows: "Recycled assistive technology equipment is any piece of used equipment, device or aid, that is now capable of being reused by someone else," (NATTAP, 2000, p. 3) and clarified that recycling programs (e.g., in the late 1990s) interchangeably used terms such as "reutilization, refurbishing, or redistribution" (NATTAP, p. 3) in program descriptions. RESNA reported that, to manufacturers and those involved in waste management, the term 'recycle' refers to the breaking down of the product for purposes of retrieving and reusing that which is usable in some manner or form, or end-of-life reprocessing (NATTAP; Environmental Protection Agency, 2008). More precise definitions of reuse evolved to clarify and quantify specific reuse activities for the purpose of understanding of some quantitative outcomes from a national perspective.

Quantitative Reporting of Initial AT Reuse Data Using Expanded Definitions of AT Reuse

The AT Act of 2004 increased accountability by requiring states to report data to measure "the number, type, estimated value, and scope of assistive technology devices exchanged, repaired, recycled, or reutilized (including redistributed through device sales, loans, rentals, or donations) through the device reutilization program" [§4(f)(2)(B)(iv)] as a way to fulfill the intent of the law to increase acquisition of assistive technology devices and services.

Under a grant from the Rehabilitation Services Administration (RSA), the Association of Assistive Technology Act Programs (ATAP) developed a reporting protocol called the National Information System for Assistive Technology (NISAT; Association of Assistive Technology Act Programs, n.d.) for states to use in collecting the data required by the law and to provide a consistent national basis for reporting aggregate state AT Act data to Congress. The reporting protocol approved by the Office of Management and Budget allows states to estimate the original value of the devices that are exchanged or refurbished/repaired/recycled, along with the amount spent to obtain the device. Programs may use the manufacturer's suggested retail price (MSRP) to determine the original value of the device. If the exact price for that particular item cannot be found, an attempt must be made to locate a comparable item and the price for that device must be used. Estimates may be used as an acceptable alternative when exact pricing information is not available (Association of Assistive Technology Act Programs).

The NISAT instructional guide defined two distinct types of AT reuse activities:

1. *Device exchange activities*. These are activities in which devices are listed in a 'want ad' type posting and consumers can contact and arrange to obtain the device (either by purchasing it or obtaining it freely) from the current owner. Exchange programs do not involve warehousing inventory and do not include repair, sanitation, or refurbishing of used devices. In some cases the statewide AT program acts as an intermediary

during the exchange; in other cases the statewide AT program is not involved in the transaction.

2. *Device refurbishment/repair/recycling activities.* These are activities in which devices are accepted (usually by donation) into an inventory, are repaired, sanitized, and/or refurbished as needed, and then are offered for sale, loan, rental or give away to consumers as recycled products. Repair of devices for an individual (without the ownership of the device changing hands) should be reported as device recycling. Open-ended device loans, in which the device borrower can keep the device for as long as it is needed, are a form of device reuse and are reported as device recycling (Association of Assistive Technology Act Programs, n.d.).

Initial Quantitative Outcomes of AT Reuse Reported by State AT Act Programs

Prior to completion and approval of the NISAT data collection protocol, the ATAP (n.d.) developed an interim data collection tool to capture data on AT Program activities. ATAP, which represents 54 of the 56 AT Act Programs, requested that its members voluntarily submit data collected between October 1, 2005, and September 30, 2006, using the interim voluntary data tool. Thirty-five states submitted data using the interim data reporting tool. Of the 35 states submitting data, 24 reported operating reuse, exchange, or long-term loan programs or a combination of programs. States reported reuse of a total of 5,602 devices. Of these, 678 devices were exchanged, 4,482 devices were reassigned, and 442 devices were on long-term loan. Devices for seating, positioning and wheeled mobility, and computer/computer-related devices constituted two of the top three types of devices acquired through each category of reuse program (i.e., exchange program, reassignment program, or long-term loan program). Devices for daily living were ranked behind seating, positioning and wheeled mobility and computer/computer related devices for exchange or reassignment programs. Recreation and leisure equipment was ranked behind seating, positioning, and wheeled mobility and computer/computer-related devices acquired under a long-term loan. Altogether, the data collected from 24 state AT programs showed that 4,765 received used devices (which meant many people received more than one device because the collection was based upon the number of persons who received devices, not the number of devices exchanged, reassigned, or on a long-term loan.). These consumers saved $5,014,921 (i.e., the cost savings estimated by subtracting the cost of used devices from the MSRP if purchased new; Buzzell, 2007).

A Closer Examination of the RSA Initiative on AT Reuse

The need for affordable AT and the new requirements for state AT Act programs to address these needs, in part through reuse initiatives, resulted in a national conversation to better understand the opportunities and challenges of AT Reuse. The RSA, the NATTAP, and Tools for Life--Georgia's state AT Project--jointly hosted the third national conference on AT reuse in May, 2006. This conference, the *Pass It On Conference on AT Reuse*, drew over 200 participants including individuals with disabilities, reuse organizations, state programs, suppliers and manufacturers. This diverse group identified that AT reuse programs need to know more about best practices in a range of topics including storage; transportation/distribution; staffing; volunteers; tracking and managing inventory; data collection; marketing and public awareness; sustainability and funding; appropriate disposal of devices; finding and retaining qualified staff; training staff and volunteers; determining the acceptability of devices (age, condition, type); matching person to device; providing training and follow-up to consumers; standards for cleaning and repairing; and liability and insurance.

Under the leadership of John Hager, Assistant Secretary of the Office of Special Education and Rehabilitation Services (OSERS), RSA announced at the May, 2006, conference the availability of funds for grants to establish model demonstrations of AT reuse, to support technical assistance activities to these grantees and others involved in AT reuse activities, and to address issues of national importance to organizations involved in these activities. The goal of RSA's reuse initiative is "to increase the availability of assistive technology through promoting and supporting the appropriate, effective reuse of AT devices at the state and local level" (Buzzell, 2007, p. 3). The support of OSERS is manifested in the programs it administers--the 87 AT reuse programs operated by state AT Act programs and U.S. territories, 12 AT reuse demonstration grants, and one technical assistance center on AT reuse (i.e., the Pass It On Center).

National Efforts to Consider the Numbers and Types of AT Reuse Programs

As a part of planning efforts for the Pass It On Conference, the NATTAP staff conducted the first nationwide effort to identify the numbers and types of AT reuse initiatives. A questionnaire, developed and disseminated via email to state AT Programs, was designed to gather initial information about the numbers and types of reuse programs, the types of organizations involved in reuse activities, the types of AT reutilized, and limitations with respect to the populations served by these programs (e.g., a specific age group, type of disability, type of AT reutilized, or purpose of the AT reuse program). NATTAP compiled questionnaire data from 40 respondents (i.e., one respondent per state) who reported a total number 633 AT reuse programs. NATTAP included four types of AT reuse programs in the questionnaire and respondents (i.e., state AT program personnel) reported on the number of programs operating in their state Of 633 AT reuse programs, 111 (18%) were classified as AT exchange programs; 487 (77%) were classified as AT recycling programs; only 1 (<1%) program was classified as a reuse program other than an exchange or recycling program; and 34 (5%) of the reuse programs were reported but not classified in the above categories and were classified as not sure. Respondents also reported that durable medical equipment devices are the most frequent type of devices reutilized (64% of all devices reutilized by these programs) and a significant majority of respondents reported AT reuse programs serve a specific geographic locality (Pass It On Center, 2006). Respondents also reported on the many types of organizations involved in AT reuse: independent living centers, university medical centers, assistive technology resource centers, civic organizations such as Lions Clubs, and various groups like the Muscular Dystrophy Association.

State AT program staff completed the questionnaire based upon their knowledge of reuse initiatives in their respective state. The data represents the first national effort to collect initial information about the extent and scope of AT reuse programs reuse activities and devices. This information along with significant and diverse perspectives of over 200 participants–representatives from AT reuse programs, state AT Act programs, manufacturers, suppliers, state agencies and individuals with disabilities–who participated at the Pass It On Conference, suggest policy implications to be addressed by decision-makers at many levels to assure that AT reuse is safe, appropriate, cost-effective, and sustainable. The data from the questionnaire is limited by its informality and by the fact that many state AT program respondents were unable to categorize the specific limits of the populations served: of 633 reported AT reuse programs, 283 could not be categorized by specific program limits (e.g., geographic area served, type of disability or ages served, etc.). Further, the results of the questionnaire suggested a need for clearer definitions for various types of reuse activities through which a more specific classification of the types of reuse programs could be accomplished.

In a subsequent 2006 effort to gather more specific and better-documented data, and to provide a useful tool to help consumers, families and providers locate reused AT, NATTAP established a public, on-line database to locate and classify AT reuse programs (Pass It On Center, 2007). NATTAP asked state AT Act programs and the organizations known to be engaged in AT reuse activities to populate this database which includes such information as how to contact programs, the type of AT reuse activity or activities offered, the types of devices reutilized, and types of disabilities served. A 2007 classification report of data collected on this site found that 154 AT reuse programs had directly listed program information on the NATTAP site. Of these programs, 60 reported that they refurbish AT (49 of which reuse mobility, seating and positioning devices); 45 reported that they reassign AT (39 of which reuse mobility, seating and positioning devices); 26 reported that they operate an AT exchange program; and 11 reported that they operate all three types of AT reuse programs (Pass It On Center). The aggregated data compiled from the database provides a more realistic picture of the numbers and scope of AT reuse efforts nationwide. Whereas NATTAP reported a total of 633 AT reuse programs from the first questionnaire, only 154 AT reuse programs were listed in the database in 2007. In follow-up calls to state AT program respondents who reported significantly more reuse programs on the questionnaire than on the database, NATTAP learned that some respondents included many small AT reuse initiatives on the questionnaire; these initiatives would not be appropriate to list on the national, public database (J. Kniskern, personal communication, September 17, 2007).

Challenges of AT Reuse

The RSA has defined 'appropriate' reuse as reuse that is "safe for reusers and meets the needs of consumers and reutilizers, results in positive outcomes for consumers, and is environmentally friendly" (Buzzell, 2007, p. 17). 'Effective reuse' is that which "produces cost savings or is cost-neutral, is sustainable, and has a positive or neutral effect on the AT field" (Buzzell, p. 21). In a presentation entitled "Addressing the Challenges in the Reuse of Assistive Technology" (Buzzell, 2006) to the Interagency Committee on Disability Research, RSA reported a lack of research on AT reuse, with (a) only three reports being found describing AT reuse programs at the time, and (b) no economic or methodological studies of device reuse (Buzzell, 2006, 2007).

RSA further highlighted that the lack of research leaves no way to understand the benefits of AT reuse in terms of such variables as cost-savings to consumers, their care givers and/or agencies, obtaining AT that would otherwise not be available, or improvements in clinical outcomes (Buzzell, 2006, 2007). If measures were developed to determine the quality of a reuse program, would such measures include quantitative data (i.e, how many devices are reutilized, how many people are served) or other program efficiencies (Buzzell, 2006, 2007) such as the wait time between a consumer's request and receipt of a device?

Although there are many different models of AT reuse programs (NATTAP, 2000), there have been no comprehensive, systematic studies to (a) consider the advantages, challenges, and perils of one type of AT reuse model over another; (b) document practices that lead to good outcomes; (c) identify how to achieve cost savings; or (d) know how to build sustainable AT reuse programs. In 2006, there was no central repository of information to help AT reuse programs to mitigate risk, reduce potential liability, understand legal and regulatory issues of federal agencies (e.g., Occupational Safety and Health Administration, Food and Drug Administration, Centers for Disease Control and Prevention, and Environmental Protection Agency) with potential interests in AT reuse (Buzzell, 2006, 2007). Further, there was scant information concerning the possible collaboration between AT reuse programs and third-party payer agencies (e.g., independent living services, vocational rehabilitation programs, or Medicaid) and the potential benefits and/or perils of such possible collaborations (Buzzell, 2006, 2007).

Given the numbers of public and private organizations engaged in AT reuse activities and the lack of information to inform decision-making about these various issues, RSA posed the question: 'How can these organizations ensure compliance with any relevant federal and/or state regulations applicable to AT reuse activities?' (Buzzell, 2006, 2007). Other questions concerned how programs would know the useful life of AT; what the overall impact on manufacturers and suppliers is; and, how the expertise of this industry can be engaged in productive dialogue with AT reutilizers, consumers, third-party payer organizations, DME/AT trade organizations, and environmental organizations. This dialogue focused on consideration of the benefits, outcomes, perils, and successful practices of AT reuse, given that AT reuse is happening across the nation in many communities (Buzzell, 2006, 2007). Finally, as a cautionary note, the question was considered regarding steps that can be taken by policy-makers, state agencies, and AT reutilizers to assure that the individuals with disabilities will have the most appropriate assistive technology and the choice of a new or reutilized device.

Meeting the Challenges and Recommendations for New Definitions of AT Reuse

The National AT Reutilization and Coordination Technical Assistance Center (housed at the Pass It On Center) was awarded a cooperative agreement from RSA in October, 2006, to address the questions and challenges presented by RSA. Because AT reuse activities involve a diverse audience of stakeholders, one of the first steps of the Pass It On Center was to launch the National Task Force (NTF) on AT Reuse to engage the expertise and perspectives of nationally known leaders and organizations in the field. The first priority identified by the NTF was to clarify and expand the current definitions of AT reuse activities because definitions impact every other challenge presented for consideration--from legal and regulatory matters to the analysis of benefits and outcomes of different models of AT reuse programs.

The NTF Study Group on the Classification of AT Reuse Activities has adopted and is disseminating the following definitions for widespread adoption by reuse programs, state AT programs, suppliers and others:

1. *Device exchange*, in which organizations facilitate the transfer of a device from a consumer who does not need the device to a consumer who could use the device – without the organization taking possession of the device at any time.

2. *Device reassignment*, in which an organization accepts devices from donors and stores them until they can be given or sold to new owners.
3. *Device refurbishment*, in which an organization takes the additional step of repairing or restoring used devices to original manufacturer specifications before giving or selling the device to a new owner.
4. *Device remanufacturing*, in which an organization alters or enhances devices before giving or selling the device to a new owner.
5. *Device recycling*, in which an organization accepts devices from donors and breaks the devices down into component pieces for recycling and disposal.

Additionally, the Pass It On Center will review the limited AT reuse outcome and cost savings data reported by state AT Act Programs to RSA for the period October 1, 2006, through September 30, 2007, and will supplement this data with comparable data from other AT reuse organizations that are not funded under the AT Act or otherwise supported by State AT Act Programs. Additional information about the work of the Pass It On Center in identifying successful practices, quality indicators, consumer-choice, and pertinent regulatory information about AT reuse is available (http://www.passitoncenter.org).

What We Know About AT Reuse Outcomes and Benefits

A review of literature shows scant evidence of research on AT reuse outcomes and benefits. An earlier Québec qualitative analysis of interviews with consumers, suppliers, professional service providers, and government administrators explored what contributed to the development of successful AT reuse policies, such as the involvement of diverse stakeholders, along with the benefits and disadvantages of such programs (Vincent, 1999). Another early study compared reuse programs to consider their feasibility (Burke, 1997). It is beyond the scope of this article to analyze the methodologies of these studies. However, these two studies, along with several other studies (J. Kniskern, personal communication, May 14, 2008) that includes a recently completed doctoral but not yet published dissertation (Bean & Morgan, 2008), will contribute to the substantive research needed on AT outcomes and benefits to inform reuse practices. A few reuse programs are beginning to explore the outcomes (a) of using technology to streamline program operations; (b) of cost-savings to consumers who acquire reutilized AT; and (c) to consumers three months after having received AT.

One example of a program that is exploring outcomes and benefits is FODAC which has refurbished and reassigned 20,000 wheelchairs since 1986. In 2004, FODAC implemented an electronic database to track quantitative data on disabilities and the types of refurbished/reassigned equipment matched to prioritized customer requests. It includes performance measures concerning why users consider reusable AT (i.e., denial from Medicaid, Medicare, or economic situation) and how they believe the AT they received will benefit them (i.e., school, work, community-living, independence, or developmental progress/recreation).

Another example is Paraquad (2008), a community-based, university-affiliated AT refurbishing and reassignment program which conducts three- to six-month follow-up surveys to measure changes in functional performance and inclusion in community activities of persons pre-owned AT. A unique aspect of Paraquad is its affiliation with the clinical staff from the School of Occupational Therapy at Washington University. This partnership has resulted in pre-and post service benefits and outcomes research studies that can inform decisions about the potential benefits and pitfalls of AT reuse.

A third program, the Kansas Equipment Exchange, reports data such as the wait time for 'average stock of AT (Kansas Equipment Exchange, 2003). The program can respond to many requests immediately, but most applicants have a wait time of three months. The delays must be balanced against the number of devices collected, refurbished and reassigned (Equipment for Independence, 2007) to respond to unmet needs for AT. What else is there to learn from these examples and what kinds of methodologies would be appropriate to measure the outcomes and benefits of AT reuse programs?

The field of AT outcomes measurement is complex because of variations in the (a) types of disabilities, (b) types of AT, (c) ages of persons using AT, and (d) settings and context in which AT is used (Johnson, Gratz, Rust, & Smith, 2007; Peterson-Karlan & Parette, 2007). The measurement of AT reuse outcomes is even more complex because all of the above variations apply as well as other variations in the types of AT reuse programs, the age of devices being reused, and the need to clarify what will yield the most useful information about AT reuse services for decision-makers. A review of literature on AT outcomes and benefits cited by the Assistive Technology Outcomes Measurement (ATOMS) project shows most of the focus of research is on development and models of interventions (Smith, Seitz, & Rust, 2006). In comparison, the emerging field of reuse outcomes and benefits currently focuses on such measures as helping persons with disabilities acquire AT they otherwise would not be able to access, cost-savings as a result of the interventions, and the satisfaction of the individual with the reused AT.

A newer tool from the ATOMS project allows researchers to gather user-specific information (e.g., frequency of use, settings of use, perceptions of whether the device aids the user in reaching goals, satisfaction with services, AT cost data, etc.) at intervals before and after receipt of AT (Sprigle & Harris, 2004). An instrument like the ATOMS tool might be adaptable for the analysis of benefits and cost savings to customers of reuse services. However, even this instrument does not allow for the examination of certain reuse program efficiencies that impact users, or the sustainability of AT reuse programs and raises numerous questions: What kinds of outcomes are relevant to consider? The benefits to consumers in functional activities or receipt of devices they cannot otherwise obtain? The advantages to agencies and third party-payers? Cost savings? Reduction of waste and environmental pollutants? These are some of the questions that can be explored through future research.

A Need for Outcomes and Benefits Research on Manufacturer and Supplier Relationships

Research concerning the outcomes and benefits of AT reuse on manufacturers and suppliers is also needed. Some AT reuse programs have reported at meetings and conferences that they have carefully cultivated strong and positive relationships with manufacturers and suppliers of AT. The suppliers can refer to reuse programs those customers who have no direct or third-party source of funding. In turn, the reuse programs can provide back-up and interim AT solutions while the customer waits for thirty-party payer approvals (Hostak, 2007). Manufacturers and suppliers also can advise AT reuse programs about technology that has been recalled, banned, or has passed its useful life. They can assist programs in determining the useful life of complex AT (Hostak). In spite of these anecdotal reports, no research on the benefits and outcomes of AT reuse to manufacturers and suppliers is evident from literature searches (ATOMS, 2007; RESNA), and yet, there is clearly a need for all stakeholders to collaborate in understanding mutually beneficial models of AT reuse (Hostak).

A Need for Outcomes and Benefits Research on Third-Party Payers Relationships

Some state Medicaid agencies are considering reused AT as a way to contain costs in response to budget constraints and increasing demand (Hostak, 2007). Lessons learned from a New Jersey Medicaid reuse effort as well as from European countries (Hostak), suggest that third-party payers should offer reutilized AT as an option--not a 'pre-requisite'--to obtaining agency-purchased equipment. The Pass It On Center is examining the success of partnerships and practices in working with third-party payers. The Kansas Equipment Exchange is one such example. The program reports savings of two million dollars through its collaborative partnership with Kansas Health Care Policy (Medicaid) and the leadership of the University of Kansas. Kansas Medicaid spends 10 million dollars each year on equipment, and approximately one-third of this equipment may be suitable for reuse. The partnership includes strong working relationships with AT suppliers who are paid for refurbishing and repair services done by vendor-certified repair technicians. The program deals primarily with durable medical equipment, but is now expanding its efforts to refurbish personal digital assistants (PDAs), global positioning systems (GPS), and other types of AT (Kansas Equipment Exchange, 2003).

A Need for Outcomes and Benefits Research on the Environmental Impacts of AT Reuse

Finally, there is a need for more outcomes and benefits research to determine the environmental impact of AT reuse efforts. Environmental impact data resulting from the reuse of AT reuse are not a measurement states are required to collect, nor is it voluntarily collected by most state AT Act Programs. However, it may be useful data concerning the outcomes and benefits of AT reuse. For example, other recycling industries report data that shows significant 'savings of energy use' resulting from recycling of iron and steel (74%), recycled paper (64%) and recycled plastic (more than 80%) (Farzad, 2008). Some AT reuse programs are capturing preliminary environmental impact data: the AT for Kansans Project and Kansas Health Care Policy (Medicaid) received a Kansas 2007 Pollution Prevention Award for keeping 1,800 devices out of landfills (Kansas Department of Health and Environment, 2007).

Summary and Recommendations

The body of current data on AT reuse outcomes is focused on quantitative, not qualitative, research that indicates a compelling need for outcomes and benefits studies useful to inform the decision-making of policy makers, suppliers, manufacturers, consumers and all stakeholders. Such research is essential to inform the development of successful reuse practices. Informed consumer choice in decisions about whether to accept an appropriate reuse device or seek a new one is another area of need for research. Reuse programs and policy-makers can also benefit for carefully planned research of return-on-investment (ROI) studies and potential benefits to consumers as measures of changes in functional performance, inclusion in major life activities, and consumer satisfaction ratings of the AT reuse services and the actual device.

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References

Assistive Technology Act, 29 U.S.C. §§ 3001 *et seq*. (2004)

Association of Assistive Technology Act Programs (n.d.) *National information for assistive technology (NISAT)*. Retrieved on August 9, 2008, from http://www.ataporg.org/atap/nisat.php

Assistive Technology for Individuals with Disabilities Act, 29 U.S.C. §§ 3001 *et seq*. (2005)

Burke, C. E. (1997). A summary of assistive technology equipment recycling: a comparison and feasibility study. *Technology and Disability, 7*, 175-182.

Buzzell, J. (2006, August). *Addressing the challenges in the reuse of assistive technology*. Presentation to the Interagency Committee on Disability Research, Washington, DC.

Buzzell, J. (2007, November). *Pass It On Center overview*. Audio conference presentation to the National Assistive Technology Technical Assistance Partnership, Washington, D.C.

Buzzell, J. (2007, May). *Overview of the rehabilitation services administration's initiative on assistive technology reuse*. PowerPoint presentation to the National Task Force on AT Reuse of the Pass It On Center, Atlanta,Georgia, 1.

Buzzell, J. (2007, July). *Overview of the rehabilitation services administration's initiative on assistive technology reuse*. Presentation to the AT Reuse Conference of the Minnesota STAR Program, St. Paul, MN. Retrieved August 7, 2008, from http://www.starprogram.state.mn.us/MN%20Reuse%20Presentation.ppt. 3, 15, 21.

Daly, L., Van Hook, B., Rahaman, A., Patterson, M., Marcus, J., & Chang, C. (2006). *Recycling technology products: An overview of e-waste policy issues*. Washington, DC: U.S. Department of Commerce

Equipment for Independence. (2007). *Kansas equipment exchange*. Retrieved August 7, 2008, from http://passitoncenter.org/documents/KFDA%20Mag%20Article.txt

Environmental Protection Agency. (2008). *Reduce, reuse, and recycle*. Retrieved May 24, 2008, from http://www.epa.gov/epawaste/conserve/rrr/index.htm

Friends of Disabled Adults and Children, Too. (2007). *Friends of disabled adults and children, too*. Retrieved April 17, 2008, from http://www.fodac.org

Hostak, R. (2007, Spring). Threat, opportunity or obligation? *NRRTS News, 2*, 1, 21.

Johnson, B. B., Gratz, E., Rust, K. L., & Smith, R. O. (2007). *Project technical report – multiattribute utility theory summarizing a methodology and an evolving instrument for AT outcomes*. Retrieved April 17, 2008, from: http://www.r2d2.uwm.edu/atoms/archive/technicalreports/fieldscans/tr-mau.html

Kansas Department of Health and Environment. (2007). *Congratulations to the 2007 Pollution Prevention Award Recipients*. Retrieved April 17, 2008, from http://www.kdheks.gov/sbcs/download/p2_award_winners_2007.pdf

Kansas Equipment Exchange. (2003). *Kansas equipment exchange*. Retrieved August 9, 2008, from http://www.equipmentexchange.ku.edu/

Morgan, K., & Bean, L. (2008, August). *AT reutilization program outcomes*. Presentation to the Washington University School of Medicine, Program in Occupational Therapy, St. Louis, MO.

National Assistive Technology Technical Assistance Partnership. (1996).

Exchange/recycling programs offer new life for at devices. Retrieved May 30, 2008, from http://69.89.27.238/~resnaorg/taproject/library/bulletins/sep98.html

National Assistive Technology Technical Assistance Partnership (2000, April). Discovering hidden resources: Assistive technology recycling, refurbishing, and redistribution. *Monograph of National Conference on Discovering Hidden Resources*. Retrieved May 21, 2008, from http://69.89.27.238/~resnaorg/taproject/library/pubs/recycling/RMtoc.htm

National Assistive Technology Technical Assistance Partnership. (2006). *NATTAP reuse questionnaire results*. [Data file]. Atlanta, GA: Pass It On Center/Tools for Life, Georgia Department of Labor.

National Cristina Foundation. (2000-2008). *Welcome to the National Cristina Foundation*. Retrieved May 30, 2008, from http://www.cristina.org

National Information System for Assistive Technology. (n.d.) *National information system for assistive technology*. Retrieved May 19, 2008, from http://www.ataporg.org/atap/nisat.php

National Safety Council. (1999). *Electronic product recovery and recycling baseline report: Recycling of selected electronic products in the United States*. Retrieved May 21, 2008, from http://www.iaer.org/communications/EPR2study.html

Paraquad. (2008, July 15) *Assistive technology reutilization program*. Retrieved August 7, 2008. from http://www.paraquad.org/Programs/Equipment/equipment.htm

Pass It On Center. (2007). *Find reuse locations*. Retrieved August 8, 2008, from http://passitoncenter.org/locations/Search.aspx

Pass It On Center. (2007). *National classification of AT reuse programs*. Atlanta, GA: Author.

Peterson-Karlan, G. R., & Parette, H. P. (2007). Evidenced-based practice and the consideration of assistive technology, effectiveness and outcomes. *Assistive Technology Outcomes and Benefits, 4*, 130-139.

Retrieved April 17, 2008, http://www.atia.org/i4a/pages/index.cfm?pageid=3428.

Smith, R. O., Seitz, J., Jansen, C. & Rust, K. L. (2006). *Project technical report – Models and taxonomies relating to assistive technology (FS7).* Retrieved April 17, 2008, from: http://www.r2d2.uwm.edu/atoms/archive/technicalreports/fieldscans/fs7/tr-fs-taxonomiesmodels-resource.html

Sprigle, S., & Harris, F. (2004). *Technical report–comparison of cost outcome methods* (Version 1.0). Retrieved May 30, 2008, from: http://www.r2d2.uwm.edu/atoms/archive/technicalreports/fieldscans/tr-cost.html

Technology Related Assistance for Individuals with Disabilities Act Amendments, 29 U.S.C. §§ 3001 *et seq*. (1994)

Technology Related Assistance for Individuals with Disabilities Act Amendments, 29 U.S.C. §§ 3001 *et seq*. (1998)

Tools for Life (2008). *Tools for Life-Georgia's Assistive Technology Act Program*. Retrieved August 10, 2008.

Touch the Future, Inc. (n.d.). *Get a computer ReBoot Services TM*. Retrieved August 10, 2008, from http://www.touchthefuture.us/reboot.htm

U. S. Department of Education. (2007). *Reuse your AT-reuse of assistive technology makes common sense* (2nd ed.) [Brochure]. Washington, DC: Author. Retrieved August 7, 2008, from http://www.ed.gov/programs/atsg/at-reuse.pdf

Vincent, C. (1999). Practices of recycling assistive technology in Québec. *Canadian Journal of Occupational Therapy, 66*, 229-239.

Perspectives of Assistive Technology from Deaf Students at a Hearing University

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Abstract: The purpose of this study was to investigate the perspectives of Deaf students attending a large 'hearing' university regarding their use of assistive technology (AT). Individual, semi-structured interviews were conducted with nine participants and responses were videotaped and transcribed from sign language to English. A collective case study approach was used to analyze the data. Three primary categories concerning perspectives of AT emerged from the qualitative analysis: (a) self-reported use of assistive technology and overall benefits, (b) barriers to AT use, and (c) facilitators to AT use. Discussion centers on the struggle to balance the triad of information that deaf students encounter in the university classroom and offers recommendations to assist deaf students in 'hearing' classrooms at the university level.

Key Words: Assistive technology, Deaf students, Higher education, PowerPoint™

Authors Note

The researchers have acknowledged that participants in this study consider themselves as part of a cultural group and refer to themselves as 'Deaf.' We also recognize the American Psychological Association (APA; 2001) guidelines regarding person first language. However, to be sensitive to the expressed preference of study participants regarding terminology, the term 'Deaf' will be consistently used throughout the article.

AT and Legislation

The Individuals with Disabilities Education Improvement Act (IDEIA) of 2004 supported the role of assistive technology (AT) as an integral and necessary component of education for all students with disabilities, mandating that AT be 'considered' for all students when program plans are developed for children with disabilities [20 U.S.C. 1401 § 614(B)(v)]. Consequently, when a Deaf child enters the special education system at the age of three years, his or her individual education program (IEP) must document that AT services and devices have been considered and, if deemed necessary, a service plan for implementation and delivery has been developed and will be implemented.

The No Child Left Behind Act of 2001 (NCLB) has placed emphasis on the participation and success of all children--both with and without disabilities--in the academic curriculum. Thus, with IDEIA and NCLB in place, it would appear that a solid foundation was in place for the Deaf child to receive AT services in the public schools from early intervention through graduation from high school.

However, research has indicated that little guidance has been provided regarding how

AT is considered and how the process occurs for young children with disabilities (Mistreet, Lane, & Ruffino, 2005). While it is beyond the scope of this study to delve into the history of AT use with the Deaf, several studies have addressed this area of interest (e.g., Mackowiak, 1989; Stinson, Stuckless, Henderson, & Miller, 1988; Zazove et al., 2004). Conclusions from these studies indicate that the use of AT is increasing in the Deaf population and AT use is beginning at an early age. Ideally, Deaf students will graduate from the public schools with AT experiences that have prepared them for effective and successful university careers.

The Americans with Disabilities Act (ADA) and Section 504 of the Rehabilitation Act Amendments of 1973 continued the legislative support for an increasing number of individuals with disabilities to enter, learn, and graduate from institutions of higher education. Among those individuals with disabilities are an ever increasing number of Deaf students and students with hearing loss. Approximately 30,000 students in colleges and universities across the U.S. are Deaf (Kolvitz, Billies, Wilcox, & Rawlinson, 2003) and attend 'hearing universities.'

The term *hearing universities* was initially coined by Komersaroff (2005) to refer to universities dominated by students who are hearing. In these institutions, the hearing students experience equality that may not naturally be assured or assumed by peer Deaf students. Thus, IDEIA established the foundation for Deaf students to receive AT services at a young age and the ADA and Section 504 support the legal right to access AT support at universities by providing equal access to materials. Yet research to date has neglected to examine the perspectives of Deaf students themselves at these institutions—the ones who have directly benefited from legislation.

Technology and Deaf Students: Instructional or Assistive?

The IDEIA defined AT devices as "any item, piece of equipment or product system, whether acquired commercially or off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" [20 U.S.C. 1401 § 602(1)]. At a hearing university, accommodations are required for Deaf students to gain access to information that is readily available to hearing students. We acknowledge that technologies viewed as instructional for hearing students become assistive for the Deaf student. For example, if a professor is lecturing and using an instructional technology such as Microsoft® PowerPoint™, the Deaf student may rely heavily on the PowerPoint™ presentation to gain information not otherwise available to him/her. When that occurs, the instructional technology then becomes AT for that student because it improves the Deaf student's functional capabilities of receiving the information. Another illustration would be if a Deaf student were interacting with peers during a class activity and using text messaging to communicate with group members. The text messaging becomes AT because it allows the Deaf student to improve his functional capability of communication, since his or her speech may be unintelligible to peers due to deafness. Therefore, for the purposes of this paper and congruent with the perspectives of our participants, we will refer to AT as devices that our participants have identified as improving their functional capabilities and/or compensating for their hearing loss.

AT has been deemed as one of the "great equalizing forces in education and meaningful inclusion of students with disabilities both in terms of promoting access to the general curriculum and in facilitating the ability of students to demonstrate mastery of that

Table 1
Demographics of Participants

Name	Hearing Loss/Age of Onset	Speech Intelligibility	Communication Mode/Language During Interview	College Status	Age
Yvonne	Severe to profound/ Birth	Intelligible	Speech	Undergrad/ junior	Early 20s
Ken	Severe to profound/ Before 1 yr	Intelligible	MCE[a]	Undergrad/ senior	Late 20s
Henry	Profound/ 3 yrs	Intelligible	ASL[b]	Undergrad/ junior	Early 20s
Tony	Profound/ Birth	None	ASL	Undergrad/ sophomore	Early 20s
Keith	Profound/ Before 2 yrs	Limited	MCE	Undergrad/ senior	Early 20s
Karl	Profound/ Birth	None	ASL	Undergrad/ junior	Early 20s
Hayley	Profound/ Before 2 yrs	Intelligible	Speech	Undergrad/ junior	Mid 20s
Jennifer	Profound/ Birth	Intelligible	Speech	Graduate	Mid 30s
Botina	Severe/ Progressive/ Before 2 yrs	Intelligible	Speech	Undergrad/ junior	Early 20s

[a]MCE: Manully Coded English
[b]ASL: American Sign Language

knowledge" (Michaels & McDermott, 2003, p. 29). AT has great potential to assist Deaf students at hearing universities. However, the Deaf student at a hearing university must assume significant responsibility for the effective use of AT. While the ADA and Section 504 delineate the responsibilities of colleges and universities regarding the education of Deaf students, the Office of Civil Rights (OCR) has clearly stipulated that it is the student's responsibility to "notify the school of their disability, request academic adjustments, and provide any necessary evidence of a disability-related need for the requested adjustment" (Milani, 1996, p. 995). The Deaf student may not know or understand the various accommodations available, understand the effectiveness of accommodations, or have the knowledge and skills to ask for the appropriate accommodations that can vary across students, the curriculum, and faculty who deliver instruction. Additionally, students are often not exposed to various potentially advantageous technologies at the high school level and may be ignorant of technologies that might be useful.

Numerous research studies indicate that Deaf students are using a range of technologies with increased frequency and consistency, such as the Internet and email (Bowe, 2002); instant messaging ([IM]; Bowe, 2000); Real-Time Graphic Display ([RTGD]; Stinson et al, 1988); captioning (Ward, Wang, Paul, & Loeterman, 2007); and Teletype-writer ([TTY]; Power, Power, & Rehling, 2007). Such studies support the basic assumptions of the current investigation that: (a) use of AT is increasing, (b) use of AT is beginning at an early age, and (c) AT holds potential to equalize the university student experience at hearing universities. Yet, there has been no research that has examined the perspectives of Deaf students at a hearing university regarding their use of AT. Therefore, the purpose of this study is to investigate the perspectives of Deaf students regarding their use of AT while attending a hearing university. Specifically, the research questions that guided this study were: (a) What are the perspectives of students who are Deaf at a hearing university regarding use of AT? (b) What barriers to AT use at a hearing university are identified by students who are Deaf? and (c) What facilitators of AT use at a hearing university are identified by students who are Deaf?

Method

Qualitative methods were chosen for use in this study to allow researchers to thoroughly explore perspectives and gain insight into the feelings, emotions, and thought processes of the participants (Creswell, 2002; Strauss & Corbin, 1998). This study used a collective case study, which investigates more than one case to understand a phenomenon, population, or general condition (Stake, 2000). Miles and Huberman (1994) stated that investigating a number of cases, as opposed to a single case, will lead to better comprehension and better theorizing. Furthermore, collective case study allowed the researchers to examine processes and outcomes across many cases and to develop a deeper understanding through more powerful descriptions and explanations.

Participants

Convenience sampling was the method used for obtaining participants. Participants were 1 Hispanic and 8 Caucasian students who were Deaf at a large, Midwestern hearing university. Students were recruited by a faculty member in the Department of Special Education and/or an undergraduate student who was also Deaf (See Table 1 for participant demographics). Nine participants agreed to be interviewed and videotaped.

Setting

The setting was a large, Midwestern hearing university with a hearing student population of approximately 20,000 students and approximately 27 Deaf students. The university has an Office of Disability Concerns (ODC) that provides services to students with disabilities, including Deaf students. These services are primarily focused on determining appropriate accommodations for participation in the university curriculum and how to access accommodations. All Deaf students must initiate contact with the ODC and coordinate interpreter services, class schedules, and any other accommodations, such as note-takers, extended test time, or alternative test settings. Requests for copies of Microsoft® PowerPoint™ slides are made directly to individual faculty. No participants mentioned the ODC in their interviews, yet all participants who had interpreters did have some contact with the ODC.

Interviews

Interviews have been described as one of the most powerful ways to understand another's perspective (Fontana & Frey, 2000), and were the primary form of data collection. The interview questions were developed to address the research questions, and while each question was asked during each interview, the interviewer was given discretion to ask additional questions to probe or clarify issues that arose during the interview process when needed. Interviews were conducted by the primary researcher and the undergraduate student. Interviews consisted of two parts: (a) a written section which focused on obtaining demographics, and (b) a face-to-face interview that was videotaped [See Appendix A]. The face-to-face interview consisted of semi-structured interview questions. The mode of communication during the interview was determined by participant preference. The interviews lasted approximately 90 minutes, and occurred during the Fall semester. Communication modes and languages included American Sign Language (ASL), Manually Coded English (MCE), spoken English, or any combination. The primary researcher asked for clarification of responses as needed during the interview.

Each videotape was transcribed by the undergraduate student who was Deaf and a native signer. Four of the interviews were randomly chosen and transcribed by a hearing student who was a child of Deaf parents with native-like sign skills. This procedure was completed to assess reliability of the transcriptions from sign language to written English and reliability was 98%. Any discrepancies between the transcribers were noted, and the two transcribers met and reached consensus on discrepant words. For example, one transcriber translated a sign as 'ongoing' while the other transcriber translated the same sign as 'continuous.'

Data Analysis

After completion of the interviews, the tapes were transcribed verbatim and the data were analyzed using a line-by-line multiple coding approach (Barbour, 2001). The nine interviews were divided among the research team members, which consisted of two faculty members from the Department of Special Education and two honors undergraduate students. Each team member analyzed all interviews. All four researchers then met frequently as a group to develop categories based on their individual line-by-line coding. Disagreements about categories were discussed, and categories were refined, expanded, and/or deleted as needed to reach concordance (Barbour). The constant comparative method by which researchers continually returned to the data for analysis was used as an overall methodological framework (Charmaz, 2000).

Confirmability

Several approaches were used to confirm the findings: triangulation, expert validation, respondent validation, and member checking. Triangulation is the process of corroborating evidence from different individuals, types of data, and different methods of data collection (Creswell, 2002). Nine different participant interviews were analyzed and common themes emerged across all participant interviews. The findings were then organized in graphic representation in the form of a concept map which is provided in Figure 1.

All interviews were read independently by an expert in the field of Deaf Education who has taught Deaf education and ASL, has native-like signing skills, and has served as an ASL interpreter. The expert validated the findings. Respondent validation was completed by reporting and requesting participant opinions of the findings. Member checking, the process of contacting participants and obtaining approval for the use of all their personal quotes, was used to further confirm the findings (Janesick, 2000). All participants confirmed the findings and gave their consent for the use of personal quotes.

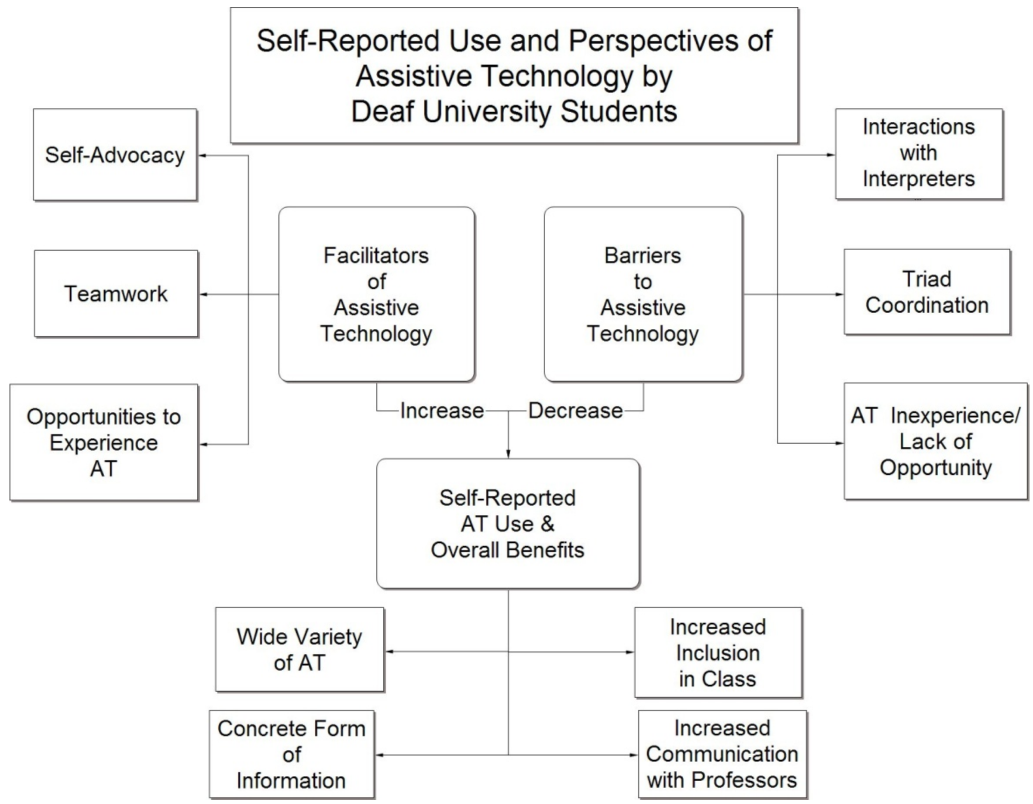

Figure 1. Themes of AT use by students who are Deaf at a hearing university.

Findings

Analysis of the data yielded three primary categories concerning perspectives of AT: (a) self-reported use of AT and overall benefits, (b) barriers to AT use, and (c) facilitators to AT use. Within each of these categories several subcategories emerged. The findings are organized by categories, and a discussion of the categories and the corresponding subcategories is presented.

Self-Reported Use of AT and Overall Benefits

Students spoke of the AT they personally used and the overall benefits of AT. Numerous AT tools were mentioned by participants (see Table 2).

There was a wide variety of AT use among participants, yet, the use was not homogenous. Instead, individual students spoke of preferences for certain AT. Across the university community one of the most commonly used assistive technologies in classrooms was PowerPoint™, which appeared to offer a comfort level for both student and professor. For the student who was Deaf, however, PowerPoint™ was not a panacea and presented its own complications which are discussed under the section *Barriers to Assistive Technology Use.*

Another type of AT that participants spoke of frequently was the Sidekick®, a mobile communication device that allows the user to receive and send IM and email. This AT was used primarily for social purposes as Henry explained,

> I pick up girls, meet girls. I use my Sidekick®, ask for their screen name. It's kind of funny, different, my hearing friends have to ask for phone

Table 2
Assistive Technology Used by Participants

Technology	Description	*N* Participants Using Technology
Captel™	A telephone that displays real-time captions of the current conversation.	1
Cell Phones/ Pagers	A long range, portable electronic device used for mobile communication.	4
Closed Captioning	Commonly known as subtitles. As the video plays, text captions are displayed that transcribe (although not always verbatim) speech and often other relevant sound.	5
Computers	A device capable of performing a series of arithmetic or logical operations.	8
E-mail	Short for *electronic mail*. A method of composing, sending, storing, and receiving messages over electronic communication systems.	6
FM Systems	Devices that transmit the teacher's voice directly to the student at a consistent level, ensuring that the teacher's voice is heard above the level of background noise.	6
Hearing Aids	Device used in some forms of deafness to amplify sound before it reaches the auditory organs.	8
Instant Messenger	A form of real-time communication between two or more people based on typed text. The text is conveyed via computers connected over a network such as the Internet.	5
Internet	An association of computer networks with common standards which enable messages to be sent from any host on one network to any host on any other.	6
Interpreters	A person who facilitates dialogue between parties who use different languages.	7
LCD Projectors	A video projector for displaying video, images, or computer data on a screen or other flat surface. It is the modern equivalent of the slide projector or overhead projector.	4
Mallard™	A web-based system used for quizzing.	1
Overhead Projectors	A display system that is used to display images to an audience.	7
PowerPoint™	A presentation program developed by Microsoft® for its Microsoft Office computer system.	8
Real Time Captioning	Simultaneously converts the spoken word into printed format using computer-aided translation, which appears on a large screen for anyone to view.	5
Sidekick®	A mobile communication device that allows the user to receive and send IM and email.	5

Table 2. (Continued)
Assistive Technology Used by Participants

Technology	Description	*N* Participants Using Technology
SmartBoard™	A large, touch-controlled screen that works with a projector and computer. The projector throws the computer's desktop image onto the interactive whiteboard.	1
Text Relay	Text characters are carried over the same Real-Time Transport Protocol (RTP) stream as voice.	2
TTY	A now largely obsolete electro-mechanical typewriter which can be used to communicate typed messages from point to point. These teletypewriters are still in use by the deaf for typed communications over the telephone.	5
TVs	A widely used telecommunication system for broadcasting and receiving moving pictures and sound over a distance.	2
Video Relay	A telecommunication service that allows deaf, hard of hearing and speech-disabled individuals to communicate over the phone with hearing people in real-time, using a sign language interpreter.	4
Videos	The part of the television signal which carries the picture information.	5
Voice Recognition Software	Software that converts a speech signal to a sequence of words in the form of digital data by means of an algorithm implanted through the computer program.	1
WebCT	Computer software program used in many colleges to access grades, assignments, and/or post messages.	7

> paper, I just give them my Sidekick®. And, if it's dark, I use the Sidekick®'s backlight. I use it to hook up with my friends, what's going on tonight.

Other students reported using the Sidekick® during group work within the classroom to communicate with hearing peers. Botina stated,

> Well, for my hearing friends, I just use the instant messenger and email. In class and also when I have a group meeting, you know if we can't get an interpreter right away, we'll just IM or email back and forth.

Participants appeared to have favorites within the AT domain. Some participants talked positively about video relay systems, while others indicated negative feelings regarding them. Keith spoke positively about communicating with faculty through TTY: "When I started college, they didn't have a really good online relay system. Now they've improved, that's improved. With relay I can call my professors to talk about issues in the classroom."

Negative comments about relay systems focused on technological problems, operational capabilities of professors, and language concerns. Henry explained his concern about the level of language with relay systems: "Before email, professors used a relay system and that uses a really high level of language. You can miscommunicate easily, so screw it." Keith expressed concern about understanding professors' operational capabilities, or lack of, when operating the relay system: "Mostly, the only problem I have is professors who do not know how to use the relay system, not technology. It's not the professors' fault."

One of the benefits of AT use in the classrooms was identified as providing a concrete form of information. Auditory information or signed information is transient. Written or visual information is non-transient, and participants spoke of the benefit of having a non-transient form of information during class lectures. All participants identified PowerPoint™ presentations as the primary instructional technology professors used to provide the visual information that assisted hearing students. Once again, the Deaf students perceived this commonly used technology as assistive when it offered them compensation for their lack of auditory input. Hayley exemplifies this when she spoke of the benefit of having visual information: "I depend on reading a lot. When I read things it makes more sense to me than when someone is talking or signing. I'd rather just read." Similarly, Yvonne spoke of the benefit of PowerPoint™: "It [PowerPoint™] helps with guiding me with homework and assignments, lectures in class. It's a guide for me to understand what the teacher is talking about."

Additionally, when visual information was provided the participants spoke of less reliance on interpreters, a feeling of greater independence, an increase in the ability to remember the information, and more time to process the information. Karl spoke of using technology and an interpreter:

> I get help from my interpreter, but if like, there is technology then I can see at the same time with other hearing people. It's a lot easier and more efficient, like if [a professor] talk, and look at the overhead, and I can't hear, so I try to look at everything with an interpreter, it's hard. It's better now with the overhead and technology, with the PowerPoint™ helps me do better.

Similarly, Keith described the benefit of using Mallard™:

> Well, sometimes professors do have what they call the Mallard™ System, where I can read notes or take quizzes to help me understand things in class. You log in with university ID, and then you have for, whatever class, you have like lessons where you take quizzes, or email with professors, …with Mallard™, my old university didn't use it, but now this one does. So it helps me because I can take quizzes many times on my own time, not follow restricted time.

AT was also identified as greatly increasing the communication between professor and student. Very few students had professors that were fluent in sign language. Thus, their primary means of communicating with the professors was technology, specifically in the form of email, IM, WebPages, and other Internet services such as WebCT (a computer software program used in many colleges to access grades purchased by Blackboard®; see http://www.blackboard.com/us/index.bbb) assignments, and/or post messages. Botina described how technology has affected interactions with professors using technology: "It's [communication with faculty] improved a lot with PowerPoint™. And they are just more knowledgeable. They know how to do the PowerPoint™ and they're not scared of new technology. They communicate more, and they're willing to accommodate you more."

Participants spoke of *more* communication between themselves and their professors when technology was utilized. Hayley described her interaction with faculty as,

> Well, I think technology helps faculty and students communicate a lot easier. Because I always bring PowerPoint™, with all the information, I feel that we [students] look at information, when s/he's talking. I feel like raising my hand and saying 'I agree' with that section point of discussion on the presentation or I feel, 'I disagree' with that. I think it helps with communication [with faculty]. No communication barriers because of that [technology].

Ken who describes himself as "a little behind in technology skills" illustrated the benefit of email when communicating with faculty:

> When you talk with faculty without using email, say you'd have to go back and forth to the building, go up, go down, oh you forgot to say something, go back up to talk with the teacher again. With email, it's right there. You can send, back, send, back. Respond. That really helps a lot. For me.

One of the perspectives that emerged regarding overall AT use was that the use of AT in the classroom does not benefit only the students with hearing loss. Participants recognized that the use of AT, such as PowerPoint™, benefited the entire class. Ken addressed this issue:

> Well I feel that not only do the teachers and technology support me, but they support everyone else as well. Maybe the teachers talk, talk, talk, and I think I'm the only one who can't understand what the teacher is saying, but that's not true. Hearing students have difficulties as well, and they would rather have PowerPoint™, papers, hard copies, and overhead projectors, showing what the teacher's talking about. I feel that teachers are not only doing PowerPoint™ for students with needs, but everyone has needs. Especially, I'm sure the hearings. Same way.

Additionally, participants spoke of how AT made them feel more included. AT use did not set them apart, but facilitated their inclusion into the classroom since all students were benefiting from the use of the technology. Tony stated that, "The technology helps me become more comfortable with the classroom, with the teacher, with the students, and makes me comfortable enough to speak for myself, share my opinion". Hayley expressed similar views,

> It [technology] improves a lot for me. Compared to high school where we didn't have a lot of technology, and we didn't use it all the time. But here, when you come to this university, you use it all the time. I've improved so much, because I'm so visual, most of my information is from looking at PowerPoint™, looking at different visuals. It's helped me participate more, communicate my opinions more.

In summary, participants reported a wide variability of AT use and highly individualized preferences for certain AT. PowerPoint™ was the most common form of AT used in the classroom, and the Sidekick® was the most common form of AT for social purposes. Participants identified AT use as overwhelmingly positive, assisting communication with professors and hearing peers, and facilitating inclusion into the classroom and university community. However, difficulties with technology use did emerge.

Barriers to AT Use

Barriers identified by the participants that impeded their use of AT had little to do with the functioning of technology. Rather, identified barriers were either interactions with sign language interpreters *and* technology or difficulties coordinating information from the professor, the interpreter, and the AT. All this information formed a complex triad, during class, which required skill to coordinate, energy to process, and collaboration to use effectively.

Participants needed and readily acknowledged the benefit of having interpreters. Henry and Keith contended that they relied on interpreters in class. Henry described his reliance on his interpreter, "I don't really use technology in classes. I'm an old school student; all I really need is my interpreter, although once in awhile if I forget to write things down I will use my Sidekick®." It should be noted that subsequent responses reflected that Henry used email to communicate with professors and fellow students. He also reflected positively about PowerPoint™ use during class. Keith also stated that he "used interpreters, but that's not really technology" in response to the question about technology in the classroom. Keith also discussed the Mallard™ system, captioned movies, PowerPoint™, email, and online relay systems to communicate with professors and peers.

Other participants identified difficulties when interpreters intermittently failed to convey the full content of what was happening in class. Participants reported knowing that the sign language interpreter was not interpreting all the professor was saying. When this occurred participants became anxious that they were missing important information. They expressed concern that they could not stop and ask their interpreter because class was continuing to move, and if they halted their interpreter, they were going to miss even more information.

Jennifer described her frustration with coordinating technology, specifically PowerPoint™, during class:

> Well, I find PowerPoint™ a little annoying for me. I don't like it because it is hard to watch the interpreter and then look at the PowerPoint™. When working with my interpreter, we have agreed that if it's a paragraph on the PowerPoint™, and the teacher is just reading, all she has to do is point and tell me to read. I'm noticing, recently, what's happening is that the interpreter is telling me to read one sentence. She says, read it, then I'm waiting, but oftentimes the speaker goes on. But technology isn't always helpful. Sometimes it causes more distractions for me.

Botina also expressed difficulties with PowerPoint™, "Sometimes I can't see the interpreter and everything on the PowerPoint™ [at the same time] so then the teacher says it in a different way." Students were frustrated at times by the presence of three types of stimuli coming at them at once: signing by their interpreter, professor speaking, and visual information, usually in the form of PowerPoint™. Participants overwhelmingly reported that coordinating this triad of information was a challenging feat.

Facilitators of AT Use

During participant interviews several themes emerged that were categorized as facilitators. These facilitators were common among participants, appeared to assist the student with classroom performance, or assisted the student with communication within the classroom. It should be noted that not all students benefited from the facilitators to the same degree.

One of the facilitators, self-advocacy, was mentioned frequently as a behavior that students either engaged in or should be engaging in to increase competency and use of AT. Self-advocacy took various forms. Some students talked with their professors on the first day of class, informing them of their disability and requesting the use of AT, such as PowerPoint™, that would aid them in comprehending lectures. One student, Ken, reported giving the professor options as to what specific accommodations would meet his needs.

> I would go to the teacher and ask the teacher if the teacher could adapt, develop PowerPoint™s, online work that repeats what we're going to discuss. Maybe at the same time, I ask if there are any volunteers, student note-takers for me, document any information.

Other students recognized the need to self-advocate but talked about their reluctance to do so. Students who did self-advocate reported positive results, as exemplified when a professor either switched to PowerPoint™ or gave the student hard copies of lecture notes.

Another facilitator of technology use was teamwork. This is especially important when the student was trying to coordinate a triad of information: professor lecture, interpreter signing, and reading PowerPoint™ slides. Jennifer admitted that she has difficulties coordinating this triad of information during class and needs to address this issue with her interpreter. "I need to let the interpreter know," Jennifer stated, "that if it's just a sentence, then go ahead and sign it. But if it's a paragraph, then give me enough time to read it." Teamwork became a facilitator when students expressed their needs regarding the triad of information to their interpreters.

Botina contrasted her experience in high school when teamwork was not facilitating comprehension to her experience at the university where the technology appears to have facilitated teamwork.

> Well, like in high school they never had handouts or PowerPoint™s, so I would always be like lost because of the group. And I'm like 'Wait, I was looking at the interpreter'. And I don't know what is going on in the group, and it was overwhelming. They were moving so right away and talking so fast, and the interpreter was just off, and I miss. Now, with the PowerPoint™ and the handouts, the group is more focused and helping me more, and it slows down the interpreter also.

Consequently, teamwork was identified as a facilitator when the student, professor, and interpreter all understood the student's technological needs and the benefits, as well as the limitations of AT.

As described in the section of self-reported AT use, students had a wide variance in the types of AT they used and preferred. One student expressed her delight and fascination with an interactive whiteboard technology, specifically, the SmartBoard™. Hayley spoke of the benefit of using a Smartboard™ in one of her classes.

> I think it helps instructors to focus on the subject. Focus on the presentation. It provides something you can use for presentations. Teachers can add to the discussions from the group and put it on the Smartboard™. It makes it easier for me to see what other people are saying. It's very fluid. It helps things go nicely.

Hayley had the Smart Board™ available in one of her classes and used it frequently for class presentations, attending to and comprehending class discussion, and presenting her own work. She specifically mentioned that the SmartBoard™ helped her express her opinions and participate in discussions. Obviously, she had to be aware of the AT, desire to learn about the technology, and successfully experience it to benefit from it. Smartboard™ technology is not common at her university and is costly. When she was given the opportunity to learn and use this AT, she did not hesitate. One does not know if she will have the opportunity to continue to use this AT upon graduation, but she is aware of it and is now proficient in its use.

In summary, facilitators of technology included self-advocacy on the part of the participants; teamwork among professors, students, and interpreters; and the opportunity to learn about new technologies.

Discussion

The discussion is organized by the three themes that emerged from the data analysis: self-reported use of AT and overall benefits, barriers to AT use, and facilitators of AT use.

Self-Reported Use of AT and Overall Benefits

Literature focused on the use of AT by individuals who are Deaf has reflected both increased use (Bowe, 2002), a wide range of AT applications (Zazove et al., 2004), and substantial benefits of AT for a community that is Deaf (Weiserbs, 2000). Findings of this study confirmed these results with regard to students who were Deaf at a hearing university.

However, one of the unique perspectives of AT that student participants emphasized was the use of AT for socialization purposes. This is encouraging since research has suggested that students who are Deaf and students who are hearing do not socialize well together (Antia & Kreimeyer, 1996). Technology, though, may be a modality to connect students who are Deaf with students who are hearing. Weiserbs (2000) found that AT has a positive influence on the relationship between students who are Deaf with their hearing peers. In this study, many participants spoke of their use of the Sidekick® for sending emails and IM and for communicating in social settings. More generally, social networking technologies are used by the hearing population for socialization purposes (e.g., MySpace® and Facebook©). Given that the hearing population has embraced such technologies, the use of social networking tools by Deaf students would facilitate socialization within the broader university community.

Using the same technology in the classroom with all students was identified as a facilitator of inclusion for students who were Deaf. For example, the use of PowerPoint™ in the classroom provides students who are Deaf with an easily accessible AT tool that was used by all. Students identified PowerPoint™ as technology that allows them to focus on lectures and participate in the classroom, while also facilitating their inclusion in activities. Inclusiveness is important for *all* students, yet students who are Deaf can have feelings of isolation in the classroom setting (Keating & Mirus, 2003). However, in this study, use of PowerPoint™ gave participants a feeling of being included.

In university classrooms, PowerPoint™ is a commonly used presentation technology. Some colleges and universities actually require instructors to use visual supports in the classroom (Hardin, 2007), and PowerPoint™ should be viewed as a necessary accommodation for many Deaf and hard of hearing students, while recognizing its benefits as a powerful instructional technology for typical students.

Barriers to Assistive Technology Use

Participants in the current study identified several barriers to AT use. Concerns included (a) difficulties coordinating the AT during class; (b) inexperience with the AT itself; and (c) the challenge of successfully managing the triad of information from the PowerPoint™, professor, and interpreter during class. Inefficiency of AT was also addressed focusing primarily on older technologies, such as TTYs and telephone relays.

Apprehension regarding the efficiency of AT could be alleviated by providing a technology specialist who is trained in both maintenance and curricula integration of tools that malfunction intermittently. Universities typically have technology personnel available for commonly used technologies (e.g., computers), but providing personnel who are specifically trained in technologies used by students who are Deaf will benefit both students and faculty. Technical support challenges are not unique to faculty and students at hearing universities. Lack of support for AT at all educational levels has previously been documented as a barrier to AT use (e.g., Beukelman & Mirenda, 1998; Carey & Sale, 1994; Copley & Ziviani, 2004; Riemer-Reiss & Wacker, 2000).

Participant concerns about lack of familiarity with AT and infrequent usage is consistent with previous studies that focused on AT use in the public schools (Derer, Polsgrove, & Reith, 1996; Lesar, 1998; Parette, 1997; Scott, 1997). Previous literature has strongly recommended involving faculty and students in the AT planning processes, whether for a single device or an entire AT program (Carey & Sale, 1994; Copley & Ziviani, 2004; Riemer-Reiss & Wacker, 2000; Todis & Walker, 1993). This recommendation is relevant to the current study in that AT planning for a classroom or entire program needs to involve all stakeholders: faculty, students who are Deaf, technology specialists, *and* interpreters.

Literature concerning the relationship between students who are Deaf and interpreters also stresses teamwork (Luckner & Muir, 2001). Interpreters facilitate communication between students who are Deaf and their hearing teachers and hearing peers (Antia & Kreimeyer, 2001), and interpreters play important roles in the success of students who are Deaf (Luckner & Muir). Therefore, professors are encouraged to be aware of the importance of the interpreter and the interpreter's part in his/her lecture. Lectures with PowerPoint™ slides are appealing to students, but when using slides in classes that have a student who is Deaf with an interpreter, college professors should be sensitive to the needs of students who must watch the PowerPoint™ presentation, the interpreter, and the college professor. Continuous feedback between student and professor is needed since the coordination of the triad of information is no small feat for the college student who is Deaf.

Facilitators to Assistive Technology Use

Identified facilitators were self-advocacy, the use of the interpreter, and AT experience. Several participants explained their role as a self-advocate for technology use. Self-advocacy is related to self-determination and unfortunately data from the National Longitudinal Transition Study (Cameto, Marder, Wagner, & Cardoso, 2003) indicate that too few people with disabilities become self-sufficient citizens and do not fare nearly as well as their nondisabled peers after schooling (Chadsey & Shelden, 2002; deFur, 2003; Nuehring & Sitlington, 2003). Individuals who are Deaf are also in this category.

Cawthon (2001) found that students who are Deaf need to be taught how to self-advocate. Essentially, the goal of the educational process is to teach all students to become self-determined adults. However, educational systems often fail to educate students with disabilities in the area of self-determination (Wehmeyer & Schalock, 2001). Students who are Deaf must serve as their own advocates with both instructors and interpreters. Preferences regarding AT, access to instructor notes, and coordination of the triad of information should be explicitly expressed at both the beginning of the semester and throughout. In addition, effective teamwork will be facilitated if the student who is Deaf also recognizes and expresses positive feedback.

Little research has focused on self-determination skills of college students who are Deaf at a hearing university; however, self-determination must be present at some level or these students would not be receiving a college education. Hopefully, at some point in the educational experience, they have learned to self-advocate. Opportunities abound at the primary, middle, and secondary school levels for students to engage and learn self-determination skills such as self-advocacy. For example, student-led IEP meetings or student-led parent teacher conferences can provide students with opportunities to learn and gain experience in self-advocacy beginning in the early grades (Boardman, Argüelles, Vaughn, Hughes, & Klingner, 2005).

Advocacy role models in the student's family have been shown to be positive influences on the development of self-advocacy (e.g., Grigal, Neubert, Moon, & Graham, 2003; Stoner, Angell, House, & Goins 2006). Opportunities to self-advocate for specific uses of AT would benefit students who are Deaf when approaching faculty to request specific AT use. When students in this study self-advocated effectively with faculty, the benefit was two-fold. Not only did the student get the needed AT, but the faculty member was able to plan and provide for AT in the classroom.

Teamwork associated with AT is a vital and necessary component for effective use. Team collaboration is widely acknowledged as best practice and mandated by IDEIA to most effectively identify, secure, and implement AT (Beigel, 2000; Downing, 2005; Lahm & Nickels, 1999; Locke & Mirenda, 1992). Students who have completed high school and are enrolled at universities are not covered by the benefits of the IDEIA, but may certainly take advantage of establishing and working with a team of stakeholders who are willing to facilitate their academic success. Teams should include the student who is Deaf, the interpreter in the classroom, the professor, the office of disability concerns, and the student's advisor. If all these team members would consult and plan for effective AT use, the student as well as the faculty would benefit.

When PowerPoint™ presentations are used by faculty in the classroom, the team should include the instructor, the student, and the interpreter. This seems to be especially important when the triad of information is coordinated. The team should discuss the use of PowerPoint™ during the instructor's lecture (read the slide verbatim or add information as students read); the interpreter's role (interpret the PowerPoint™ slide as professor reads or just point directing the student to read); and the student's self-advocacy (express when having difficulty with watching all three: interpreter, professor, and PowerPoint™). Decisions could be negotiated according to individual preferences regarding when to sign, how long to allow the student to read slides without interruption, and how to inform the student that the instructor is providing new information not on the slides.

Limitations

While this study utilized responsible qualitative research methodologies, there are several limitations that might influence the validity of the findings. The first limitation of this study is related to generalizability of the findings which is inherent in qualitative research. The findings are based only on the perspectives of nine Deaf students at a large hearing university in one Midwestern state. A sample using more universities in a larger geographic region would have enhanced the generalizability of the findings.

Similarly, since the study was conducted at only one university, Deaf students from other universities may have different experiences with AT. Similarly, faculty from other universities may have had more or less experience with Deaf students, which could have resulted in different outcomes related to perceived barriers and facilitators to use of AT in university classrooms. Therefore, caution must be exercised not to generalize the experiences, perspectives, and responses of the participants to all Deaf students at hearing universities.

References

Americans with Disabilities Act, 42 U.S.C. §§ 12101 *et seq*. (1990)

American Psychological Association. (2001). *Publication manual of the American Psychological Association* (5th ed.). Washington, DC: Author.

Antia, S. D., & Kreimeyer, K. H. (1996). Social interactions and acceptance of deaf or hard-of-hearing children and their peers: A comparison of social-skills and familiarity-based interventions. *Volta Review, 98*, 157-180.

Antia, S. D., & Kreimeyer, K. H. (2001). The role of interpreters in inclusive classrooms. *American Annals of the Deaf, 146*, 355-365.

Barbour, R. S. (2001). Checklists for improving rigor in qualitative research: A case of the tail wagging the dog? *British Medical Journal, 322*, 1115-1118.

Beigel, A. R. (2000). Assistive technology assessment: More than the device. *Intervention in School & Clinic, 35*, 237-244.

Beukelman, D., & Mirenda, P. (1998). *Augmentative and alternative communication: Management of severe communication disorders in children and adults* (2nd ed.). Baltimore: Brookes.

Boardman, A. G., Argüelles, M. E., Vaughn, S., Hughes, M. T., & Klingner, J. (2005). Special education teachers' views of research-based practices. *Journal of Special Education, 39*, 168-180,

Bowe, F. G. (2000). *Broadband and Americans with disabilities*. Silver Spring, MD: National Association of the Deaf. Retrieved September 26, 2008, from http://www.newmilleniumresearchorg./disability.pdf.

Bowe, F. G. (2002). Deaf and hard of hearing Americans' instant messaging and e-mail use: A national survey. *American Annals of the Deaf, 147*(4), 6-10.

Cameto, R., Marder, C., Wagner, M., & Cardoso, D. (2003). Youth employment. In *NTLS2 Data Report: Reports from the National Longitudinal Transition Study, 2*(2). Retrieved September 26, 2008, from http://www.ncset.org/publications/viewdesc.asp?id=1310

Carey, D. M., & Sale, P. (1994). Practical considerations in the use of technology to facilitate the inclusion of students with severe disabilities. *Technology and Disability 3*, 77-86.

Cawthon, S. W. (2001). Teaching strategies in inclusive classrooms with deaf students. *Journal of Deaf Studies and Deaf Education, 6*, 212-225.

Chadsey, J., & Shelden, D. (2002). Social life. In K. Storey, P. Bates, & D. Hunter (Eds.), *The road ahead: Transition to adult life for persons with disabilities* (pp. 137-156). St Augustine, FL: Training Resource Network.

Charmaz, K. (2000). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 509-536). Thousand Oaks, CA: Sage.

Copley, J., & Ziviani, J. (2004). Barriers to the use of assistive technology for children with multiple disabilities. *Occupational Therapy International, 11*, 229-243.

Creswell, J. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Merrill Prentice Hall.

deFur, S. H. (2003). IEP transition planning: From compliance to quality. *Exceptionality, 11*, 115-128.

Derer, K., Posgrove, L., & Reith, H. (1996). Survey of assistive technology applications in schools and recommendations for practice. *Journal of Special Education Technology, 8*, 62-80.

Downing, J. (2005). *Teaching communication skills to children with severe disabilities*, Baltimore: Brookes.

Fontana, F., & Frey, J. (2000). The interview: From structured questions to negotiated text. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 645-672). Thousand Oaks, CA: Sage.

Grigal, M., Neubert, D. A., Moon, M. S., & Graham, S. (2003). Self-determination for students with disabilities: Views of parents and teachers. *Exceptional Children, 70*, 97-112.

Hardin, E. E. (2007). Presentation software in the college classroom: Don't forget the instructor. *Teaching Psychology, 34*(1), 53-57.

Individuals with Disabilities Education Improvement Act, 20 U.S.C. §§ 1400 *et seq*. (2004)

Janesick, V. (2000). The choreography of qualitative research design. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 379-399). Thousand Oaks, CA: Sage.

Keating, E., & Mirus, G. (2003). Examining interactions across language modalities: Deaf children and hearing peers at school. *Anthropology & Educational Quarterly*, *34*, 115-135.

Kolvitz, M., Billies, P., Wilcox, D., & Rawlinson, S. (2003, July). *A showcase of services and resources for students who are deaf or hard of hearing*. Symposium conducted at the meeting of the Ahead: Association on Higher Education and Disability, Dallas, TX.

Komesaroff, L. (2005). Category politics: Deaf students inclusion in the 'hearing university.' *International Journal of Inclusive Education, 9,* 389-403.

Lahm, E. A., & Nickels, B. L. (1999). Assistive technology competencies for special educators. *Teaching Exceptional Children, 32*(1), 56-64.

Lesar, S. (1998). Use of assistive technology with young children with disabilities: Current status and training needs. *Journal of Early Intervention, 21*, 146-159.

Locke, P., & Mirenda, P. (1992). Roles and responsibilities of special education teachers serving on teams delivering AAC services. *Augmentative and Alternative Communication, 6*, 38-49.

Luckner, J. L., & Muir, S. (2001). Successful students who are deaf in general education settings. *American Annals of the Deaf, 146*, 435-446.

Mackowiak, K. (1989). Deaf college students and computers: The beneficial effect of experience on attitudes. *Journal of Educational Technology Systems, 17*, 219-229.

Michaels, C. A., & McDermott, J. (2003).

Assistive technology integration in special education teacher preparation: Program coordinators' perceptions of current attainment and importance. *Journal of Special Education Technology, 18*(3), 29-44.

Milani, A. A. (1996). Disabled students in higher education: Administrative and judicial enforcement of disability law. *Journal of College and University Law, 22*, 989-1043.

Miles, M., & Huberman, A. (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage.

Mistreet, S. G., Lane, S. J., & Ruffino, A. G. (2005). Growing and learning through technology: Birth to five. In D. Edyburn, K. Higgins, & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 273-307). Whitefish Bay, WI: Knowledge by Design.

No Child Left Behind Act, 20 U.S.C. §§ 6301 *et seq*. (2001)

Nuehring, M. L., & Sitlington, P. L. (2003). Transition as a vehicle: Moving from high school to an adult vocational service provider. *Journal of Disability Policy Studies, 14*, 23-35.

Parette, H. (1997). Assistive technology devices and services. *Education and Training in Mental Retardation and Developmental Disabilities, 32*, 267-280.

Power, D., Power, M. R., & Rehling, B. (2007). German deaf people using text communication: Short message service, TTY, relay services, fax, and e-mail. *American Annals of the Deaf, 152*, 291-301.

Rehabilitation Act Amendments, 29 U.S.C. §§ 701 *et seq*. (1973)

Riemer-Reiss, M. L., & Wacker, R. R. (2000). Factors associated with assistive technology discontinuance among individuals with disabilities. *Journal of Rehabilitation, 66*(3), 44-50.

Scott, S. B. (1997). Comparison of service delivery models influencing teachers' use of assistive technology for students with severe disabilities. *Occupational Therapy in Health Care, 11*(1), 61-74.

Stake, R. (2000). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 435-454). Thousand Oaks, CA: Sage.

Stinson, M., Stuckless, E. R., Henderson, J., & Miller, L. (1988). Perceptions of hearing-impaired college students toward real-time speech to print: RTGD and other educational support services. *The Volta Review, 90*, 339-348.

Stoner, J. B., Angell, M. E., House, J. J., & Goins, K. (2006). Self-determination: Hearing the voices of adults with physical disabilities. *Physical Disabilities: Education and Related Services, 41*(2), 3-35.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage.

Todis, B., & Walker, H. M. (1993). User perspectives on assistive technology in educational settings. *Focus on Exceptional Children, 26*(3), 1-16.

Ward, P., Wang, Y., Paul, P., & Loeterman, M. (2007). Near-verbatim captioning versus edited captioning for students who are deaf or hard of hearing: A preliminary investigation of effects on comparison. *American Annals of the Deaf, 152*, 20-28.

Wehmeyer, M. L., & Schalock, R. L. (2001). Self-determination and quality of life: Implications for special education services and supports. *Focus on Exceptional Children, 33*, 1-16.

Weiserbs, B. (2000). Social and academic integration using e-mail between children with and without hearing impairments. *Computers in the Schools, 16*, 29-44.

Zazove, P., Meador, H. E., Derry, H. A., Gorenflo, D. W., Burdick, S. W., & Saunders, E. W. (2004). Deaf persons and computer use. *American Annals of the Deaf, 148*, 376-384.

Appendix A

Interview Questionnaire for Deafed.net Research Project

Please answer as many questions as you can. You may skip questions you feel uncomfortable answering, or do not apply to you. Some questions may have several answers that apply to you. You are not limited to one choice.

Demographic Information

Please answer the following written questions.

1. What is your gender?
   a. Male
   b. Female
2. How old are you?
   a. 16-19
   b. 20-29
   c. 30-39
   d. 40-49
   e. 50+
3. What is your nationality?
   a. Caucasian
   b. African American
   c. Hispanic
   d. Native American
   e. Asian
   f. Pacific Islander
   g. Other
   h. Not Available
4. What is your hearing status?
   a. Deaf
   b. Hard of Hearing
   c. Other
5. What is the cause of your hearing loss?
   a. Genetic
   b. Childhood disease
   c. Trauma
   d. Age-related
   e. Unknown
   f. Other
6. Check all of the answers that describe where you were educated from 3 years-to high school graduation.
   a. Residential School
   b. Self-Contained class with a deaf educator in a public school program
   c. Integrated/Mainstreamed into general/regular education classes with an interpreter
   d. Integrated/Mainstreamed into general/regular education classes without an interpreter
   e. Other
7. Which of these describes your *primary* place of education?
   a. Residential School
   b. Self-Contained class with a deaf educator in a public school program
   c. Integrated/Mainstreamed into general/regular education classes with an interpreter
   d. Integrated/Mainstreamed into general/regular education classes without an interpreter
   e. Other

Real World Applications of Technology

8. Which of the following internet technologies do you use?
    a. Email
    b. Chat Rooms
    c. Instant Messaging
    d. Blogs
    e. Listservs
    f. Web Boards
    g. Usenet
    h. Text Relay
    i. Video Relay
9. Of the internet technologies that you use, how often do you use them and what benefits (if any) do they provide you?
10. Which of the following portable communication devices do you use?
    A. Blackberry
    B. RIM
    C. Sidekick
    D. PDA
    E. O-Go
    F. Cell Phones
    G. Other
11. When using portable communication devices, which programs do you use frequently?
    a. Email
    b. Instant Messaging Programs
    c. Relay
    d. SMS/Text Messaging
    e. Internet
12. Of all the portable communication devices you use, what benefits do they provide you?

Technology in the Classroom

13. Please describe how you use technology in your classes.

14. What technologies do instructors/professors/ lab assistants/teacher assistants use in your classes/labs?
15. How does technology facilitate communication between you and your hearing peers?
16. How has technology assisted your integration into the college classroom?
17. How has technology improved or changed your communication with college faculty?
18. How has technology improved your understanding of class lectures?
19. How has technology improved your understanding of material in labs, study groups, etc.?
20. If you don't utilize an interpreter what, if any, technology do you use to acquire information from lectures, from professors, and from peers?
21. What, if any, assistive listening devices do you use?
22. If you could design an assistive listening device, what would you incorporate and why?
23. How can technology improve lecture comprehension?
24. How has classroom technology changed since you were a child?
25. Have you improved or changed your assistive listening devices since you were a child?
26. What classroom struggles do you have that technology could make easier?

Assistive Technology and Emergent Literacy for Preschoolers: A Literature Review

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Abstract: Despite the legislative mandate for assistive technology (AT) consideration and the tenacity of researchers, educators, and practitioners to develop more proficient readers at younger ages, cohesive and comprehensive emergent literacy technology planning has not been sufficiently developed for preschool children with disabilities. The purpose of this review is to synthesize information and research on available AT used with young children to promote the development of emergent literacy skills. Following the background discussion, key articles will be summarized, synthesized, and critiqued. Discussion focuses on the lack of empirical research in the combined areas of emergent literacy, AT, and preschool children; the need for conceptualized definitions of AT and emergent literacy across disciplines; existing barriers; and gaps in the research.

Keywords: Assistive technology, Emergent literacy, Preschool, Early childhood

Literacy skills are critical for every person in the U.S. Legislation such as the Goals 2000: Educate America Act and No Child Left Behind Act of 2001 (NCLB) stress the importance of reading at every entry level--from early childhood through adulthood. They have emphasized that creating a literate society is considered of paramount importance. Given this expectation for children entering Kindergarten, the push for effective, early, literacy instruction must become a curricular concern and emphasis for early childhood educators. Additionally, the prominence of providing students with disabilities access to the general curriculum only strengthens the significance of literacy skill development in early childhood environments given that access to the general curriculum for preschool children occurs within the daily, instructional, early childhood curricula.

Developing the skills necessary to become literate and perform competently in a literate society begins very early in a child's life. From birth, children begin to interact with the world around them, and some of the most naturalistic behaviors of children can influence the beginnings of literacy development. For the purpose of this article, emergent literacy is conceptualized as global early experiences that create a foundation of life-long literacy and academic and personal success (Lankshear & Knobel, 2003). The early experiences that children engage in from birth through the time when they adopt conventional literacy skills bring "meaning to reading and writing" (Koenig & Holbrook, 2000, p. 265). These early experiences include: (a) learning to listen and respond to oral communication; (b) interacting with written text (e.g. holding books, 'reading' books by using the pictures); and (c) exploring the written and verbal world (e.g. scribbling with a crayon, turning pages, talking with others, and pretending to read; Justice & Pullen, 2003; Koenig, 1992). In short, emergent literacy is the cornerstone of future literacy functioning.

NCLB created the Early Reading First (ERF) program to improve teacher practices, instructional content, and classroom environments in preschool settings. The anticipation was to assist in ensuring that young children start school with the skills needed for academic success. Whether educators and researchers agree on the means government is using to promote literacy and institute lofty literacy goals for all children, there is no disagreement that literacy is one of the most important areas of learning for all individuals. There is a stronger emergent literacy skill development research base for children ages five to eight, K-3rd grade, and older elementary and middle grade students than for children who are three to five years of age. In general, the research base is slowly but steadily validating best practices for early literacy education of children (Erickson & Koppenhaver, 1995).

Assistive Technology

Just as the definition of early literacy has expanded, so have the parameters of assistive technology (AT). Technology can take many forms such as (a) no-tech, (b) low-tech, and (c) high-tech. No tech is simply that: no technology is involved; instead, strategies are used to provide an opportunity for learner success (e.g. extended time, colored folders, index cards, chunking materials, and/or pairing pictures with print). Low-tech solutions involve use of straightforward tools such as simple voice output devices, adapted scissors, raised-lined paper, step-by-step picture schedules, and /or printed labels with essential vocabulary. High-tech solutions typically involve the computer or have computer components, such as specialized software and advanced hardware devices. AT encompasses both low- and high-tech options with the federal definition culminating and addressing all aspects:

AT has been defined in the Individuals with Disabilities Education Improvement Act of 2004 (IDEIA) as "any item, piece of equipment, or product system, whether acquired commercially or off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability" [20 U.S.C. § 1401(a)(25)]. This legislation echoed the benefit of AT by emphasizing that both Individualized Education Plan (IEP) and Individualized Family Services Plan (IFSP) teams consider the use of AT within the child's learning environment (Mandlawitz, 2006). Addressing AT considerations is not a mere luxury, but rather a federally mandated requirement.

In addition to the federal mandates, a position statement generated by the Division on Mental Retardation and Developmental Disabilities of the Council of Exceptional Children stated that persons with developmental disabilities do, in fact, benefit from the use of AT (Parette, 1997). More specifically for young children, the National Association for the Education of Young Children (NAEYC, 1996) has supported the developmentally appropriate integration of technology in preschool settings.

AT can benefit children with increased opportunities for socialization, communication attempts and interaction, increased self-esteem and confidence, as well as developing language and communication skills (Erickson & Koppenhaver, 1995; Hutinger & Clark, 2000). This parallels the Social Learning Theory first presented by

Vygotsky (1996) in which children learn through interaction, communication, and play, thus strengthening the importance of AT and its critical link to increased communicative attempts, more engaged play, and increased socialization. Children vary greatly on how they access, use, and engage learning materials (Strangman & Dalton, 2005). AT provides tools for young children to become active versus passive learners.

Preschoolers with special needs have many options at their disposal with the advances in technology, availability of AT, as well as the growing array of AT devices. However, it should be noted, having a repertoire of devices is not enough to ensure that the needs of a student are compensated with appropriate technology tools. The challenge has been taking the next step, such as matching appropriate AT to the needs of preschoolers with disabilities. A key factor to successful integration is to match learner needs with appropriate technology needed for the instructional task, while simultaneously evaluating the teacher's knowledge and experience to implement the AT (Judge, 2006).

AT, Emergent Literacy, and Preschool Aged Children

AT may hold promise for helping aid children's development in many areas; however, even with the recognition of the benefits of technology there has been little information about the effect technology use has on preschool-aged children's development (Skeele & Stefankiewicz, 2002). It is very possible that AT could enhance the developmental skills targeted by emergent literacy activities (e.g., cognitive development, language development), but there is a dearth of empirical studies which address the acquisition of emergent literacy skills and the use of AT.

Earlier works of Kamil and Intraror (1998) and Lankshear and Knobel (2003) exposed the fact that the area of literacy and the use of technology were radically under-researched. Kamil and Intraror reviewed the literature for empirical based research articles from the years 1986 to 1995 that pertained to school–aged children and literacy and technology use in a broad sense. Lankshear and Knobel built on Kamil and Intrator's review by surveying professional journals for research studies published from 1996 through 2002, and which encompassed new technologies (computer-based applications) and early childhood literacy (ages 0-8 years). Building on these earlier works we examined current literature that addressed assistive technology, emergent literacy and early childhood (ages 3 to 5).

The purpose of this review is three-fold: to (a) conduct a literature review of scholarly publications in the area of AT that focus on emergent literacy for preschoolers, (b) discuss the outcomes and benefits of AT, and (c) describe implications for future research. This review closely follows a research synthesis model developed by Edyburn (2000). Within such a model, the examination of the literature was conducted by applying four procedures. These included: (a) search procedures, (b) inclusion criteria, (c) relevance, and (d) completion of article analysis form per each article reviewed. The following section provides greater detail regarding each procedure.

Method

Procedures

Search procedures. Article search procedures were conducted using the following components: (a) electronic-based searches in the Library Information Access System through the Educational Resources Information Center (ERIC), ProQuest, and

Infotrac® using AT with key descriptors or truncation (i.e., 'technology,' 'disabilities,' 'alternate and augmentative communication [AAC],' 'emergent literacy,' 'early literacy,' 'preschool'); (b) a manual search of refereed journals publishing articles on disabilities, early childhood education, literacy, AAC, and AT; and (c) a traditional search using the reference section of articles obtained through the above two methods.

Inclusion criteria. Using the selection criteria procedures described above, more than 500 articles were found. The selection

Table 1
Coverage and Scope of Articles Selected for Review

Study	Purpose	Critique
Beck (2002)	Case study examining how AT affected emergent literacy in a preschool classroom for students with multiple disabilities	Variations were noted in how technology components were used which may call into question the fidelity, reliability and validity Case study methodology. Noted a teacher-made checklist to collect data on progression of both student receptive and expressive knowledge of symbols though it was not specifically described. Technologies used: picture communication symbols, adapted books, Big Mack switch, Intellikeys/Intellitools.
Hutinger et al. (2006)	Longitudinal Study *Dependent variable:* Computer use; teacher perception *Independent variables:* Use or non use of the model Length of time the teachers received replication training and follow up	Strong reliability, validity, and fidelity measures *Primary findings:* Teachers need significant training and support when implementing an innovation Children did make gains in literacy measures *Secondary findings:* Data analysis is ongoing Technologies used: computer-based activities/software
Lankshear & Knobel (2003)	Intent was to map recent research pertaining to new technologies and early childhood literacy in ways that may be useful to early childhood educators and researchers	Teachers' attitudes and perceptions did impact technology use and were related to lack of understanding software, narrow definition of literacy, lack of time, and expertise. Similar search and procedure as this review.
Marsh (2004)	Family surveys: Avg age of children in the families was 2 yrs 8 mo. Families were targeted from disadvantaged environments in home. 26 families of the 44 volunteered to be interviewed and they were the parents of 13 boys and 13 girls	The authors make a case for techno-literacy to actually be considered a form of emergent literacy in itself; in essence, it is not how technology can enhance literacy but the fact that technology has become a part of emergent literacy as much as the experience. Different cultural perspective than the dominant culture in the U.S. Technology used: television, film, computer games, and mobile phones.

criterion was further refined by limiting the inclusion to AT with the following categories: emergent or early literacy (n = 23), then further refinement of early childhood literacy (n = 6). Articles published between the years 2002 to 2007 were reviewed to establish the relevance to the special topic of the emergent literacy and the use of AT. Only peer-reviewed articles published in journals were used in this review. See Table 1 for a brief purpose and content analysis of articles selected for review.

Relevance. An article was determined relevant and was included if it was peer-reviewed and published between 2002 and 2007 and the primary focus of the article was related to AT in the areas of preschool, early literacy, or emergent literacy. Articles were excluded if (a) AT was only mentioned as a consideration or a recommendation; (b) AT was demonstrated as a tool, but not one specifically targeting early or emergent literacy; or (c) emergent literacy research was conducted on children older than five years.

Article analysis. A content analysis was generated to provide a summary of selected articles. The analysis was divided into examining six categories (a) background information (i.e., full citation, purpose of study); (b) participant characteristics (i.e., background characteristics of study participants, number not completing study and why); (c) research design (i.e., design of the study, description of theory or model); (d) practice characteristics (i.e., independent variables; characteristics of the intervention measures; treatment fidelity); (e) outcomes (i.e., outcome measures; how were they measured; measurement of reliability or validity); and (f) synthesis findings (i.e., how are characteristics of the practice related to the outcome; positive or negative outcomes; level of measurement used to describe the practice and outcome). Results from the analysis are summarized in Table 1.

Limitations

This review was a focused examination of current articles (within the last five years) specifically addressing AT, emergent literacy, and early childhood. Because of the specific nature of this review, there are limitations that should be noted. One possible limitation may be the omission of important articles written prior to 2002, or work not published in peer-reviewed journals (e.g., reports, conference papers, etc.). Another possible limitation may be the exclusion of articles outside the parameters of all three descriptors (i.e., AT, emergent literacy, and early childhood). An attempt to conduct an exhaustive search of literature was the ultimate goal; however, there may have been additional search techniques not explored. Only journal articles published in English were examined in this review. This resulted in a pool of only five articles meeting the specific criteria for this review.

Findings and Discussion

This section of the review includes a synthesis of the findings from five articles satisfying the selection criteria. Specifically, this section will provide an assessment of available research in the field of AT and preschool children's emergent literacy development. This review investigated the following themes present in the body of research: (a) lack of clear or poorly communicated conceptualizations of key terminology, (b) implementation barriers, and (c) limited research base.

Conceptualization Problems

As stated previously, the intent of this review was to find articles that specifically addressed emergent literacy and AT within the context of preschool aged children's development. When examining the selected articles, there appeared to be a lack of or poorly communicated delineation of the terms 'emergent literacy' and 'AT.' Differences in orientations with regard to these two key terms could lead to a convoluted conceptualization.

In all of the articles reviewed the authors noted that there was considerable work in the area of emergent literacy; however, authors of three articles did suggest that the term emergent literacy had been limited only to print-based materials. Marsh (2004) stated that the view of current definitions of emergent literacy were too restrictive and needed to be reconceptualized. Lankshear and Knobel (2003) concurred with Marsh's evaluation and assertion that the acquisition of literacy is too narrowly defined. All of these researchers agree that literacy experiences should be viewed in a monolithic way by examining emergent literacy with a broader approach and within a variety of contexts. These researchers made a point to explain that they were examining 'techno-literacy,' but did not clearly define the dimensions of such a term. Further, when these researchers introduced the term techno-literacy they may inadvertently generated a distinction between techno-literacy and emergent literacy where the terms had been perceived as two different entities.

Hutinger, Bell, Daytner, and Johanson (2006) broadly conceptualized the term to encompass a wide array of skills and behaviors. They demonstrated their broader conceptualization by the scope of their outcome measures through examination of emergent literacy behaviors beyond simple print awareness and interactions with text. In their three year longitudinal study, Hutinger et al. examined the emergent literacy growth of preschool children at risk for or having disabilities (e.g., orientation to book, assessing early writing development, child's communicative attempts); student behavioral changes with regard to literacy (e.g. attending skills, interactivity, response to pictures); and teacher outcomes (e.g. increased comfort with technology, resources and technical assistance needed). These researchers reflected a marriage between emergent literacy and technology with AT providing an avenue for interaction and engagement with literacy.

Interestingly, Beck (2002), in an article published more for early childhood education practitioners, narrowly defined emergent literacy in both scope and validation of AT: "Emergent literacy is concerned with the early phases of literacy development, the period between birth and the time when children read and write conventionally" (p. 44). Unlike the other articles reviewed, there was no clear assertion that technology should be considered in the conceptualization of emergent literacy.

Another interesting finding related to the conceptualization of emergent literacy was that the articles in research journals seemed to stress the need for incorporating technology literacy within the construct of emergent literacy. In contrast, the article in a practitioner friendly journal presented a very traditional definition of emergent literacy and AT, with AT not being considered as an integral part of an emergent literacy program. There was no clearly operationalized definition of emergent literacy across the articles reviewed. All of the ideas were related but there were slight, and possibly unintended, variations in the conceptualization of emergent literacy across studies. A universal definition of the term emergent literacy is needed to include behaviors for interacting with both print and technology-based materials. In light of these findings, it is evident that future research would benefit from a consistent and global description of what constitutes emergent literacy behaviors taking into account the advancements in technology and other learning tools, such as digital and virtual learning.

The problems with the conceptualization of AT is slightly different than the conceptualization of emergent literacy. Variations in the conceptualization of emergent literacy are often reflected across researchers in the field (c.f., Beck, 2002; Neuman & Dickenson, 2001). In contrast, the conceptualization of AT has benefited from a well-defined standard definition provided by federal mandates. However, in implementation, variations in the conceptualization of AT can occur from other professional, general educators, curriculum developers, and families. For example, the impetus for expanding access and educational opportunities for all learners has resulted in a stronger examination of universal design for learning (UDL) principles and its integration into classrooms. The concept of UDL has blurred the once clean definition of AT. Consequently, many persons both in and outside the field of AT and special education view AT and UDL as synonymous entities.

To expound, many researchers in the field of AT conceptualize AT as a continuum of devices and strategies (Mistrett, Lane, & Ruffino, 2005). Other educators and professionals tend to equate AT with more expensive high-tech devices often overlooking low-tech options; that is, sometimes individuals of influence in a child's education may overlook effective low-tech devices and may be dissuaded from investigating AT because of a perceived expense and training requirements (Ashton, 2000). This incorrect conceptualization may be inadvertently reinforced because many AT research articles seem to focus more on high-tech options. This was true for articles in this review: three articles dealt exclusively with high-tech (Hutinger et al., 2006; Lankshear & Knobel, 2003; Marsh, 2004); one focused on both high- and low-tech (Beck, 2002); and only one article investigated low-tech resources (Weikle & Hadadian, 2003). AT can be incorrectly conceptualized when the focus is placed on the technology itself rather than technology as a tool for learning.

Barriers to Implementation

A majority of articles reviewed discussed possible barriers to using technology with young children (Hutinger et al., 2006; Lankshear & Knobel, 2003; Marsh, 2004; Weikle & Hadadian, 2003). The most common barrier identified in this review dealt with teacher perceptions, attitudes, and practices. Teachers play a significant role in the implementation of technology in the classroom while parents were viewed as the gatekeepers and implementers in the home environment (Hutinger et al.). Studies reveal that teachers need training and technical support to infuse AT into their classrooms. Given that technology seldom is implemented with young children in isolation, there is no doubt that the teacher's ability, confidence, as well as perceived usefulness of the technology greatly influence the frequency and duration of technology use (Hutinger et al.). As a result, teachers with greater levels of perceived comfort with technology were also more likely to implement technology-enhanced activities versus only viewing the computer as the only source of technology (Hutinger et al.).

Weikle and Hadadian (2003) provided practical recommendations for parents and professionals to enhance literacy by using AT. The authors emphasized that both parents and professionals are hesitant and resistive to acknowledge the importance of technology in the enhancement of emergent literacy skill development. It was also revealed that the lack of society's acceptance of AT with the youngest of learners does create a barrier to implementation of possible successful intervention strategies.

Interestingly, the identified barriers revolved around socio cultural issues rather than practical concerns. For example, none of the studies in this review suggested that funding, either positively or negatively, influenced AT and emergent literacy instruction. Likewise, technology itself was not identified as a barrier.

Limited Research Base

This examination identified a recurring theme that there is a limited amount of research addressing AT, emergent literacy, and preschool children simultaneously. This paucity of research was addressed in some manner within all articles reviewed. Lankshear and Knobel (2003) examined 'new technology' as it relates to emergent literacy and characterized the research in this area as 'piecemeal' and 'hopelessly inconclusive.'

For this review, a concerted effort was made to locate scholarly articles in the areas of AT, emergent literacy, and preschool children concomitantly. Given the criterion, the review only yielded five peer reviewed articles in the past 5 years. One of the articles selected for analysis in this review was a review of research from 1996 to 2002 (Lankshear & Knobel, 2003). These researchers used similar procedures implemented in this review and located only five articles. Therefore, over an 11-year period, only 11 articles were located which addressed the search descriptors. As previously discussed, much work continues to address emergent literacy skill acquisition as well as the use of AT, though not in conjunction with each other at the preschool level.

Outcomes and Benefits of AT

The premise of this literature review was that meaningful integration of technology could enhance emergent literacy for preschool children. This review generated the following: a need for (a) more empirical research in the area of AT, emergent literacy, and early childhood; (b) shared professional perspectives regarding the conceptualization of emergent literacy, technology, and AT in early childhood education; (c) increased collaboration, communication, and investment of time and resources among key stake holders regarding AT and its role in emergent literacy for young children; and (d) heightened recognition of the socio cultural influences affecting technology and AT integration in early childhood emergent literacy programs and activities. Each of these is discussed in the following section.

Need for Empirical Research

Technology is indeed an undisputable presence in all aspects of life in contemporary society today. In 2003, 91% of children in nursery school through 12th grade (n = ~53 million) used computers and 59% (n = ~35 million persons) used the Internet. The high percentage of preschool-aged children in 2003 that actively interacted with computers and computer related technologies (66%; n = ~3 million preschoolers) further accentuates the presence of technology in the lives of individuals beginning at a very young age (National Center for Educational Statistics [NCES], 2005).

Further evidence of the trend toward increased technology integration on a very basic level is the continuing increase of computers and their use in American schools. In 1998 the average public school contained approximately 90 computers as compared to approximately 154 computers in 2005. Additionally, access to the Internet in instructional settings has increased from 51% to 94% from 1998 to 2005 (NCES, 2008).

To ensure full potential for students with disabilities from this increased access to computers and the Internet, AT is often an integral part of the instructional activity. As a result, researchers must decipher the effectiveness of AT isolated from other educational interventions (Fennema-Jansen, Edyburn, Smith, Wilson, & Binion, 2007). Currently, initiatives are in place to gauge the outcomes of AT in school settings (e.g., Project OATS; Fennema-Jansen et al.). While there are similarities in preschool children's abilities, use, and needs a compared to older children's skill sets, an examination of appropriate AT tools and devices for preschoolers is underexamined (Judge, 2006; Lankshear & Knobel, 2003). More AT projects such as Let's Play (http://letsplay.buffalo.edu/index.html) and similar initiatives are needed to provide a foundation for future research.

Common Conceptual Framework

Research studies in the area of AT, emergent literacy, and preschool children that adhere to scientific rigor (e.g., replicable, empirically sound) and work in tandem with current programs and practices provide insightful information to chart new pathways for learning. The process of establishing a conceptual framework is currently reflected in the efforts of several states (e.g., Florida and Georgia) to establish emergent literacy curriculum standards for preschools. Another example is the National Educational Technology Standards for Students (NETS-S; International Society for Technology in Education, 2007) in grades PK-2 (ages 4-8). The next step in extending and refining the conceptualization of emergent literacy and AT with preschool children is to look across published standards to identify commonalities and interrelatedness. This conceptualization allows for the development of measurable indicators for technology and emergent literacy competence in young children. A common conceptual framework provides parameters for researchers, educators, and families.

Increased Collaboration, Communication, and Investment

Increased collaboration, communication and investment of time and resources among key stake holders regarding AT and its role in emergent literacy for young children is essential. Lankshear and Knobel (2003) asserted that few mainstream journals address technology in conjunction with emergent literacy. It is critical that successful practices be disseminated to those needing the information most (i.e., families and professionals). In order to provide key resources and proven approaches, stakeholders must align technology and strategies, while carefully documenting outcomes. Through collaboration, stakeholders bring about the best literacy experiences and opportunities for preschoolers with each lending their expertise and insight.

Recognize Socio Cultural Influences

Evidence-based practices and programs promoting effective integration of technology and AT with emergent literacy can be rendered ineffectual by extenuating socio cultural influences. For example, teachers who are not comfortable with technology and do not use technology in their personal lives may be resistant to integrating technology in emergent literacy programs. In this case, teachers' comfort levels determined the socio cultural environmental condition for the children they were serving. Additional socio cultural factors such as family beliefs, interaction patterns, gender, ethnicity, and socioeconomic status (SES), can be involved in determining effective integration practices. Further, it appears a catalyst for widespread implementation of AT with young children lies in addressing socio culture challenges present in early childhood environments.

Conclusion

Researchers and practitioners alike have advocated that working on developing emergent literacy skills among young children could help alleviate negative academic and personal outcomes. As technology continues to expand and grow, more AT, both low- and high-tech, will continue to be developed. Therefore, incorporating technological advances should be a key component in designing the most effective and innovative emergent literacy interventions.

References

Ashton, T. M. (2000). Assistive technology. *Journal of Special Education Technology, 15*(1), 57-58.

Beck, J. (2002). Emerging literacy through assistive technology. *Teaching Exceptional Children, 35*(2), 44-48.

Edyburn, D. L. (2000). 1999 in review. A synthesis of the synthesis of the special education technology literature. *Journal of Special Education, 15*(1), 7-18.

Erickson, K., & Koppenhaver, D. (1995). Developing a literacy program for children with severe disabilities. *The Reading Teacher, 48*, 676-684.

Fennema-Jansen, S., Edyburn, E., Smith, R., Wilson, S., & Binion, M. (2007). Developing a statewide system for providing and assessing outcomes of assistive technology. *Journal of Special Education Technology, 22*(1), 37-52.

Goals 2000: Educate America Act, 20 U.S.C. §§ 5811 *et seq.* (1994)

Hutinger, P., & Clark, L. (2000). TEChPLACEs: An internet community for young children, and their families. *Teaching Exceptional Children, 32*(4), 56-63.

Hutinger, P., Bell, C., Daytner, G., & Johanson, J (2006). Establishing and maintaining an early childhood emergent literacy technology curriculum. *Journal of Special Education Technology, 21*(4), 39-54.

Individuals with Disabilities Education Act Amendments, 20 U.S.C. §§ 1400 *et seq.* (2004).

Individuals with Disabilities Education Act, 20 U.S.C. §§ 1400 *et seq.* (1990).

Individuals with Disabilities Education Improvement Act, 20 U.S.C. §§ 1400 *et seq.* (2004).

International Society for Technology in Education. (2007). *The ISTE national educational technology standards (NETS•S) and performance indicators for students.* Retrieved October 8, 2008, from http://www.iste.org/Content/NavigationMenu/NETS/ForStudents/2007Standards/NETS_for_Students_2007_Standards.pdf

Judge, S. (2006). Constructing an assistive technology toolkit for young children: Views from the field. *Journal of Special Education Technology, 21*(4), 17-24.

Justice, L. M., & Pullen, P. C. (2003) Enhancing phonological awareness, print awareness, and oral language in preschool children. *Intervention in School & Clinic*, *38*. 87-98.

Kamil, M., & Intrator, S. (1998). Quantitative trends in publication of research on technology and reading, writing, and literacy. In T. Shanahan & F. Rodriguez-Beown (Eds.), *National Reading Conference Yearbook 47* (pp. 385-96). Chicago, IL: National Reading Conference.

Koenig, A. J. (1992). A framework for understanding the literacy of individuals with visual impairments. *Journal of Visual Impairment & Blindness, 86*, 277-284.

Koenig, A. J., & Holbrook, M. C. (2000). Ensuring high-quality instruction for students in braille literacy programs. *Journal of Visual Impairment & Blindness, 94*, 677–694.

Lankshear, C., & Knobel, M. (2003). New technologies in early childhood literacy research: A review of research. *Journal of Early Childhood Literacy, 3*(1), 59-82.

Mandlawitz, M. (2006). *What every teacher should* *know about IDEA 2004*. Boston: Allyn & Bacon.

Marsh, J. (2004). The techno-literacy practices of young children. *Journal of Early Childhood Research, 2*(1), 51-66.

Mistrett, S., Lane, S., & Ruffino, A. (2005). Growing and learning through technology: Birth to five. In D. Edyburn, K. Higgins, & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 545-569). Whitefish Bay, WI: Knowledge by Design.

National Association for the Education of Young Children. (1996). *Technology and young children – ages 3 through 8: A position statement of the National Association of the Education of Young Children*. Washington, DC: Author: Retrieved July 8, 2008, from http://www.naeyc.org/about/positions/pdf/PSTECH98.pdf

National Center for Education Statistics. (2005). *Rates of computer and Internet use by children in nursery school and students in kindergarten through twelfth grade: 2003* (NCES 2005–111). Washington, DC: U.S. Department of Education. National Center for Education Statistics. Retrieved July 8, 2008, from http://www.nces.ed.gov/pubs2006/2006065.pdf

National Center for Education Statistics. (2008). *Digest of education statistics: 2007* (NCES 2008–022). Washington, DC: U.S. Department of Education. Retrieved July 8, 2008, from http://nces.ed.gov/programs/digest/d07

Neuman, S., & Dickinson, D. K. (Eds.). (2001). *Handbook of early literacy research*. New York. Guilford.

No Child Left Behind Act, 20 U.S.C. §§ 6301 *et seq*. (2001)

Parette, H. P. (1997). Assistive technology devices and services. *Education and Training in Mental Retardation and Developmental Disabilities, 32*, 267-280.

Skeele, R., & Stefankiewicz, G. (2002). Blackbox in the sandbox: The decision to use technology with young children with annotated bibliography of internet resources for teachers of young children. *AACE Journal, 10*(2), 79-95.

Strangman, N., & Dalton, B. (2005). Using technology to support struggling readers: A review of the research. In D. Edyburn, K. Higgins, & R. Boone (Eds.), Handbook of special education technology research and practice (pp. 545-569). Whitefish Bay, WI: Knowledge by Design.

Vygotsky, L. (1996). *Thought and language* (rev. ed.). Cambridge: MIT Press.

Weikle, B., & Hadadian, A. (2003). Can assistive technology help us to not leave any child behind? *Preventing School Failure, 47*, 181-186.

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Articles may be submitted under two categories—*Voices from the Field* and *Voices from the Industry.*

Voices from the Field. Articles submitted under this category should come from professionals who are involved in some aspect of assistive technology service delivery with persons having disabilities, or from family members and/or consumers with disabilities.

Voices from the Industry. Articles submitted under this category should come from professionals involved in developing and marketing specific assistive technology devices and services.

Within each of these two categories, authors have a range of options for the type of manuscript submitted. Regardless of the type of article submitted, primary consideration will be given by the journal to work that has *quantifiable results*.

Types of articles that are appropriate include:

- **Applied/Clinical Research.** Original work presented with careful attention to experimental design, objective data analysis, and reference to the literature.
- **Case Studies.** Studies that involve only one or a few subjects or an informal protocol. Publication is justified if the results are potentially significant and have broad appeal to a cross-disciplinary audience.
- **Design.** Conceptual or physical design of new assistive technology models, techniques, or devices.
- **Marketing Research**. Industry-based research related to specific AT devices and/or services.
- **Project/Program Description.** Grant projects, private foundation activities, institutes, and centers having specific goals and objectives related to AT outcomes and benefits.

In all categories, authors MUST include a section titled 'Outcomes and Benefits' in which a discussion is provided related to outcomes and benefits of the assistive technology devices/services addressed in the article.

Manuscript Preparation Guidelines for Submission to

Assistive Technology Outcomes and Benefits

All articles submitted will be refereed by the Editorial Review Board. Recommendations on suitability for publication will be taken as final by the Editor.

All other items would not be reviewed, but the editors reserve the right to refuse or (with the approval of contributors) to edit copy.

1. Each manuscript must reflect style guidelines of the *Publication Manual of the American Psychological Association* (5th edition, 2001).
2. Manuscripts should be **no more** than 25 pages in length (**double-spaced**), *including* references, tables, and figures. Due to the electronic format of the journal, all submissions should be submitted as email attachments in a Microsoft® Word format. The following information should be provided on the cover page of each manuscript:

    - Author'(s') full name(s) and title(s)
    - Name of corresponding author
    - Job title(s)
    - Organization(s)
    - Full contact information of the corresponding author, including email address, postal address, telephone and fax numbers
    - Each manuscript should have at least the following components:
        - Title (up to 10 words)
        - Abstract (75 to 150 words) presenting the main points of the paper and the contributor's/s' conclusions regarding outcomes and benefits
        - 3-4 keywords
        - Main body of paper
        - **Outcomes and Benefits section**
        - References

3. Submissions should be double-spaced.
4. Articles should be subdivided into unnumbered sections, using short, meaningful headings according to *Publication Manual of the American Psychological Association* (5th edition, 2001).
5. Footnotes and endnotes are **not** accepted; all such information should be included in main text.
6. The keywords (just after the abstract) should be separated by **commas**, and each keyword phrase should have initial caps (e.g., Communication devices, Families).
7. Authors should not use <u>underline</u> to emphasize text, but use *italics* instead.
8. For figures, **.tiff, .eps,** and **.jpg** are preferred formats. Figures should be embedded in the text narrative at appropriate places and centered horizontally. Captions (maximum 6 to 8 words each) must be provided for every figure (<u>below the figure</u>) and must be referenced in the text. If scanned images are used as figures, authors are responsible for insuring that they are crisp images (i.e., no pixilation, fuzziness, or shading artifacts).

In the event that the file(s) can't be opened, the Editor will contact the corresponding author by email and request that the appropriate format be provided. Figures should NOT have text captions embedded in them. Text captions should be contained in the narrative. Figures that are copyrighted or adapted from copyrighted figures must have approval for use. Notation of this approval is included in the figure caption along with a letter from the copyright holder indicating approval for use or adaptation (see p. 174 of APA Manual for guidelines).

Sample

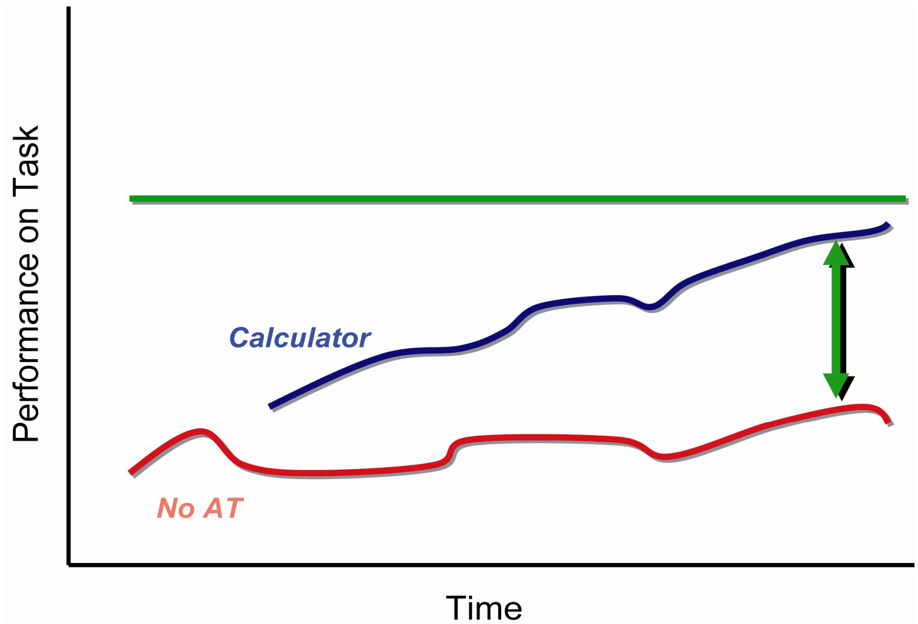

Figure 1. Comparison of direct teaching vs. use of calculator on functional performance. Source: ©2007, SEAT Center. Used with permission.

If the figure is excerpted or adapted from a previously published source:

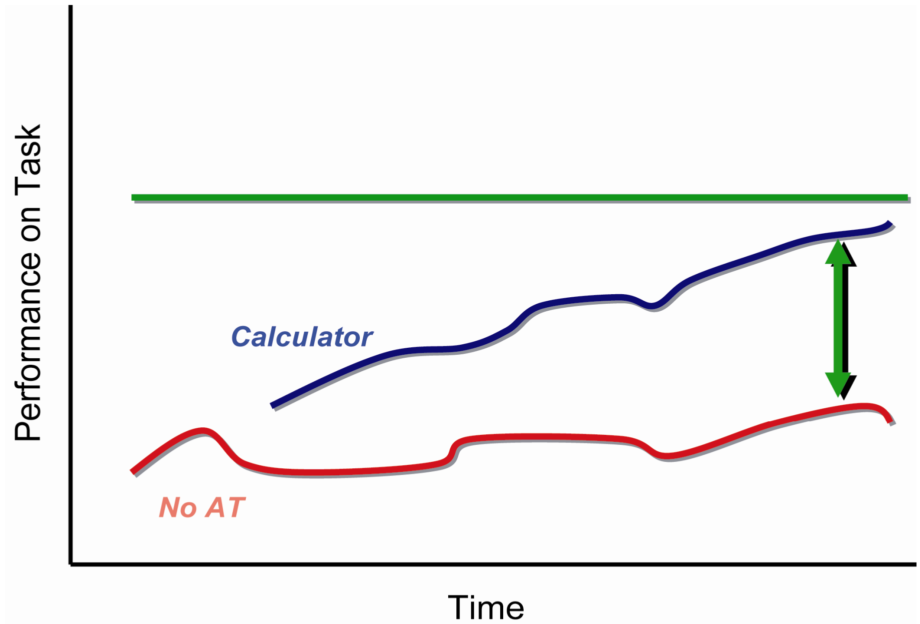

Figure 1. Comparison of direct teaching vs. use of calculator on functional performance. Source: Parette, H. P., Peterson-Karlan, G. R., Wojcik, B. W., & Bardi, N. (2007). Monitor that progress! Interpreting data trends for AT decision-making. *Teaching Exceptional Children, 39*(7), p. 6. Used with permission.

9. Tables should be included in the text at appropriate places and centered horizontally. Captions (maximum 6 to 8 words each) must be provided for every table (above the table) and must be referenced in the text. Tables should not be graphic images, but should be original tables created using the Table feature of Microsoft® Word (see pp. 147-176 of APA Manual for table preparation guidelines).

    Example:

    Table 1

    Focus Group Participant Demographics

Professional	Gender	Degree	Yrs. Education	Role	Classroom
Sam	M	BS	16	Teacher	Pre-K
Joan	F	BS	17	Aide	Pre-K
Deborah	F	BS	16	Aide	Pre-K
Makela	F	HS	12	Aide	ECE
Tom	M	BS	14	Aide	ECE

10. The References section should contain appropriate citations noted in the APA Manual (5th ed.)

    Sample citations

Journal article

James, P., & Tatem, J. J. (2003). Assistive technology benefits. *American Journal of Occupational Therapy*, *39*, 336-337.

Paper presentation

Stuart, S. K., & Kemp, L. M. (2003, January). *Native Americans and AAC issues*. Paper presented to the Annual Meeting of the Assistive Technology Industry Association, New Orleans, LA.

Book

Kalyanpur, M., & Harry, B. (1999). *Culture in special education. Building reciprocal family-professional relationships*. Baltimore: Brookes.

Book chapter

Soto, G., Huer, M., & Taylor, O. (1997). Multicultural issues in augmentative and alternative communication. In L. Lloyd, D. Fuller, & H. Arvidson (Eds.), *Augmentative and alternative communication* (pp. 406-413). Boston: Allyn and Bacon.

Legislation (Any law that is described in the manuscript narrative must be included in the Reference List; see p. 404 of APA Manual)

Individuals with Disabilities Education Act Amendments, 20 U.S.C. § 1400 *et seq* (1997).

No Child Left Behind Act, 20 U.S.C. 6301 *et seq*. (2001)

Electronic Resources

Use of electronic sources has become increasingly common, though many authors are unfamiliar with appropriate citation and referencing formats when using such sources. For any electronic citation, please refer to pp. 268-281 in the *APA Manual* for appropriate formats. Please be sure that the most current link to the file is presented in the reference (Note: Authors often use older Web citations that are no longer accessible or that are archived on other sites. Check the link to all electronic citations to ensure that it is still active; if not, be sure to locate the current link and include that in the reference.)

Institute for Matching Person and Technology. (2007). *Matching person and technology (MPT) assessment process*. Retrieved August 15, 2007, from http://members.aol.com/impt97/mptdesc.html

11. All statistical symbols should be in italics.
12. The Editor will acknowledge receipt of a submitted article immediately.
13. Authors are encouraged to write in the third person and use "person-first" language, i.e., the individual *precedes* the disability. For example, phrases such as "persons with disabilities," "students with mental retardation," "and "adults with cognitive impairments" are more appropriate than such phrases as "the disabled," "learning disabled students," or "mentally retarded adults." Consumers and family members who submit manuscripts describing specific practices may use the first person.
14. A cover statement in the submission should indicate that the manuscript has not been published in whole or substantial part by another publisher and that it is not currently under review by another journal.

All submissions for the sixth volume of ***Assistive Technology Outcomes and Benefits*** **are due by April 30. 2009.**

After a manuscript has been accepted for publication and subsequent to making all changes recommended by the editorial review board, authors must send a copy of the revised manuscript and a computer file to the Editor via email to: **hpparet@ilstu.edu** or via mail to: Dr. Phil Parette, Special Education Assistive Technology (SEAT) Center, Illinois State University, Campus Box 5910fa, Normal, IL 61790-5910