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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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.

Editing policies are based on the **Publication Manual**, the American Psychological Association (5th ed.). Additional Information is provided on the inside back cover. Any signed article is the personal expression of the author; also, any advertisement is the responsibility of the advertiser. Neither necessarily carries the endorsement of ATOB unless specifically approved by the ATIA.

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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—Challenges in the Assistive Technology Field

Phil Parette, *Editor*
David Dikter, *Associate Editor*

Welcome to the first issue of *Assistive Technology Outcomes and Benefits* (ATOB), a joint publication of the Assistive Technology Industry Association (ATIA) and the Special Education Assistive Technology (SEAT) Center at Illinois State University! This transdisciplinary journal is anticipated to provide a meaningful forum for the discussion of innovative assistive technology (AT) approaches that result in outcomes and benefits for persons with disabilities. Until recently, little attention has been given to outcomes in the AT field. To address this problem, three federal projects have been funded to examine AT outcomes, and are approaching this daunting task from very different perspectives. Their recommendations over the next few years will drive future research and development activities. However, until the AT field better understands the scope of outcomes assessment and evaluation, ATOB will provide a venue for dialogue to facilitate understanding of issues that confront developers, practitioners, consumers with disabilities, and their families. The articles presented in this issue—both *Voices from the Field* and *Voices from the Industry*--reflect meaningful efforts at documenting outcomes and benefits from these varying perspectives. A brief overview of each of the articles in this issue is presented below.

The first article presents *Voices from the Field*--Dave Edyburn and Roger Brown, Assistive Technology Outcomes Measurement System (ATOMS) Project—who describe the theory, development, and research efforts of the one of the three federally funded AT outcomes projects focusing on advancing our understanding of current and future practices.

Their article devotes specific attention on ATOMS research directed at validating selected components of a proposed outcome system based on a theoretical framework. The proposed system involves user-friendly data collection instruments, compiles information from multiple sources, and provides visual representation of the data to facilitate interpretation and decision-making.

In the second article--a *Voice from the Industry*—Patti Murphy, Dynavox Systems, describes the background and success of the Augmentative and Alternative Communication (AAC) Olympics project implemented in a Florida public school system. This highly successful consumer-focused event allows students with significant communication and physical disabilities to build AAC competencies through participation in a meaningful Olympics experience. The approach described includes multiple strategies to provide students with disabilities the structure to develop needed AAC competencies, coupled with needed community social and learning opportunities both for the students and their parents.

The third article—a *Voice from the Field* reported by Brian Wocik, George Peterson-Karlan, Emily Watts, and Phil Parette describe an innovative assistive technology (AT) preservice model implemented at Illinois State University in Fall, 2003. Drawing on national technology standards, the context for the model incorporates both traditional approaches (coursework and experiential activities) and alternative approaches (on-line modules and hands-on evaluative activities). Data are presented that support the effectiveness of the alternative approaches, followed by a discussion of strategies for expansion of the outcomes measurement system to include a range of both teacher and student outcomes, including implementation with inservice audiences across Illinois.

In the fourth article--a *Voice from the Industry*—Linnea McAfoose, Dynavox Systems, discusses a case study of a 17-year-old high school student who communicates using a DynaVox 3100. Readers are presented with a discussion of a team approach employed by education and engineering specialists at DynaVox Systems who collaborated with the student to effectively match unique device features to the student's environmental needs, resulting in an increase in the efficiency of the student's communication capabilities. Of particular importance was the quality of life outcome described subsequent to the decision-making process.

In the fifth article—*Voices from the Field*--Sean Smith and Steven Smith, University of Kansas, describe a study designed to provide a mentorship training program that used special education and elementary education student interns to assist teachers with their technology infusion efforts. This novel approach suggested that teacher mentoring supported by student interns (with limited technology expertise) can support AT integration efforts in classroom settings, although the authors caution that time, preparation, and support capabilities are integral to successful implementation of the approach.

In the sixth article—*Voices from Industry*--Rupal Patel, Sam Pilato, and Deb Roy, Northeastern University, present an interesting AAC development process employing a semantic two-dimensional image (meaning) vs. a syntactic (sentence structure) approach. The authors report that use of a meaning-based approach leads to more natural message construction. Of particular interest to readers are the potential benefits of the new design for persons with severe speech and motor disabilities, including more fluid, expressive and efficient communication.

Based on reader response to this first issue, subsequent issues will be published with the associated *Call for Papers* being made available at the ATIA website. We hope that you find the *Voices* contained herein--both from Industry and the Field--to be helpful and informative, and agree with us that they contribute to better understanding and communication within the discipline about AT outcomes and benefits.

Creating an Assistive Technology Outcomes Measurement System: Validating the Components

Dave L. Edyburn and Roger O. Smith
University of Wisconsin-Milwaukee

Abstract: The topic of assistive technology (AT) outcomes has only recently received attention in the professional literature. As a result, there is a considerable void in the profession's ability to address contemporary questions about the value and use of AT. The purpose of this article is to highlight the theory, development, and research efforts of the ATOMS Project as it seeks to create a prototype of an AT outcome measurement system. Specific attention is devoted to research efforts to socially validate selected components of a proposed outcome system. The results reveal significant support for a system that utilizes a theoretical framework; involves paper or electronic format data collection instruments that do not require extensive training and expertise; assimilates data from multiple sources; and provides visual representation of the data to facilitate interpretation and decision-making. The benefits and outcomes of this research and development agenda are described.

Keywords: Assistive technology outcomes, Theoretical considerations, Social validation research, The ATOMS Project

Fuhrer (1999) observed that interest in the outcomes of assistive technology (AT) is a relatively recent phenomena. Support for this observation is easily gathered by reviewing the journal literature and leading personnel preparation textbooks. Prior to 1996, there is little evidence to indicate that the profession was concerned about issues associated with the collection and use of AT outcome data. Apparently, we never asked ourselves for evidence concerning the impact of AT. It was *obvious* that AT was valuable for an individual with a disability. We observed a problem, provided appropriate AT devices and services, and then watched the transformation that occurred when an individual completed a task that was formerly difficult or impossible to do. To the extent that we sought to collect data, we simply asked the individual if they liked the new device and whether they found it helpful. In hindsight, we appear so naive.

An Emerging Field

Arguably, several milestones can be documented that served to increase the profession's awareness and sensitivity about the need to begin asking questions regarding the measurement of AT outcomes (The ATOMS Project, 2003). Early works raised questions about whether or not the profession would make the commitment to measuring assistive technology outcomes (DeRuyter, 1995) and why outcome data was essential for addressing questions about the quality of service delivery systems (DeRuyter, 1997). The first special issue of a journal devoted to AT outcomes appeared less than a decade ago (Smith, 1996) with a second special issue following four years later (Edyburn, 2000). Thus, the first indications of an emerging discipline focusing on measuring AT outcomes can be found in the journal literature.

Developmentally, the discipline of AT outcome measurement is less than 10 years old. The emerging literature can be characterized as philosophical and theoretical as leaders clarify the importance of the research and development agenda. As a result, there is an urgent need for maturation of measurement theory and instrumentation development.

RESNA (1998a, 1998b, 1998c) published a three-volume monograph with the results of a state-of-the-art survey of AT outcome assessment practices. The findings revealed that a majority of the instruments used by practitioners for measuring the outcomes of AT were self-developed with unknown technical adequacy qualities. This landmark work graphically illustrated the dismal condition the profession was in relative to AT outcome measurement.

The current state of AT outcome measurement can also be understood from the results of two studies that have sought to extract AT outcome data from large extant data sets. While the findings provide a glimpse of the number of individuals that use AT, they are also disappointing as we have learned that there are serious flaws in current professional practice such that outcome data are not routinely collected (Carlson, Ehrlich, Berland, & Bailey, 2001; Moser, 2003).

Increased awareness about the deficits in the AT outcome knowledge base and the dawn of the 21st century created a context of increased accountability and desire for understanding the value of technology investments. Recognition of these issues resulted in the establishment of three national research centers to advance an agenda to substantially increasing the knowledge base surrounding AT and its effective use by individuals with disabilities.

The Office of Special Education Programs (OSEP) funded the National Assistive Technology Research Institute (NATRI) based at the University of Kentucky. This center is charged with conducting assistive research, translating research into assistive technology practice, and providing resources to improve the delivery of AT services. Several in-progress studies hold considerable potential for informing state and federal policy concerning effective AT practices (Lahm, Bausch, Hasselbring, & Blackhurst, 2001). To learn more about this center, visit the NATRI home page: http://natri.uky.edu.

A second federal agency was also concerned about AT and has funded priorities to advance a research agenda concerning assistive technology outcomes. In October 2001, National Institute on Disability and Rehabilitation Research (NIDRR) funded two, five-year, research centers to address the gap in data collection efforts concerning AT outcomes, as well as the paucity of measurement instruments and strategies. The Assistive Technology Outcomes Measurement System (ATOMS) Project is based at the University of Wisconsin-Milwaukee. To learn more about this center, visit: http://www.atoms.uwm.edu. The Consortium for Assistive Technology Outcome Research (CATOR) is housed at Duke University. To learn more about this center, visit: http://www.atoutcomes.org.

Given the lack of data on AT outcomes and the importance of such information for a wide variety of stakeholders (i.e., individuals with disabilities, AT service providers, administrators, funding agencies, AT developers), one of the key activities of the ATOMS Project has focused on the development of a prototype of a large-scale AT outcome measurement system. The purpose of this article is to describe the theory development underlying such a system and preliminary research that has been conducted to socially validate the components.

Method

In order to begin operationalizing a vision of what a future AT outcome system might look like, the ATOMS Project has engaged in a number of research and development activities to design a prototype. These activities include conducting an extensive number of field scans to ascertain the what efforts have been devoted to measuring the outcomes of AT and determining what types of innovative research methodologies might be suitable for collecting reliable and valid outcome data to inform AT decision-making.

For the purpose of this investigation, seven components of a proposed AT outcome system were identified by the research team for social validation. The seven components included: (a) theoretical framework; (b) expertise, training, and availability of the assessment instruments; (c) data collection techniques; (d) data assimilation; (e) data reduction and visualization; (f) dynamic norming; and (g) data-based decision-making. Each component is described briefly below.

Components of an AT Outcome System

Previous research by the ATOMS Project suggested that the construct of AT outcome may be multidimensional (change in performance/function, change in participation, usage (why or why not), consumer satisfaction (process, devices), goal achievement, quality of life, and cost) rather than something that can be captured in a single score (Edyburn, 2003). In addition, significant methodological challenges remain to be resolved on how to isolate and discern the specific impact of AT as it is frequently implemented concurrently with other interventions (Smith, 2002). As a result, ATOMS Project researchers believe there is a significant need for building AT outcomes systems that are grounded in a *theoretical framework*.

Test developers use a continuum of approaches for designing assessment instruments: from informal assessment tools that require little training to administer to expensive and comprehensive instruments that require extensive training to administer and interpret. As a result, questions must be raised about the desired level of commitment needed to implement an AT outcome system. That is, will the profession need a cadre of assessment professionals (e.g., school psychologists) to administer, analyze, and interpret comprehensive evaluation tools? Or, will it need to focus on creating powerful assessment tools that are easily, validly, and reliably administered by a wide range of professionals? Hence, there is a need to understand the perspectives of the field regarding the *expertise, training, and availability of the assessment instruments*.

Traditionally, assessment data has been collected through paper and pencil instruments. However, personal digital assistants (PDAs) and web-based data entry interfaces have emerged as potential tools for streamlining the time involved in data collection and improving the quality of data. While this vision is futuristic, is it practical given current levels of technology access and the availability of trained personnel? As a result, questions must be raised about the assumptions associated with data collection methods and preferences. That is, should an outcome system be built that only permits data to be uploaded from PDAs? Or, should users have to enter all data through a web-based interface? Hence, there is a need to understand the design features necessary to support legacy, as well as, emerging *data collection techniques*.

In an attempt to improve the quality of AT outcome data, some have suggested the creation and validation of a select set of assessment instruments will resolve the issues associated with what data to collect. Others have argued that an outcome system must be inclusive in that the profession cannot dictate the specific data collection instruments that may be used in a given locale. As a result, questions must be raised about the desirability of data assimilation tools built into an outcome system. That is, will the system accept data from a wide variety of assessment tools rather than a standardized list? To the extent possible, can the system help users understand the relationships among data collected using instruments that are based on a variety of assumptions and methodological approaches? Hence, there is a need to understand the desirability of *data assimilation* as a design principle for a prototype AT outcome measurement system.

One of the intrinsic challenges associated with data interpretation involves seeing past the raw numbers in order to distill and understand patterns. This is particularly important in large data sets where the sheer volume of data can skew significant findings. As a result, questions must be raised concerning preferences for interacting with data. One promising application in this area involves visualization analysis tools. Hence, there is a need to understand the importance of designing tools that facilitate *data reduction and visualization* as part of an outcome measurement system.

One of the inherent difficulties associated with disability research is the intrinsic nature of making inter-individual comparisons. That is, the unique nature of an individual's disability often precludes the opportunity to make comparisons with others. This is especially true with low incidence disabilities where an individual may be the only one in a geographic area. Combine this challenge with the incidence of a specific type of AT and it is readily apparent that it is not possible to compare an individual's performance to a group in order to understand the developmental context of enhanced performance. However, the ubiquitous nature of the Internet offers some intriguing possibilities for addressing these challenges. The ATOMS Project has outlined a concept we call, "dynamic norming." Essentially this involves extracting data in a real-time database to make comparative norm groups. Users of the outcome system could make any number of comparisons using with simple search parameters to compares a client's performance to (a) other individuals with similar disabilities who have used the same AT; (b) the types of services the client has received; or (c) a gap analysis of the compensation (AT) by comparing the performance results with the results of non-disabled individuals. Hence, there is a need to understand the perceived value of a *dynamic norming* component in an AT outcome system.

Little is currently known about decision-making associated with AT outcome data. That is, if several professionals were to review the same data set, would they all come to the same conclusion about whether or not the AT devices and services were enhancing performance? The lack of attention to AT outcomes in personnel preparation suggests that there could be considerable variation in understanding and interpretation outcome data. As a result, there is an urgent need to understand the need for tools and resources that support *data-based decision making.*

Sample

In order to obtain social validation data concerning the emerging design framework for a prototype assistive technology outcome system, data were collected as part of a presentation about the ATOMS Project at a large annual conference on AT (Edyburn & Smith, 2002). The conference attracts a diverse group of participants (e.g., special educators, occupational therapists, speech/language pathgologists, administrators, AT specialists, parents) that could be considered potential users of the proposed outcome measurement system. Approximately 80 participants attended the presentation and were invited to voluntarily complete an anonymous feedback form during the presentation. A total of 58 responses were received at the conclusion of the presentation. Clearly, the procedures represent a convenience sample which limit the generalizability of the results but provide valuable formative social validation evidence.

Validation

The seven components of the proposed AT outcome system were each communicated by the presenter through (a) verbal description, along with (b) a single *PowerPoint* slide to describe the function and possible utility of the component. Following the description of each component, session attendees were asked to validate the importance of the component by ranking on a five-point scale (1=*no value*, 3=*some value*, 5=*great value*) the perceived value of the strategy for including the proposed component in an AT outcome system. The anonymous questionnaires were returned to the presenter at the conclusion of the presentation.

Analysis

To analyze support for each component, data from the social validation exercise were counted and totaled. For this analysis, responses 4 and 5 were combined to indicate each respondent's valuing of a component as being of *significant value* in an outcome system.

Results

The results of this social validation investigation are illustrated in Table 1. The respondents provided overwhelming support for the seven proposed components of an AT outcome system. That is, the following formative design principles were socially validated by a diverse group of potential users of a proposed outcome measurement system:

1. A system should be designed using a *theoretical framework* supporting the relationship of variables involved in AT outcomes (e.g., satisfaction, performance, use, quality of life, etc.). 95% of the respondents indicated that this component would be of *significant value*.

2. Outcome assessment instruments *should not require extensive training* and expertise to administer and should be readily available. 86% of the respondents indicated that this component would be of *significant value*.

3. *Data collection tools* should support traditional paper and pencil instruments as well as portable handheld devices (PDAs) and web-based interfaces. 100% of the respondents indicated that this component would be of *significant value*.

4. Tools should be available for *assimilating data from multiple sources* and instruments in ways that allow comparisons to be readily made. 83% of the respondents indicated that this component would be of *significant value*.

5. Easy to use tools must be provided to allow professionals and end users to reduce multiple scores into easy-to-understand *visuals that foster interpretation of the data*. 86% of the respondents indicated that this component would be of *significant value*.

6. Given the unique and low incidence nature of many AT interventions, tools should be available that facilitate *dynamic norming* (individual and group comparisons) of the AT outcomes data. That is, it should allow comparisons of an individual's scores with others like him/her in terms of their disability, length of device use, type of device, environment, expectations, and other variables? 88% of the respondents

indicated that this component would be of *significant value*.

7. Tools should be available to *facilitate decision-making* based on the data. 78% of the respondents indicated that this component would be of significant value. This item received the lowest rating of the seven components. This may be a reflection of the thinking of several respondents who questioned the value the entire system if it did not address this component.

Discussion

The discipline of AT outcomes is still in its infancy and suffers from a lack of data to support claims about the effectiveness of AT. As a result, there is a need for considerable conceptual work to guide research on AT outcomes (Lenker & Paquet, 2003).

The ATOMS Project has proposed the development of an AT outcomes information system that would facilitate the collection and use of outcome data. The results of this preliminary study reveal a high level of support for seven components of a proposed system.

The current study is subject to a number of limitations primarily due to the conceptual format of the proposed outcome system prototype and lack of a working prototype. Also, the use of a convenience sample limits the application of the results. Despite these shortcomings, the social validation process provides important formative evaluation of the current development efforts and engages the profession in a dialogue about a shared vision concerning the purpose and use of an AT outcome system. Obviously, additional research is needed concerning the development and use of AT outcome measurement system.

Outcomes and Benefits

Preliminary research and development work by the ATOMS Project reveals the following insights associated with the outcomes and

TABLE 1
Percentage of Respondents Valuing Proposed Components of an AT Outcome System

Component	*Perceived Value of This Strategy (%)*		
	No Value	*Some Value*	*Great Value*
Theoretical Framework	0	4	96
Expertise, Training & Availability	0	9	91
Data Collection	0	2	98
Data Assimilation	2	14	84
Data Reduction & Visualization	2	12	86
Making Data Meaningful	3	9	88
Applications of Data (Decision-Making)	5	13	82

benefits of AT:

1. The suggestion that AT outcomes involves more than simple consumer satisfaction received an encouraging reception by the participants in this study. In response, they supported efforts to develop conceptual models that will enable the profession to develop data-based evidence about AT outcomes.

2. Participants in this investigation preferred data collection instruments that do not require extensive training to implement and are inclusive of a variety of assessment instruments and data collection tools (e.g., paper and pencil, PDA, web-based interfaces) rather than approaches that involve extensive clinical data collection efforts and expertise to administer. This work also supports the desirability of initiatives within the AT industry to build data capture mechanism into AT devices.

3. Potential users of AT outcome data expressed a preference for tools that help them understand the meaning of the outcome data they have collected. This, in turn, would facilitate appropriate decision-making.

4. The concept of dynamic norming, extracting data in the database to make comparative norm groups, was positively received by the participants in this study. Social validation of this unique design principle in developing AT outcome systems is important given that it represents an advance that would be impossible to achieve with traditional approaches to tests and measurement.

Conclusion

The knowledge base concerning how to measure the outcomes of AT is still in its infancy. Considerable work is needed to define the theoretical constructs necessary to create data collection systems that will produce outcome data for subsequent analysis and understanding of the impact AT.

This report presents a brief summary and analysis of some initial efforts of the ATOMS project to define potential components of an AT outcome system. Future studies will explore additional design considerations, usability, and applications of an AT outcome system. For additional information, please contact: atoms@uwm.edu.

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The Augmentative and Alternative Communication Olympics: Raising and Showcasing Communication Competencies

Patti Murphy
DynaVox Systems LLC

Abstract: The Augmentative and Alternative Communication (AAC) Olympics is a project serving a twofold purpose for augmented communicators in the Broward County Public School System in Florida. While allowing young augmented communicators to build competencies in using AAC devices, the Olympics provide a meaningful extracurricular experience to students with significant communication and physical disabilities. Training sessions give students the structure needed to hone AAC skills to increase their proficiency with the technology that likely will be their primary means of self-expression for life. The practices also provide social and learning opportunities that special education students don't often get outside of the classroom. Participants can develop relationships with peers of differing abilities while their parents meet the parents of other augmented communicators, often for the first time. This article discusses the background and success of the inaugural AAC Olympics, as well as considerations for its future.

Keywords: AAC Olympics, Building, Demonstrating, Competencies

An organized event for elementary and high school students who use alternative and augmentative communication (AAC) devices can raise the comfort level with the devices while contributing significantly to their competent and consistent use of the technology. Such activities allow students to meet other augmented communicators, in some cases for the first time, and to learn from more experienced communicators. This can help to alleviate the sense of isolation that students with disabilities may experience in learning or social situations especially when interacting with peers who do not have disabilities. Also these events can motivate augmented communicators to set new communication goals and enhance their social development.

One example of such an event is the AAC Olympics at Nova Southeastern University in Davie, Florida (Everybody Is a Winner in AAC Olympics*,* 2003). Students in the Broward County Public School System with significant physical disabilities and profound expressive language impairments with the ability to hold a conversation using assistive technology qualify to participate in the AAC Olympics. This article highlights the inaugural event, held in December 2002, discusses plans for, and provides an epilogue highlighting the second AAC Olympics in late January 2004 (C. B. Weech, personal communication November 18, 2002 through January 13, 2003; B. Saunders, personal communication November 21 through November 26, 2003; May 6 through 28, 2004).

A Desire to Break Barriers, A Plan to Break New Ground

Opportunities for students with the most significant disabilities to participate in extracurricular activities that foster both opportunities to build relationships with peers and positive learning experiences are rare. Augmented communicators face additional barriers to participating in such activities because of the challenges they encounter in their attempts to express themselves both in and out of school. These include physical and mechanical difficulties, natural time constraints and communication partners who fail to listen. Such barriers often are compounded by limited opportunities to practice using the technology both in and out of school, often stalling their development of language skills. In her proposal for the grant for the AAC Olympics submitted in the spring of 2002, Weech wrote:

Because it takes augmented communicators (i.e. individuals using an electronic device) longer to produce an utterance than speaking peers, they are not often given as many opportunities to participate in the frequently fast-paced world of the classroom. Communicative efforts are thus not reinforced, leading to the disappearance of newly developed skills. In a vicious cycle, augmented communicators are then seen as less competent and are given even fewer chances to contribute to class activities. This eventually leads to non-use of the electronic devices that might provide the only avenue for displaying social and cognitive competence. (p. 2)

Weech (2002) also noted that the parents of students who use AAC devices have limited opportunities to network with other parents of augmented communicators or to see their children with disabilities participate in school-sponsored activities. She and her colleagues at the Exceptional Students Education Program (ESE) in Fort Lauderdale believed that an event such as the AAC Olympics, loosely modeled on an interscholastic athletic competition, would fill gaps in both areas. Weech referred to the event as an exhibition giving each student a chance to showcase and be recognized in a positive way for his or her abilities rather than a contest in which their abilities would be judged. It was decided early in the planning stage to present all participants with a gold medal as a reward for their efforts and performance.

The inaugural AAC Olympics was sponsored by Citibank's Success Fund Grant, which is administered by the Broward County Educational Foundation for Broward County Public Schools. The South Region Assistive Technology Education Network, vendors of AAC technology and local businesses also provided financial or in-kind support.

From Practice to Performance

Twelve students representing 11 South Florida schools participated in the AAC Olympics, including two adult students who served as masters of ceremonies for the event. After-school training sessions that began in October focused on helping them to build communication and language skills needed to succeed in games to be played at the event, which took place on a Saturday in mid-December. The sessions were held in a classroom engineered for children using AAC on the Nova Southeastern campus.

Members of the school system's assistive technology team, including seven speech-language pathologists, a teacher and an occupational therapist, facilitated the sessions. Assisting them were faculty from the speech and language pathology program at Nova Southeastern and parents of participants. The university's AAC lab assistant, a graduate of the Broward County Public Schools and an augmentative communicator, also served on this team of volunteers. Each participant received one-to-one support from a volunteer. The team of volunteers used a training protocol to ensure that all participants received identical instruction in the skills required for the event. Facilitators considered the goals of each student's individual education plan, information gathered from a brief and informal assessment done with each student at the first session, and their own AAC expertise in determining which skills the students would aim to improve. These skills included (a) vocabulary retrieval and message clarification; (b) fluency, including the use of word prediction; (c) narrative writing and text editing; (d) speed and accuracy using switch access; (e) message formation and sequencing; (f) re-wording phrases and sentences; and (g) word morphology, the ability to change the tense or form of a word.

The sessions included separate drills for each skill and opportunities to use the skills in games that ESE staff invented specifically for the Olympics. The vocabulary that the students used while in training was different than that used in the actual event.

Olympics participants included users of both low-tech and high-tech communication devices. Games were modified during the training period to accommodate the abilities and progress levels of the students, and to encourage greater use of communication symbols to build messages as moderators found some students to be overly dependent on letter-based communication (i.e., spelling), defeating the purpose of the activities.

It's How They Played the Game

The AAC Olympics audience of roughly 70 people included family members, friends, teachers and former teachers of the participants, as well as other members of the local education community. During the opening ceremonies, participants, wearing AAC Olympics T-shirts with the name of a sponsor shown on the back, made their way to the stage as a recording of the theme song from the International Olympic Games played in the background. The master of ceremonies introduced each younger participant, using biographical information that he gathered from interviews with each participant, and then programmed the information into his device. The students then participated in a series of three language-based games. Though not competitive in a traditional sense, the games provided incentive for the students to move forward in their use of AAC devices. As Weech (cited in Everybody Is a Winner in AAC Olympics*,* 2003) noted, "They did not compete against each other. They competed against the skills with which they entered" (p. 8). While facilitators made it clear that the purpose of the games was not to determine who could communicate the fastest, some noted that the event seemed to trigger a natural competitiveness for some participants.

The object of the first game, 'I Spy,' was for the students to identify, find and say a word as quickly as possible after hearing a moderator's description of the word. A game called 'Yo-Yo' required each participant to name as many items as possible in a single category (i.e., fast food) using the method (retrieval of vocabulary directly from communication page or from a pop-up) that was fastest for him or her. The third game, 'Quick Change,' required each participant to use the word morphology feature of the communication device as quickly as possible.

In keeping with the effort to highlight the strengths of each participant, some students demonstrated their AAC skills by performing activities other than or in addition to the games. One student, for instance, told jokes programmed into his device. Another recited a holiday poem.

Outcomes and Benefits

The AAC Olympics served as a catalyst for noticeable improvement in the everyday communication practices of participants. The following examples are presented to illustrate changes that occurred in the lives of these young children.

One boy who participated in the Olympics, a bright sixth-grader, uses a DynaVox 3100 to communicate. Fully included in regular classes at school, he constantly seeks new mental challenges and ways to stimulate his creativity.

The AAC Olympics provided both along with the practical benefit of helping him to break his habit of spelling out all he had to say using the QWERTY keyboard on the device, which he accesses via visual, three-column scanning. His participation in the event taught him to retrieve words and phrases on the device for faster and more efficient communication. He reported himself that, with the aid of his device, he has "gotten better at scanning" and has "learned to find the words on his DynaVox instead of spelling them." This boy particularly enjoys writing. The skills he cultivated through his training for the AAC Olympics will allow him to progress with his goals of learning to edit his work and to e-mail his friends using the device.

Another Olympics participant, a six-year-old girl, is in a fully inclusive first grade classroom at school. She's been using her DynaMyte more often to express needs at home than she did before participating in the AAC Olympics, her mother stated. She makes more frequent use of the device's word morphology feature and her sentence construction has improved. It surprised the girl's mother that despite its non-competitive nature, the AAC Olympics has helped her daughter to overcome her shyness. She said her daughter now communicates more confidently when using the DynaMyte when she's with more than one person at a time.

A nine-year-old boy who receives home schooling and communicates using a DynaVox 3100 that he accesses via direct selection, developed "a more mature way of expressing himself" through his participation in the AAC Olympics, his mother stated. For example, instead of simply saying 'red' when asked what his favorite color is, he now replies in a full sentence, saying, "My favorite color is red." The boy also navigates his communication pages with greater precision than before, allowing him to find and select vocabulary in a more efficient manner. His mother said that the greatest challenge for her was to resist the inclination to compare him to other participants though the non-competitive atmosphere helped her to avoid that.

Post-game Feedback

The single source of quantifiable feedback on the AAC Olympics was the response to a form letter asking parents whether they wanted ESE to repeat the event the next school year. Organizers reported that the response was overwhelmingly positive.

An Encore and New Strategies

Preparations for the second AAC Olympics reflect the success of the inaugural event. Fourteen students, including three newcomers, accepted invitations to participate in the 2004 event. Many participants will be using advanced skills developed through last year's competition. Six training sessions, conducted in the same manner as before, will have occurred before the day of the event.

This year's AAC Olympics will focus on increasing the length of verbal output that participants are able to deliver using their devices. One new game designed to help meet this objective is a variation of Jeopardy, the television game show. Attendants of participants noted that the augmented communicators rarely asked questions, waiting for others to address them first instead. Because the game requires contestants to provide questions that match answers presented to them, organizers of the AAC Olympics thought it would be a good tool to encourage communicators to ask questions in real-life situations.

The 2004 AAC Olympics also will feature more writing activities using computer emulation technology with the communication devices. Another goal is to increase support for the event from local businesses beyond monetary donations and in-kind resources such as medals, T-shirts and refreshments. Organizers hope that by generating greater community support, the AAC Olympics will raise awareness of AAC in segments of the community with little or no exposure to it.

Epilogue

While the second AAC Olympics on January 31, 2004, largely replicated the inaugural event, the event reached new levels on various fronts. Twelve participating students (11 returning from last year and one newcomer) played a completely different set of games requiring them know more about the operation of their communication systems and to demonstrate advanced skills in their use of the systems. While last year's event focused on the retrieval and delivery of single-word vocabulary, the goal of this year's event was for students to increase their mean length of utterance by using longer phrases and sentences. Students played variations of the television game shows Jeopardy and $10,000 Pyramid, using phrases and sentences to make relevant comments in the course of the game. Such statements ranged from, "It's the next contestant's turn," to "I'll take Pop Music for $200" when choosing a Jeopardy category, to "I learn about Abraham Lincoln" when asked to name things one learns in history class in the $10,000 Pyramid game.

Two students participated in the Olympics by conducting a survey of their peers during the practice sessions and presenting the results during the actual event, an activity designed to build conversation turn-taking skills. The students asked questions on topics of interest to young people (i.e., "What's your favorite food?").

Parents again gave positive feedback after the event. Noting that they are not always present during their children's speech therapy sessions, parents said that they appreciate the AAC Olympics because it presents an opportunity for them to learn about features of the communication devices. A girl who accessed her device via direct selection told her mother that she wanted to go back to using her head switch because she was impressed when she saw another Olympics participant access his communication device with considerable speed by using a switch.

The effort to raise AAC awareness through the AAC Olympics advanced with the 2004 event, which attracted an audience of approximately 12 more people than the 2003 event. A professional videotape of the 2004 proceedings has provided organizers with a tool for generating publicity and soliciting financial support for future events. The 2004 AAC Olympics was not grant-funded, but increased monetary and in-kind support from businesses, vendors of AAC products and non-profit AAC organizations and anonymous donors covered the associated costs. Organizers are considering ways to enhance future events, such as recruiting more students from the district to participate, inviting other school districts to participate, increasing volunteer support and promoting the Olympics as an opportunity for young augmented communicators to develop a social network while learning from one another.

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Assistive Technology Outcomes in a Teacher Education Curriculum

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Abstract: This article describes a comprehensive assistive technology (AT) teacher preparation model designed to address both general education and special education or early childhood education students. National technology standards provide the context for the model that incorporates (a) an innovative component, consisting of web-based modules and hands-on experiences, designed to prepare general education teacher candidates; and (b) a traditional component, consisting of coursework and experiential activities designed to prepare special education and early childhood education teacher candidates. This report presents preliminary outcome data for 503 general education teacher candidates who used the innovative component. The data indicate that a majority of students (86.9%) using the two-stage innovative component achieved targeted knowledge and performance competencies. Recommendations are offered for expansion of the outcomes measurement system to include a range of both teacher and student outcomes and for expansion of the model to inservice training to general education and special education teachers.

Keywords: Outcomes, Benefits, Assistive technology, Higher education, Teacher education

Technology development and related societal changes, the standards-based reform movement, and legal mandates are propelling changes in the way we view the knowledge and practices teachers must have about technology on exiting higher education. Technology is developing both in terms of reduced cost, greater potential benefit and greater integration into home, work, and school settings. By 1997, 80% of children had used a computer at home or in school (Tapscott, 1998). The explosion of the computers, the Internet, and digital technology has, in turn, produced the 'Net Generation' (Tapscott, 1998). These children are "the first to grow up surrounded by digital media…that they think it is all part of the natural landscape (Tapscott, 1998, pp. 3-4). They are also more comfortable and have greater knowledge about the technology of our society than their parents and teachers. In addition, cultural, educational, and legal changes have increased the variety of students served in a typical elementary, middle or high school building (Rose & Myer, 2002). Today's schools are a mix of students from varied cultural and economic backgrounds of which some are making educational progress, some are not reading on grade level, some are gifted, some whose first language is not English, some have behavioral, attentional, and motivational problems, and some have sensory, communication, cognitive, emotional or learning disabilities (Rose & Myer, 2002).

Student outcomes have become a clear focus of national debate and action. Both the 1997 IDEA Amendments and The No Child Left Behind Act of 2001 (NCLB) have increased the focus on the academic outcomes of students with disabilities in the general education curriculum. At the same time, increased attention to determining and measuring meaningful outcomes related to AT is emerging as a national dialogue (e.g., Assistive Technology Outcomes Measurement System, 2003; Consortium on Assistive Technology Outcomes Research, n.d.). However, the preparation of today's teachers to utilize technology directly impacts the potential for students to achieve meaningful outcomes through educational or assistive technology (AT) use. The number of students per computer in schools has declined from an average of 125 to 4.9, though the use of those computers varies widely (Lahm, 1996). The AT available to persons with disabilities has grown to over 25,000 assistive technology items, equipment and product services (Abledata 2000) and the IDEA Amendments of 1997 *require* that AT must be considered for use with an estimated 6.2 million students ages 6-21 with disabilities. However, the preparation of teachers to consider and use technology in general, and AT in particular, has demonstrated a varied response. Less than half of teacher preparation programs have stringent technology requirements and few preservice training programs include coursework or experiences on AT applications and issues (Lahm, 2003).

In response to these needs and trends, standards have been established for the preparation of teachers to use educational technology, in general, (ISTE, 2004a, 2004b) and for the preparation of special education teachers to use technology and AT, specifically (CEC, 2001; Lahm, 1996). These standards incorporate the principles of the standards-based reform movement in K-12 education (cf., McDonnell, McLaughlin, & Morison, 1997; Thurlow, 2000). Key elements of education include (a) goals, (b) indicators of success, (c) measures of progress, (d) reporting, and (e) consequences (Thurlow, 2000). The purpose of this article is to: (a) provide a description of the instructional and AT influences on teacher preparation curricula, (b) present an overview of a teacher preparation model to foster AT outcomes, (c) discuss preliminary results from the model, and (d) present future directions for the model.

AT Influences on Teacher Education Curricula

Consideration of AT outcomes for teacher preparation in higher education has been influenced by the emergence of *instructional technology*, by the emergence of state-delineated K-12 educational standards, and by the broadening of the conceptualization of what constitutes AT. These influences are briefly described in the following sections.

Instructional Technology

Instructional technology (IT), sometimes referred to as educational technology, has developed in response to demands to improve teaching, learning, and information management. Generally, IT focuses on six interrelated teaching processes: (a) planning instructional interventions; (b) preparing print, audio, video, or digital instructional materials; (c) instructing the relevant content (knowledge and skills); (d) managing student interests, materials, or data during instruction; (e) assessing student learning; and (f) extending instructional impact through maintenance and generalization procedures (Newby, Stepich, Lehman, & Russell, 2000). In a Concord, NH high school, students in the English class read *Catcher in the Rye* in either paperback or digitized text version; have prompted strategies to improve reading comprehension available in the digitized version if they need them; and synthesize important elements in a chapter, tie them to their own lives, and communicate this to classmates using videos, posters, animated scenes, written papers, oral reports, and collages (Rose & Myer, 2002). Developing such integrated use of IT in teaching has greatly impacted preservice teacher education programs and the development of standards for teacher education (ISTE, 2004b).

K-12 Standards Movement

At the same time that teacher preparation standards are developing in response to technology development, so too are the expectations for how students graduating from our nation's schools will use technology. The current K-12 educational reform movement began with the publication of *A Nation at Risk* (National Commission on Excellence in Education, 1983), and its specific concerns regarding the mediocrity of education in the U.S. Many rigorous responses ensued, particularly at state levels. For example, the Illinois Learning Standards (ILS) (Illinois State Board of Education, n.d.) define what students should know and be able to do as a result of their school learning experiences and reflect a new understanding of the role of technology in preparing students to successfully exit from public education. Beyond the specific knowledge and performance standards to develop skills in English/Language Arts, Math, Social Studies, and Science, the ILS explicitly require students to: (a) apply learning using technology to solve problems; (b) communicate and make connections; and (c) use technology to access information, process ideas and communicate results (Illinois State Board of Education, n.d.a). Therefore, it is essential that teachers be competent in both knowledge and application of technology if these outcomes are to be achieved with diverse learners (Illinois State Board of Education, n.d.b).

A Broadened Conceptualization of AT

Instructional technology and the expectations for student competence with technology represent a macro context within which the AT mandate serves to influence teacher preparation. The requirement itself--to consider the student's educational need for AT--developed in the larger context of the technology, disability, and public policy. The potential of technology to impact the lives of people with disabilities was first highlighted as public policy in Technology and Handicapped People (U.S. Congress, Office of Technology Assessment, 1982). This report was powerful in advancing the argument that public investment in research and development would reap individual and public benefit (Edyburn, 2000). This argument resulted in a series of public laws that have advanced public policy and funding for research, development, and adoption of technology by individuals with disabilities. Historically, however, educational professionals have focused their attention on understanding the functional outcomes of AT for persons with physical, sensory, and communication disabilities. Recent AT research, development, and application has placed increasing emphasis on students with mild disabilities (Behrmann & Jerome, 2002), thus broadening the scope of educators' understanding of AT. Although there is a range of technology that can support reading, writing, math, information acquisition, organization, and cognitive processing, the issues of what, how, and when to use these technologies with K-12 students with disabilities are not yet clearly understood (Peterson-Karlan, 2003). The current broadened view of AT use requires teachers to be able to consider AT to both enhance acquisition and performance of academic skills and enable functional outcomes (Peterson-Karlan, 2003) for some students while also attempting to integrate instructional technology (IT) for all students (Blackhurst, 1997).

Technology Standards in Teacher Education

To meet these dual goals, new teachers must emerge from teacher preparation programs with appropriate knowledge and skills. To accomplish this, there must be national standards to create consistency and credibility for teacher preparation programs (Lahm, 2003). Technology standards for all teachers

[International Society for Technology in Education (ISTE), 2004a, 2004b] have been adopted by the National Council for Accreditation of Teacher Education (NCATE) to support technology integration into professional teacher preparation programs. The Council for Exceptional Children (CEC) (2001) has also created performance-based technology standards for teacher preparation (both initial and advanced certification) that include the use of AT. Accredited teacher preparation programs must align specific national technology standards (ISTE, CEC, and NCATE) with: (a) course sequences, practica, field-based experiences, and student teaching; and (b) requirements of the state-level certification standards for general and special education teachers. Presented in Table 1 are general categories of current technology standards, with links to sites containing specific information about these standards.

TABLE 1

Technology Standards Related to Teacher Preparation

National Educational Technology Standards (NETS) http://cnets.iste.org/	*ITPS-9: Assistive Technology Standard (All teacher education candidates)* http://www.itps.ilstu.edu/	*Core Technology Standards (ISU)* http://www.isbe.net	*Advanced Technology Standards (ISU)* http://www.isbe.net http://www.cec.sped.org
• Demonstrate sound understanding of technology operations & concepts; • Plan & design effective learning environments & experiences supported by technology; • Implement curriculum plans, including methods & strategies for applying technology to maximize student learning; • Apply technology to facilitate variety of effective assessment & evaluation strategies; • Use technology to enhance their productivity & professional practice; • Understand social, ethical, legal, & human issues surrounding use of technology in PK-12 schools & apply those principles in practice.	• Demonstrate ability to use range of AT to work effectively & equitably with students with disabilities.	The following statement represents a synthesis of 8 knowledge & 10 performance standards: • Understand legal, educational, & societal issues regarding technology & AT; • Demonstrate skills using range of AT devices or materials, educational software, & AT product systems that promote accessibility & independence; • Understand roles of special educators, related service providers, general educators, & families in collaborative service delivery processes that address assessment, selection & matching to learner's needs & preferences • Understand potential funding sources, implementation of AT, curriculum integration, & periodic evaluation	The following statement represents a synthesis of 6 knowledge & 22 performance standards: • Understand AT concepts & relationship to diversity, educational technology use, assessment, diagnosis, evaluation, equity, ethical, legal, & human issues. • Understands and uses AT funding sources & processes for acquisition, maintenance, security, & ergonomic implementation. • Develops personal philosophy & goals for using technology in special education. • Matches learner, technology, tasks, & environmental factors using team process, to include determination of need for comprehensive assistive or instructional

associated with providing assistive technology in K-12 learning environments.	technology evaluation. • Utilizes best practice strategies for acquiring information and technology & subsequent effective classroom implementation, including data management strategies, with students/others to achieve mastery & AT maintenance. • Provides culturally-sensitive technology supports to students receiving instruction in general education classrooms & other professionals & family members. • Participates in best-practice AT teaming & advocacy activities, including provision of inservice training. • Maintains AT professional development knowledge & skills.

Creating a Model to Achieve Student Outcomes

The standards-based reforms, legal mandates, and the broadening conceptualization of what constitutes AT compel higher education to develop AT instructional delivery and assessment systems to prepare all future teachers. The Illinois State University (ISU) model, described in the following sections employs two complementary instructional systems—alternative and traditional--for the delivery and assessment of AT competencies (see Figure 1) for both general education, special education, or early childhood education teacher candidates. These systems work together to ensure *all* teacher education candidates can demonstrate competence in using assistive technology in the classroom.

The Alternative System – ITPS Competency 9

In response to planning for NCATE program accreditation review at ISU, an Instructional Technology Passport System (ITPS) was developed (see http://www.itps.ilstu.edu/ for more information) as a performance-based assessment system for meeting both the national and the Illinois Technology Standards for All Teachers (Illinois State Board of Education, n.d.b). The ITPS system includes 10 technology standards designed to develop technology competence among all teacher education candidate graduates. Approximately 750 teacher candidates across 37 teacher education programs participate in the ITPS system each semester.

Of particular interest is the ninth ITPS standard that addresses AT. Developed collaboratively by professionals across disciplines at ISU, the learning experiences associated with the ITPS-9 system are crafted to reflect sensitivity to the wide range of teacher candidates' experiences with working with students with disabilities while also insuring development of a basic foundational knowledge in the variety of assistive technologies available and ways that AT can be used to enhance student performance.

The ITPS 9 system, designated the 'Alternative System' (see Figure 1), is designed to provide elementary, middle school, and secondary education majors (approximately 600 teacher candidates each semester) with a basic awareness level regarding AT. The system employs a blended learning approach incorporating two stages: (a) online instruction and an objective evaluation, and (b) hands-on experiences and a performance based evaluation. In Stage 1, each teacher candidate accesses six online AT modules. The modules are organized around the following topics: (a) An Introduction to Assistive Technology; (b) Assistive Technology Used for Common Academic Tasks; (c) Assistive Technology to Aid in Communication; (d) Assistive Technology to Aid in Mobility and Positioning; (e) Assistive Technology Commonly Used by Students who are Deaf or Hard of Hearing; and (f) Assistive Technology Commonly Used by Students with Visual Impairments.

The first module provides basic information such as a legal definition of AT devices and services, a functional definition of AT, a rationale as to why AT is an integral part of the classroom, and a discussion comparing assistive and instructional technologies. Each subsequent module is designed to provide the teacher candidate with topical information about the characteristics about the potential users of the AT, a variety of ATs available, and potential ways that the assistive technology can be used in the classroom. Each module combines textual descriptions with images or short video clips/vignettes depicting AT use in educational environments as well as hyperlinks to a variety of web based resources. In addition to the modules, a series of 'help sessions' are offered throughout the semester to assist teacher candidates who have questions or need clarification of module content. The modules serve to provide teacher candidates with a foundational knowledge of the variety of ATs available and their applications.

Once teacher candidates complete the online modules, an online exam related to the modules must be passed. The test consists of 30 multiple-choice questions. The questions are randomly drawn from a stratified bank of questions that balance questions related to characteristics of assistive technology users and the array of available ATs and their use in educational environments across each of the topical areas. Teacher candidates are offered two exam opportunities to achieve the passing criterion of 90%. In the case that a teacher candidate has failed to achieve criterion on the first two attempts, he or she is encouraged to review his or her first two exams and take advantage of a help session prior to attempting the exam for a third time. If the teacher candidate is still unable to pass the exam after the third trial, an alternate exam is made available to the student. The alternate exam consists of a series of fill in the blanks based on the module content. The criterion for mastery on the alternate exam is 100%. Finally, should the teacher candidate not achieve criterion on the alternate exam, he or she is required to enroll in a semester long course focusing on assistive technology (part of the traditional system discussed below).

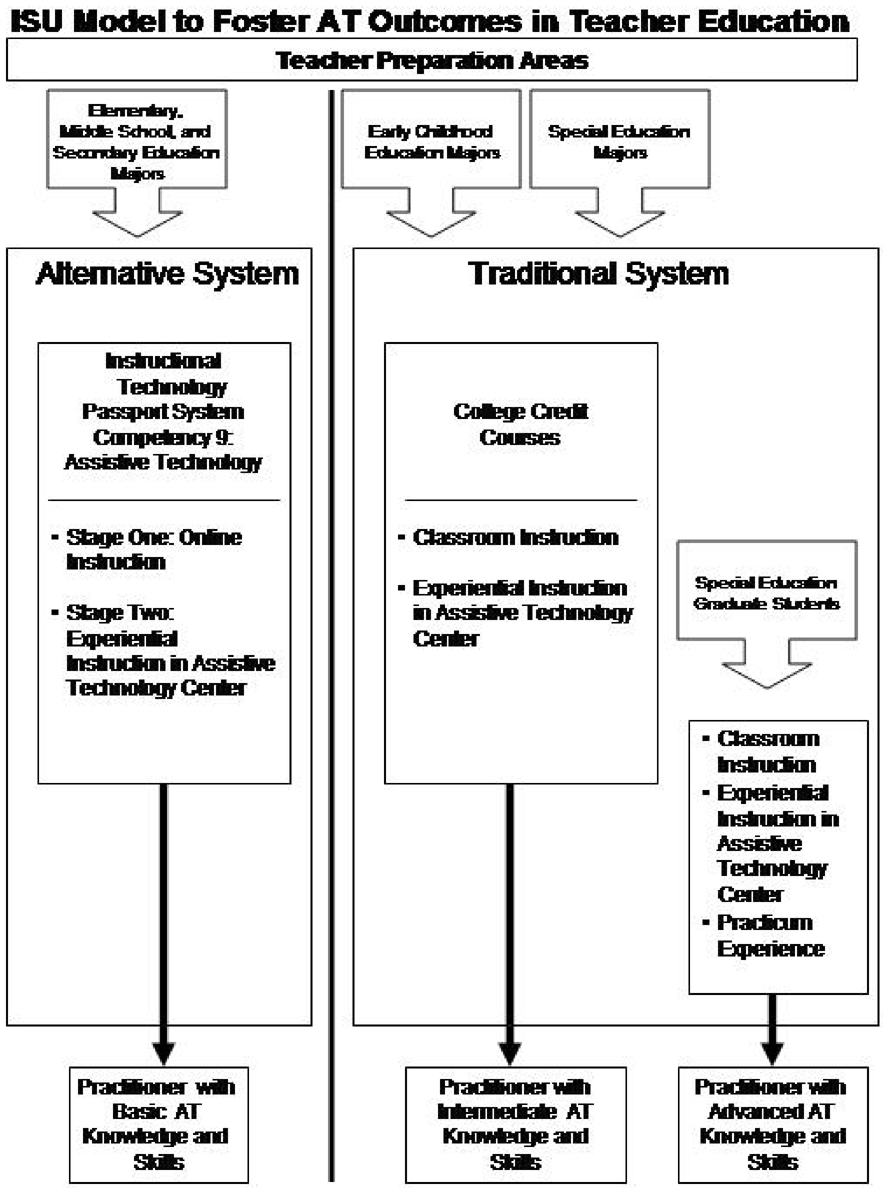

Figure 1. ISU model to foster AT outcomes in teacher education.

The second stage emphasizes using AT in ways it might be used in the classroom. Each teacher candidate visits the Special Education Assistive Technology (SEAT) Center, a centralized location on campus developed to facilitate learning about AT. The SEAT Center began operation in Fall, 2001, with the mission of supporting teacher preparation and professional development, research in various areas of AT, and service to schools and families. For more information on the SEAT Center, please visit http://www.coe.ilstu.edu/seat.

When the teacher candidate visits the SEAT Center, he or she participates in a variety of self-paced activities using various ATs. The activities are designed to provide experience in using common AT tools and strategies. After the teacher candidate has completed the activities, he or she is assessed using a performance checklist. Specifically, each candidate needs to demonstrate competence in the following: The teacher candidate (a) adapts text (size, contrast, audio, mp3) to create accessibility and foster the student's learning; (b) demonstrates proficiency in operating various equipment to ensure accessibility (e.g., close captioning, FM/IR listening systems, sound field amplification, etc.); (c) demonstrates proficiency in using visual strategies to aid in the instruction of students with disabilities; and (d) demonstrates proficiency in using common built-in accessibility options in current operating systems. Successful completion of these task areas results in mastery of Stage 2 and subsequent completion of the alternative system within the ISU model.

The Traditional System – Coursework & Experiential Activities

The second system, designated as the traditional system, targets all teacher candidates enrolled in special education or early childhood preparation programs culminating in attainment of intermediate knowledge and performance skills. It also prepares practicing teachers returning to ISU to obtain advanced AT knowledge and skills (see Figure 1). This is accomplished through using traditional coursework, and hands-on experiences using AT at the SEAT Center. Students participating in this system take intensive AT courses and participate in other courses or field-based experiences in the sequence having AT content. Graduate students, seeking advance knowledge and skills related to assistive technology, complete a 3-semester hour professional practice that requires (a) completion of a comprehensive student-centered AT evaluation and assessment, and (b) designing and conducting AT professional development activities.

Outcomes and Benefits

The Alternative System for preparing general education students represents the more innovative component of the preparation model and is the focus of this preliminary report. These systems were fully implemented in Fall, 2003, and thus, only limited data are currently available. However, these data support the potential of this approach for preparing general educators to engage in the 'consideration' of AT. The data described here is presented in Tables 2, 3, and 4. During this period, 503 preservice teachers participated in the Alternative System. By December, 2003, a majority of students (*n*=437; 86.9%) had passed on stage 1 (knowledge); an additional 66 (13.1%) had not yet completed this stage. Of those who had passed stage one, 164 students (35.2%) passed the on-line exam on their first attempt, having spent an average of 26.35 minutes in on-line examination, while an additional 270 passed the exam on their second (45.5%) or third (12.4%) attempt. An additional three students completed the exam in an alternate form. A total of 465 students (92.4%) completed Stage 2 (see Table 5), experiential lab-based activities with all students passing in an average of 70.9 minutes. Of the 503 students eligible to participate, 432 (85.9%) successfully passed both stages and therefore reached mastery on the ITPS-9 competency. Of the 71 students who did not reach mastery (see table 6), 28 (5.6%) did not begin the modules, 14 (3%) did not finish either Stage 1 or 2 after they had begun, and 29 (5.9%) failed Stage 1 and could not advance to or complete stage two.

TABLE 2

Pass/Fail Rates by Attempt for Stage One of Alternative System

Attempt	*M Score (out of 30)*	*M Time (out of 40 mins)*	*Pass*		*Fail*	
			N	*% of Attempt*	*N*	*% of Attempt*
First	24.9	26:21	184	35.2	302	64.8
Second	27.2	31:24	212	72.4	81	27.6
Third	28.1	29:24	58	80.6	14	19.4
Fourth	100 %	N/A	3	100	0	0

TABLE 3

Percentage of Persons Not Completing Attempt on Stage One Exam of Alternative System

Attempt (Not Yet Taken)	*Total Pending*	
	N	*% of Total*
First	37	7.4
Second	9	1.8
Third	9	1.8
Fourth	11	2.2
TOTAL	66	13.1

TABLE 4

Percentage of Persons Passing Exam at Each Attempt Level for Alternative System

Attempt	*Cumulative Pass*		
	N	*Students Who Have Taken Exam*	*Total Eligible Students*
		%	*%*
First	164	35.2	32.6
Second	376	80.7	74.8
Third	434	93.1	86.8
Fourth	437	93.8	86.9

TABLE 5

Pass/Fail Rates and Related Statistics for Stage Two of Alternative System

N	*% Passing*	*% Failing*	*M Attempts*	*M Time to Completion*	*% Completed*	*% Not Completed*
465	100	0	1	70.9 min.	92.4	7.6

TABLE 6

Reasons Candidates Did Not Complete Entire Alternative System

Reason for Deficiency	*N*	*% of Total*
Stage One Not Done	10	2
Stage One Failing Status	20	4
Stage Two Not Done	4	< 1
Stage One Failing Status; Stage Two Not Done	9	1.9
Stage One Not Done; Stage Two Not Done	28	5.6
TOTAL	71	14.1

A pre- and post-survey of students across six areas revealed an increase in the percentage of students rating themselves as having *functionally adequate* AT knowledge or skills in: (a) the range of AT devices ([pre]17.1% to [post] 50.5%); (b) AT options for academic areas ([pre]11.7% to [post]42.9%); and (c) AT for persons who are deaf/hard of hearing or have communication, physical, or visual disabilities being similarly reported. However, traditionally delivered courses do not typically incorporate such pre- and post-participation measures. Therefore, no equivalent data is available for special education for students who participated in the Traditional System. None the less, at this point in time, the implementation of these two systems seems to indicate that preservice teachers are, indeed, making gains in their AT knowledge and skills. However, additional and more long-term information will be needed to document these gains and to evaluate the effectiveness of these systems within the ISU Model.

Future Directions

Thus far, standards have provided the framework for a system of instructional delivery, traditional courses of study and practicum, field-based and student teaching experiences. As a result, ISU and the Department of Special Education are among the first to receive full accreditation in 2003 under both the NCATE and Illinois State Board of Education (ISBE) standards for teacher preparation. However, the ISU model represents only a beginning component of a process for producing and evaluating meaningful AT outcomes for teacher education graduates. To determine outcomes and benefits of a model for measuring AT outcomes in teacher education programs, systematic efforts in data collection related to individual student outcomes (e.g., preservice teachers, inservice teachers, K-12 students), program evaluation, and research are needed. Furthermore, to meet the needs of teachers already in the field, exploration into expanding the scope of this model to foster continuing personnel development and capacity building should be undertaken.

Measuring AT Outcomes

For those who participate in the Alternative System, additional information and research are needed regarding changes in: (a) values and attitudes toward students with disabilities, (b) willingness to use AT, and (c) degree of AT applications in their teaching. Time periods for the collection of this data could occur during their student teaching experiences as well as during their first years of teaching. For special education majors who participate in the Traditional System, there is a need to develop and validate criteria for evaluating: (a) occurrences of AT consideration in student-centered planning, (b) the integration of AT into students' with disabilities educational programs, and (c) the use of AT in the measurement of students' educational progress and in district and state assessments. Additionally, case-study based repeated measures of performance should also be developed to measure progress toward proficiency and application of AT knowledge and skills. Also, follow up data are needed from graduate students on their perceptions of their role as AT specialists and how they are fulfilling their role.

Measuring educational and social outcomes for K-12 students may include investigating: (a) the extent of AT integration into academic, vocational, or life skills instruction, (b) the changes in student performance, (c) the extent and nature of participation with typical peers, (d) the participation and performance in state and district assessments, (e) quality of life, and (f) the changes in intensity of supports needed by the student to achieve independence. K-12 student outcomes specifically related to AT acceptance or abandonment may include determining: (a) the factors in the decision making process that lead to a specific AT device or service, (b) extent of device usage, (c) cultural and familial expectations and assumptions about AT and acceptance by others, and (d) degree to which training related to the AT occur. Measures such as these can be modified and refined when recommendations about nationally recognized outcomes indicators are disseminated by the ATOMS and CATOR projects in 2004.

Expanding the Model

The ISU Model was developed in response to the needs of preservice training of teachers with regard to AT. However, the need for continuing professional development in AT for current practicing special and general education teachers suggest that the Alternative System should be expanded beyond pre-service education. A pilot project (Peterson-Karlan & Parette, n.d.) is underway to assess the feasibility of training general and special education teachers, paraprofessionals, and administrators to attain the basic knowledge and performance competencies. In the pilot project, the web-based, interactive learning module from the Alternative System will be available to approximately 250 teachers, paraprofessionals, and administrators across Illinois. Using an existing state-wide coalition of school districts and social service agencies, the hands-on learning and performance evaluation activities will be provided through a series of regional workshops for the school-based staff. The pilot will also explore the outcomes of this training over time on teachers' use of AT, future AT training, and direct student outcomes. The exploratory study will examine such initial outcomes as: (a) degree of professional and family involvement in AT planning, (b) integration of AT into students' individual educational plans, (c) frequency of student AT usage in educational environments (d) documentation of educational progress associated with AT use and (d) reductions in costs associated with AT recommendations. If feasible and successful, continued expansion of the model could result in a structure for a comprehensive, partnership-based system focused on improving professional development outcomes related to AT based on best practice recommendations.

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Using AAC Device Features to Enhance Teenager's Quality of Life

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Abstract: The subject of the attached case study is Sara, a 17-year-old high school honors student who communicates using a DynaVox 3100, which she accesses via single-switch visual scanning. A team of education and engineering specialists at DynaVox Systems LLC collaborated with Sara to identify and maximize her use of device features and accessories that would allow her to use the computer, telephone and other electronic equipment in the home environment without assistance. This team also worked to increase the efficiency of Sara's communication. Essential to achieving this goal were the DynaVox's environmental control and rate enhancement features, the DynaBeam wireless computer access component, and the pages for visual scanners on the Word Power–2 application developed by Inman (2003). Using this combination of technology, Sara can communicate effectively and efficiently, and operate a variety of consumer electronic equipment on her own, enhancing her quality of life.

Keywords: AAC device features, Enhance, Teenager, Quality of life

The environmental control and rate enhancement features of an augmentative and alternative communication (AAC) device can have a powerful impact on the lives of people with significant physical disabilities. Environmental control can make it possible for such individuals to perform ordinary activities such as talking on the telephone, e-mailing friends or turning on a CD player, eliminating the need for assistance from others. Rate enhancement features allow augmented communicators to express themselves quickly, efficiently and effectively. When used together and routinely, these features of the device can be a catalyst for self-sufficiency for augmented communicators, while increasing efficiency in their interpersonal communication.

This action research project, which began in January 2003 and continued for a period of approximately nine months, focused on a young adult's use of the DynaVox 3100 at home to access the computer, use the telephone and control household electronic equipment. The project team also explored ways for her to communicate more efficiently, particularly online and by telephone.

Sara's Situation

Sara is a 17-year-old honors student who has athetoid cerebral palsy with severe spasticity. She attends regular classes at her local public high school. She communicates using a DynaVox 3100 voice-output communication device with a dynamic display screen. The device is developed and manufactured by DynaVox Systems LLC. Sara accesses the DynaVox 3100 via single-switch visual scanning, using a head switch attached to her wheelchair to select vocabulary.

Sara's academic performance and level of participation in social activities is competitive with that of her peers without disabilities according to the Participation Model developed by Beukelman and Mirenda (1998).

She composes, arranges and performs music using the Song Editor on the DynaVox, and has experienced great success in the musical training she's received outside of school.

This AAC device has played a major role in Sara's accomplishments both as a student and a musician, and in her interpersonal relationships. Since Sara got the device approximately four years ago, she has used it as her main system of communication. She and has developed communication skills that have allowed her to stay actively involved, meeting competitive participation with peers criteria (Beukelman & Mirenda, 1998), while realizing her full potential to communicate her unique ideas.

The Problem

Sara reached a point where she needed to expand the application of the environmental control and computer access capabilities of her AAC device in order to become more self-sufficient, particularly at home. Additionally, she wanted to learn new ways to accelerate and fine-tune her communication, particularly via telephone,e-mail, and in social situations. Sara reported that she frequently missed opportunities to communicate ideas or opinions in conversations with peers because she was unable to complete her messages on the AAC device quickly enough to participate in the conversation before her friends had moved on to another topic.

Sara's goals were like those of most teenagers. She valued privacy while communicating via e-mail or the telephone and wanted opportunities to be at home alone. Throughout her early teen years, Sara lacked fulfillment of these age-appropriate desires because she required the assistance of family members to operate the computer, telephone, lights and other household electrical equipment. Out of necessity, Sara's mother often served as an intermediary while Sara was on the phone with friends or writing personal e-mails.

Researchers have noted that gaps often exist between the use of assistive technology in learning environments and at home. Wright (2000) stated:

With the extension of technology enhanced learning opportunities for an increasing number of students in the educational realm, the lack of technology crossover to the home environment is becoming increasingly apparent. As students only have a portion of their day at school, it is vital that this access to technology cross over to the home setting. (p. 1)

The Starting Point

At the outset of working with Sara, the team of education and engineering specialists, including a certified speech-language pathologist, recognized that she needed to increase her home use of the AAC device. Additionally, Sara needed to develop strategies that would allow her to communicate more quickly. She also needed strategies for overcoming some of the functional limitations of using an AAC device. The first step toward achieving these goals was to assess her use of the environmental control and computer access capabilities of her device. The team also assessed the methods used to access the telephone and the application of the rate enhancement features. Assessment was conducted through interviews with parents/caregivers and Sara about aspects of her communication system that satisfied her needs and aspects that could be improved. Observation of Sara communicating and using the computer were videotaped and analyzed to determine the speed of computer access, words per minute, and mean length of utterance (MLU). The use of these strategies allowed those working with Sara to identify the device features and rate enhancement strategies that were available, but underutilized, on her communication system. Finally, Sara practiced using the new features in a controlled environment, while the team facilitated the integration into her home and daily teenage routines.

When the team began working with Sara, she used her home computer to compose school assignments, surf the Internet, and communicate via e-mail. She accessed the computer using row/column scanning and word prediction on the WiViK keyboard, a software program manufactured by Prentke-Romich Corporation, that provides an on-screen keyboard and mouse. When Sara used the WiViK program, one of her family members had to unplug the switch that was connected to Sara's AAC device and plug it into a switch box on the computer. Sara used her switch to scan the on-screen keyboard and perform mouse moves. Sara found WiVik to be adequate, but slow, and she did not have access to her communication device while using the program. To save time, she often dictated her assignments or e-mails while her mother typed them into the computer.

The team noted that it took Sara three minutes and 50 seconds to log onto the Internet and go to instant messaging using the onscreen keyboard and mouse moves. This included the time it took to enter her screen name and password, a task that required Sara to make 15 to 20 head strokes on her switch.

Sara's telephone use at this point was a few times per month at best and she had no way to access the phone directly. When Sara did participate in telephone conversations, another person held the phone to her ear and relayed messages to the person on the other end, while Sara communicated using her AAC system and limited vocalizations.

Similarly, Sara made little use of the infrared environmental control capabilities of her AAC system other than to operate the stereo or television. Consequently, it was difficult for her to be at home alone for a significant length of time because she could not operate electronic household appliances, such as lights, the air conditioner, or phone without assistance. This dependency also affected the rest of the family, Sara's mother for example, could not attend her younger son's ballgames because Sara needed her help at home.

When the team first met with Sara, she communicated reliably using her AAC system at an average rate of 5.6 words per minute. Her MLU was 13.2 words. These averages were determined through the analysis of a language sample taken during the first meeting with Sara.

Sara used Word Power-2, an application developed by Inman (2003). The page set included a fixed core vocabulary, a QWERTY keyboard and word prediction.

Sara scanned blocks of items on the display screen of her AAC system, row by row, then activated her switch when she reached her desired selection. Sara learned this access method at the age of 5, when she used an older and less sophisticated communication device. When Sara reported that scanning came naturally to her with a bit of practice, she made the analogy that it was like tying shoes, a skill that comes easily to most people after a period of teaching and learning. Sara also noted that a strategy commonly used in baseball helped her to develop good scanning skills as a child. Like a batter keeping an eye on the ball, Sara kept her eye on the button containing her desired selection on a communication page, then activated her switch as soon as the scanner highlighted the block containing that selection.

As a visual scanner, however, Sara's use of Word Power was limited because she did not use the pages that were designed for optimal visual scanning. Instead, she used pages in the application designed for direct selectors. The direct selection pages featured a QWERTY keyboard located in the middle of a page, making it cumbersome for her to spell out messages. When Sara attempted to scan the QWERTY keyboard, for instance would get part of the keyboard and a word predictor in one block instead of the whole keyboard. The arrangement of parts of speech of the direct selection pages was not conducive to building sentences by scanning. In some cases, Sara would have to scan multiple rows on the page to get from a subject to a verb when building a sentence. To reach her desired selection, she often had to scan significant amounts of vocabulary that she didn't need, slowing the pace of her communication.

Sara accessed vocabulary more quickly when she began to use the scanning pages in Word Power-2 (the same scanning pages found in the original Word Power application) during her work with the team. The frequency-of-use keyboard on the scanning pages made it possible for Sara to spell out messages quickly because of its compact positioning. Sara could scan the whole keyboard in one block and the letters that she needed most often could be reached most easily because they were presented in some of the first available selections within that keyboard layout. The core vocabulary arrangement has allowed Sara to build sentences with greater speed and ease because she can scan groups of any part of speech as one block.

Figure 1 shows the direct selection page set on the original Word Power and Figure 2 Word Power-2's visual scanning pages. The numbers on these figures show the pattern which Sara scanned through on each page set. They indicate the sequence in which the blocks were highlighted. The blocks show the vocabulary that was grouped together when that section was scanned.

When the team first met with Sara, she used no social scripts or abbreviation expansions, and few pre-programmed messages. Her strategic skills, discussed by Light and Binger (1998) as "compensatory strategies that may be utilized by individuals who use AAC to overcome functional limitations that restrict their effectiveness as communicators" (Light & Binger, 1998, p. 2), needed to be further refined to enable her to develop strategies to overcome some of the difficulties she identified during day-to-day communication.

The Essential Elements

After assessing Sara's use of her communication system, the team identified the DynaBeam and Word Power-2 application as essential elements to increase her home use of the AAC system and improve her rate of communication.

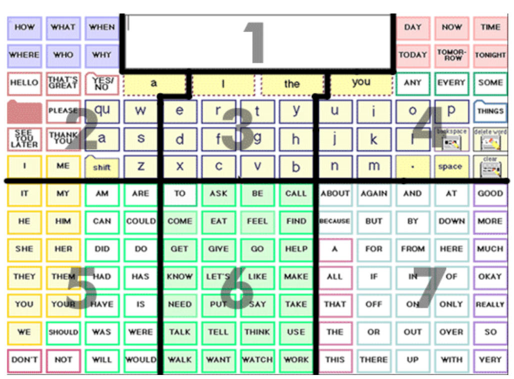

Figure 1. Word Power direct selection page

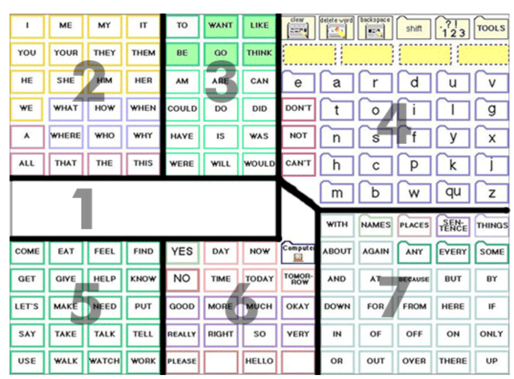

Figure 2. Word Power 2 scanning page

The DynaBeam is a separate component that provides wireless computer access to those who cannot access a computer through traditional means. While Sara had a DynaBeam of her own, she was not familiar with its use or the system features that would allow her to access it through her device.

Word Power–2 is an updated version of the original Inman application (Inman, 2003) that Sara used previously. Word Power 2 features communication pages for visual scanners and provides access to computers directly from those pages. It also features common keyboard shortcuts for computer access, such as macros to complete a task that would otherwise require the execution of a series of commands, and numerous preprogrammed keyboard shortcuts defined by Microsoft for a wide variety of applications.

Used in combination with her AAC system's environmental control and rate enhancement features, these elements have allowed Sara to expand her use of the communication device in the home environment for purposes beyond communication. They also allow her to communicate more efficiently on the telephone, via e-mail and in person.

Results

The DynaBeam gives Sara a way to use the computer without having to rely on others to unplug her communication device, set her up at the computer and plug in the computer emulation software. Now, Sara can set herself up to use the computer by positioning herself in front of it so that her DynaVox can send infrared signals to the DynaBeam to operate the computer.

Sara finds the keyboard and mouse emulation capabilities of her AAC system to be more efficient than the software program she used previously provided. To access the Internet, for instance, Sara no longer has to enter her screen name and password letter by letter. By using the DynaBeam in conjunction with the capabilities of her AAC system and Word Power-2 to construct macros, she can log onto the Internet and go to instant messaging in two head strokes. It takes her 44 seconds to complete the task, nearly one-sixth the time it took her to do so before.

The same combination of technology also allows Sara to create macros that make it easier for her to access websites directly from her AAC system. Before she had access to macros, Sara had to type the names of the websites she wanted to visit in the address bar with the exception of sites whose names appeared in the bar automatically because she had visited them recently. In such cases, she could get to a site with a single press of her head switch. Now, she can access any site in the same manner, selecting the desired site from a pop-up menu. As a result of Sara's ability to access new web sites more quickly than before by using spelling, word prediction and macros that emulate keyboard shortcuts, she can quickly and independently navigate to any destination she chooses. In doing so, she makes use of many of the preprogrammed keyboard shortcuts within the Word Power 2 page set. These include shortcuts for common extensions such as 'www.,' '.com' and shortcuts to select the address bar, cut and paste text, and perform a wide range of other functions. Additionally, Sara can add macros for new sites to her system because of the DynaVox's capacity to allow the user to program and customize her own communication device.

Sara can now access the telephone and make calls on her own using a telephone access page that the team helped her create. She selects the number of the person she wants to call from a list of frequently called friends and relatives programmed into her AAC system. Using macros while on her telephone page, Sara can dial the number with a single stroke of her head switch, similar to pressing one button to make a call using a telephone's speed-dial feature. The environmental control features on her AAC system activate the phone.

Dovetailing with Sara's use of rate enhancement strategies for computer and telephone access is her expanded use of the AAC system's environmental control capabilities. Practice sessions with the team gave her a foundation to use these capabilities to operate lights, the air conditioner and other home electronics on a daily basis, bringing her to a higher level of self-sufficiency.

Communication Efficiency: A Quality of Life Issue

The use of macros to work online or use the telephone is one of several rate enhancement features that Sara has started using on a daily basis. Among the features that have allowed her to create and deliver communication messages more quickly are the Word Power-2 visual scanning pages. Their design lets Sara scan blocks of core vocabulary and pop-ups in a frequency-based sequence that allows her to build messages more quickly and easily than she could with the direct selection-based pages. The compact frequency-of-use keyboard on the layout makes it convenient for Sara to add fringe vocabulary to messages by spelling words letter-by-letter and using word prediction. Another advantage of the application is that there is little to no repetition of core vocabulary in its word prediction buttons. This allows word predictor buttons to be reserved for those less frequently used words that need to be accessed by spelling.

Social scripts as defined by Burkhart and Musselwhite (2002) provided another way for Sara's e-mail and telephone communication to be more rapid and effective than before. With help from the team, Sara created and programmed a series of social scripts, with simple yet meaningful messages to use in conversations with friends and family. She used the social scripts to initiate and maintain early portions of a conversation. Once the communication partner had been engaged, Sara was then able to develop novel messages to share during the conversation.

Abbreviation expansion allows Sara to deliver messages by selecting a series of just two or three letters referred to as a salient letter code. Light, Lindsay, Siegel, and Parnes (1990) found that the use of salient letter codes was an effective means by which literate individuals with physical disabilities could retrieve pre-programmed messages. Additionally, they speculated that this strategy may have been even more effective had the individuals in the study been able to personalize the codes rather than adhere to the predefined codes which were required during their research (Light et al., 1990). Since Sara can assign her own codes to the abbreviation expansions she uses, she has a personalized tool for establishing the salient letter codes for these expansions. Sara finds such codes helpful in the halls at school and when she is on the phone or computer. For example, she can select 'hh' to say "Hey, how's it going?" It allows her to express needs and ask for help more quickly than spelling the full message or selecting a series of buttons on her AAC system to create the message. For example, to let someone know that she needs to go to the bathroom, Sara selects 'sgb.'

Additionally, Sara's rate of communication had more than doubled to 11.5 words per minute. Her mean length of utterance increased to 18.7 words, an increase of more than five words.

The communication strategies that Sara has learned in recent months have raised her comfort level when she is out in the community or at home alone for a few hours at a time. Now she has a way to call her mother, a neighbor or a close friend for help with personal care, which she did not have before.

With time, practice, and professional guidance, Sara has made her newfound shortcuts for using the technology routine. Her ability to accomplish daily tasks and to use the rate enhancement strategies has increased significantly. She has the satisfaction of addressing daily needs on her own and is enjoying a better quality of life that extends to her entire family.

While the strategies for rate enhancement and computer access used with Sara were effective for her, one must exercise care in applying these results across all augmented communicators. The study was limited to a single subject. Although the results may be of interest to related augmented communicators, generalizations may not be accurate. The action research project offers preliminary information on the use of environmental control, rate enhancement features, and Word Power 2 on the DynaVox 3100. While the use of macros for computer access, social scripting, and infrared environmental control may have widespread application for individuals of varying cognitive abilities, use of strategies such as the salient letter coding associated with abbreviation expansion and the scanning of a core word vocabulary system will require more complex cognitive skills and physical abilities and therefore may vary in their effectiveness to enhance the rate of communication for any individual.

It is the use of a combination of these strategies that resulted in the increased rate of speech and MLU, and greater self-sufficiency and speed for computer and telephone access for Sara. Future research should consider further evaluation of these strategies as a whole. Additionally, there is limited research that considers computer access through the use of an AAC system from within the communication software and the communication pages that are used by that individual. Comparative studies that focus on both the benefits and limitations of this approach to computer access would assist clinicians in determining the importance of considering this feature on an augmentative communication system while drawing attention to the importance of computer access for individuals with disabling conditions.

Outcomes and Benefits

Sara, 17, was a proficient augmented communicator when she began working with the team of education and engineering specialists to increase her use of the environmental control and rate enhancement features of her DynaVox 3100 communication device, which she accesses via single-switch scanning. While the device played a key role in her academic and social successes, she had not yet developed strategies for using its environmental control capabilities and rate enhancement features.

The effort to maximize Sara's use of the environmental control and rate enhancement features on her AAC device focused on devising strategies for Sara to access the computer and telephone without assistance from family members. Sara now realizes many benefits by using the computer and telephone on a regular basis, including greater self-sufficiency, enhanced interpersonal communication and more time for herself. The strategies allow her to use assistive technology for daily activities in her home environment without assistance. Sara has privacy when she communicates with friends on the telephone or via e-mail because she no longer needs an intermediary to help with the preparation or mechanics involved. She can be at home alone for significantly longer periods of time because she can use the computer and telephone readily. She has made a habit of using the infrared environmental control capabilities of her AAC device to use the telephone, control the lights and use other electronics in her surroundings.

A key step toward achieving these results was to incorporate the DynaBeam computer access component and the Word Power-2 application into Sara's routine use of her communication system. Using the DynaBeam with the computer access pages on Word Power-2, Sara can use the computer without assistance. The DynaBeam allows her to maintain access to her AAC device while she is at the computer because she does all environmental control and computer access directly from her communication pages. Word Power-2 also provides macros that allow Sara to access the Internet or visits a website with one press of her switch. The program that Sara used previously required her to spell out her screen name, password and the names of websites letter by letter. This process was not only time-consuming (it took Sara 3 minutes and 50 seconds to access the internet compared to 44 seconds with the DynaBeam and Word Power-2), but also involved considerable physical effort. Sara had to activate her switch 15 to 20 times just to get online.

The telephone access pages that Sara and the team created on her AAC device provided macros that allowed Sara to make a phone call with one stroke of her switch, eliminating her need for assistance and increasing her privacy while communicating on the phone.

The rate enhancement strategies that Sara uses daily as the result of her work with the team facilitate her communication in a variety of settings. Central to this improvement is Sara's use of Word Power-2's visual scanning pages because their design matches her physical abilities more closely than that of the direct selection pages she used before. Other rate enhancement strategies featured in the application, such as macros and the frequency-of-use keyboard, allow Sara to access vocabulary quickly and easily, allowing her conversations to flow more smoothly. The same holds true when she exchanges e-mails with others. Abbreviation expansion is a rate enhancement feature that has made a noticeable difference for Sara, whether she's communicating by telephone or in person.

A significant quantifiable outcome of Sara's combined use of these strategies is the increase in the rate and content of her communication. From the beginning of this project to its completion, the number of words per minute that Sara communicates increased from 5.6 to 11.5, and her mean length of utterance from 13.2 to 18.7 words.

Sara's increased use of the rate enhancement and environmental control capabilities has reduced her need for assistance with daily tasks. Because she requires less help, her family can devote more time to other activities. Sara, meanwhile, has significantly reduced the amount of time and effort it takes to express herself, ultimately increasing her opportunities for fluent and meaningful communication.

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Technology Integration Solutions: Preservice Student Interns as Mentors

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Abstract: To support the integration of technology in the K-12 special and general education classroom, especially for students with disabilities, teachers must be experienced in the application of technology to curriculum. Professional development programs continue to provide opportunity, but often do not result in teacher proficiency in the integration of technology. This study examined the effectiveness of a mentorship-training program that employed special education and elementary education student interns to assist teachers with their technology infusion efforts. Results suggest that mentoring supported by student interns can support integration efforts, specific to the needs of students with disabilities. Implications for supporting teacher technology infusion are discussed.

Key words: Technology integration, Teacher technology training, Technology for students with disabilities, Teacher mentoring

Since the passage of the Technology-Related Assistance for Individuals with Disabilities Act of 1988 and the inclusion of assistive technology (AT) as an integral component of the Individuals with Disabilities Education Act of 1990 (IDEA), technology has been seen as an effective tool to assist individuals with disability in their overall growth and development. During the 1990s, it became obvious that technology could serve students with disabilities and, for many, be a major catalyst in improving access to the general education curriculum (Edyburn, 2000). Acting on this fact, IDEA 1997 requires that AT be considered for every child receiving services under an Individualized Education Program (IEP). As a result, today every IEP must consider AT as a possible tool to further enhance a child's education.

Growth in AT expectations has paralleled a steady, if not significant, improvement in access to classroom-based technology. Computer-based classroom technologies provide a wide-range of possibilities for interaction between students and the world in which they live. Acquisition of computer-based technologies for education has been increasing steadily for years resulting in a significant increase in available instructional computers per student. In 1984 the national average of instructional computers for each student was 125 (students per instructional computer). Today, that ratio is 4 students per instructional computer (Market Data Retrieval, 2004). Further, in classrooms across the country, disparities in students' access to technology due to poverty appear to be diminishing. Other leading indicators of increased presence and use of technology in education reported by the National Center for Educational Statistics (May 2001), include 83% of fourth graders eligible for the national free and reduced-price lunch programs have access to computers in their classrooms and the percent of schools with Internet access has increased from 35% in 1994 to 98% in 2000.

With increased presence and access to technology, the challenge to schools, teachers, and parents struggling with the integration of technology into the lives of individuals with disabilities is improving; however, challenges continue to exist. For general education preservice and inservice teachers, initiatives like the Preparing Tomorrow's Teachers to

Use Technology (see http://www.pt3.org) have lent support to this issue of technology integration (Rockman, 2004), and models have been proposed to address technology use deficiencies (Maryland Department of Education, 2004). Still, the literature indicates much more potential then actual application in this arena (Virginia Educational Technology Alliance, 2004).

A significant obstacle toward integrating technology into instruction appears to be the method by which teachers receive technology training (Bullock, 2004). Often, teacher professional development workshops provide limited extended support and follow-up. Joyce and Showers (2001) argue that teacher development should be innovation-related, continuous over several sessions, and involve a variety of formal and informal training sessions in order to meet the needs of the teacher or faculty member. Joyce and Showers' theory-demonstration-practice-feedback-coaching model has shown rather conclusively that staff development is central to instructional change involving teacher models. Their model further emphasizes the need for the learner to be shown how an application works, be provided an opportunity to practice with the application, and then receive follow-up support to allow for further practice and related critical feedback.

Recent case studies and pilot training programs have illustrated how colleges of education and K-12 schools have attempted to integrate technology into the general education classroom (Howland & Wedland, 2004; Sherry & Chiero, 2004). Sherry and Chiero have extended the professional development experience and conducted a program of research examining how technology can be used through a community of learners supporting and mentoring each other. Similar research indicates that when teachers are supported on a continuous basis within their classroom, efforts to apply technology can be successful.

In this study, we examined the learning process through the application of a student-to-teacher mentoring model. Preservice teacher education students were used to provide enhanced instruction to classroom teachers in order to gain insight into the teachers' comfort with, and use of, a standard educational software product (i.e., HyperStudio®, Roger Wagner Publishing Company, 2004). We focused on this application since it has been used extensively across all elementary grade levels and has been shown to be applicable to the needs of students with disabilities (Bryant & Bryant, 2003). Further, we examined the effects of the student-to-teacher mentoring model on the ability of the classroom teacher to implement the technology into the educational curriculum and whether this was ultimately beneficial to learners with challenges, including those with stated disabilities on Individualized Education Plans. Finally, we compare this mentorship model with current technology training practices available to most teachers in the K-12 environment.

This study strove to use these students in order to examine a potential model that could be replicated in all student teaching experiences. The questions posed in this study were: (a) What is the effectiveness of a traditional professional development experience with supportive ongoing relationships via the preservice teacher education student mentors? (b) What levels of technology comfort and use (specific to the needs of students with learning challenges) are exhibited in teachers who receive supportive training? and (c) What is the comfort level of teachers who use HyperStudio® as an application, how do they use this software with students with special needs?

Method

Preservice Teacher Education Mentors

Out of 110 seeking placement, six preservice teacher education students in their final year of a five-year School of Education program were randomly selected from those assigned to participate in a 14-week teaching internship during the spring semester. All students had completed a required Introduction to Educational Technology course earlier in their program. Similarly, students had e education coursework where faculty had integrated Internet-based resources and multimedia presentations to enhance student understanding. Students were selected more for their ability to successfully relate and interact with the faculty participants in the study. Their enthusiasm for teaching, learning and integrating technology was considered a bonus and would hopefully be seen as an influential feature to the mentoring process. A student's individual experience with technology was not a consideration in the process of selection; individual expertise was varied. Instead, they were placed according to their interest in teaching students from diverse socio-economic and ethnic backgrounds. They also sought to student teach in a fully inclusive elementary school in an urban setting.

Three of the six students were concurrently pursuing a Masters of Education (M.Ed.) in Special Education. The remaining students were concurrently pursuing a M.Ed. in Elementary Education. Each student was assigned to mentor an elementary general education teacher. Two of the preservice teacher education students also mentored an elementary special education teacher. These preservice teacher education students spent a majority of their day in the general education setting co-teaching and working with small groups of students with disabilities as well as students experiencing learning challenges.

While each preservice teacher education student had completed a three credit hour course in Instructional Technology during their undergraduate coursework, none of the preservice teacher education student felt competent using/teaching the HyperStudio® program. Thus, training on how to use and teach the program to others was required prior to beginning the mentoring process.

Classroom teachers (experimental). Six general education and two special education teachers from a local elementary school in a Midwestern urban school district participated in this study. This school has 65% of their students on a free or reduced lunch program. Twenty-five percent of the student body (K-6) have IEPs. Of the six general education teachers, one taught kindergarten, one taught second grade, two taught third grade, one taught fifth grade and one taught sixth grade. The two special education teachers collaborated with specific grade levels. For example, one of the special educators worked with the K-3 grade classrooms while the other special educator supported the 4-6 grade level teachers. The average years of teaching experience for the eight cohort members was seven years. All faculty members had at least two classroom computers with broadband Internet connections. Prior to this study, all computers had the software program HyperStudio® installed on all classroom and lab computers.

Classroom teachers (control). Nine general education teachers, one paraprofessional, and one speech pathologist from the same low socio-economic local elementary school participated as the control group in this study. The nine teachers represented grade levels K-6. The paraprofessionals worked primarily with classroom teachers in grades 4–6. The speech pathologist served all grade levels with the majority of students being in the second and third grade classrooms. The average years of teaching experience for the nine general education teachers was eight years. All participants had classroom access to at least two computers with a broadband Internet connection. Each computer had HyperStudio® installed.

Training Procedure

In late January and early February, the six preservice teacher education students and the nineteen building personnel participated in a half-day overview of HyperStudio®. The training sessions were organized into three separate offerings. The first two, held in late January, were specifically for school personnel. Control and experimental participants were equally divided across the two half-day training sessions. Personnel were only required to attend one of the two training sessions. The third training session was conducted in early February specifically for the preservice teacher education students. Each session was conducted in site school's computer lab equipped with 25-networked computers, a presentation system, and a scanner.

Preservice teacher education interns. Based on professional development guidelines (Joyce & Showers, 2001) and the National Staff Development Council's Standards (NSDC) (see http://www.nsdc.org/), the authors decided to train the preservice teacher education students through a series of demonstration, practice and critical feedback components. The training was completed in a single 120-minute session. The session included several activities based on an overview of the HyperStudio® program. The goal of the preservice-training program was to teach HyperStudio® basics and develop working example files (stacks) integrating multiple user-interactive features. An additional training goal was to support student comfort levels and reinforce their ability to teach others how to use this application.

Following the demonstration and practice model, preservice teacher education students were introduced to five *specific* features of HyperStudio®: (a) creating a basic stack; (b) incorporating art, graphics and images into a stack; (c) modifying stacks with color, background adaptations and user-interactive features; (d) integrating video and audio; and (e) incorporating relevant instructional content into the final product (stack). At the end of the training, participants demonstrated their competency using HyperStudio® by developing, editing/modifying an original user-interactive multimedia stack for instruction.

The training also featured demonstration and practice guided by the Session Trainer. The Session Trainer was a faculty member in Instructional Technology at the University of Kansas. The session featured a question and answer format to identify areas of concerns and offer critical feedback where necessary. During this training, preservice teacher education students created additional stacks that featured extensive multimedia components. Training also modeled applicability across the grade levels since these students were working with different grade levels and teachers. On completion of their training, preservice teacher education students were able to use the program for its intended purpose; completing a well-designed user-interactive multimedia stack. It should be noted that technology training sessions did not focus on mentoring or teaching issues directly, but instead focused on specific *how to* components of the technology application.

Teacher Training

The 19 faculty members participated in one of two half-day introductory sessions on HyperStudio®. These sessions were held in the school's computer lab in late January. The sessions introduced faculty to HyperStudio®

basics (e.g., creating a stack). Similar to the preservice teacher education student training, these training sessions featured a demonstration and practice model where participants were engaged in the design of instructional stacks. By the end of the session, participants had each created a HyperStudio® stack that included text, pictures or graphics, sound, and related multimedia components. A second Instructional Technology Specialist with similar training, experience and background as the Instructor for the preservice teacher education training provided instruction. Training materials and procedures were identical for both the preservice students and the elementary school faculty.

Assessment of Training

Semi-structured interviews before and after the training were used to seek information from teachers and preservice teacher education participants about the training program, mentoring experience, and related technology training efforts. Audiotape interviews, conducted individually for all participants were approximately 30 minutes in duration. Participants were interviewed twice, once (a) before his/her technology training session, and (b) after his/her technology mentoring experience was completed. Interview questions were designed to explore technology and mentoring issues that preservice teacher education participants might have concerning the training process. Participants were questioned about concerns associated with the use of HyperStudio® as well as teacher training. Questions for students were generally organized into three categories: (a) comfort with the HyperStudio®, (b) concerns with the mentoring process, and (c) general issues concerning the integration of HyperStudio® into their curriculum specific to the needs of students with disabilities. Interview questions for faculty were related to how the combination of the training and ongoing one-on-one support (for the experimental group) would result in an increased willingness and ability by faculty to integrate technology into their curriculum.

Analysis of Interviews

Interviews were conducted at the beginning and the end of the 14-week study. Data was collected and analyzed with participants being offered the opportunity to member check related transcripts. The data gathered included only the personal experiences and opinions of the participants. The analysis of the interviews followed procedures described by Lincoln and Guba (1985) and Patton (1980). Using the process of *constant comparison*, responses were coded and sorted according to themes that emerged. All interviews were audio taped and transcribed for content analysis by university staff. To check the reliability of the interpretations, all the recordings of interviews were reviewed to confirm quotes and organizations of patterns of participant responses. To reduce the potential bias in data collection and subsequent analysis, a school of education doctoral student in special education checked and coded the transcribed responses. Reliability was determined by comparing the correspondence of the coding/organizations of the individual reviewers. Member checking was also performed to ensure credibility and trustworthiness of the data. Participants unanimously perceived the presented results as accurate reflections of the training and concerns specific to integration.

The interview responses were examined and partitioned into data units (i.e., comfort with using classroom computer). These data units were organized into categories (i.e., technology use) established from specific themes that developed out of the teacher interviews. These categories were grouped directly from the themes to organize the findings. Analysis identified five categories of faculty comfort and related integration issues: (a) support from preservice teacher education student mentors, (b) one-on-one training in a familiar physical setting, (c) on-going support and structure, (d) understanding to develop innovative technology-based instruction for students with disabilities, and (e) overall efforts to integrate technology.

Results

Teacher responses to the interview questions, once organized into themes, offered an understanding to the effectiveness of the mentor-based HyperStudio® training program. In the section below, we try to describe these themes and offer participant feedback to measure the effectiveness of the training. We have organized the data across the two groups of participants: (a) teachers who received one half-day training session (control); and (b) teachers who received the half-day training session and follow-up mentoring (experimental). The purpose was to examine the effectiveness of a traditional professional development experience with supportive ongoing relationships via the preservice teacher education student mentors. Similarly, we sought to better understand technology comfort and use specific to the needs of students with learning challenges.

Introductory Training

Previous studies of technology-based professional development training have noted that in order for teachers to feel comfortable with a particular software application they must see the software in use, have an opportunity to practice, have ongoing support, and see the relevance of the application to the instructional needs (Strudler & Wetzel, 1999). We developed a similar working assumption and so supported the initial training with an online tutorial (see http://learngen.org/cohorts/coh_southparkl obj.html). The online material featured four specific task tutorials including: (1) import graphics, (2) create button, (3) create button hyperlink, and (4) add text to card. Each component included a step-by-step tutorial, an interactive assignment, samples of successful assignments, and related web-based links that include in-depth HyperStudio® tutorials developed for, and by, teachers. These resources were introduced and reviewed with all teachers during the initial half-day training.

Control group faculty. It was clear from reading the transcripts that all teachers felt they benefited from the half-day training. Teachers reported having some level of comfort with HyperStudio® and increased knowledge about the use of the application within their classrooms. One participant shared,

> It got me to sit down and look at HyperStudio®. [The Technology Staff] installed it on my computer four weeks before the class but I didn't have time to look at it. Your overview answered my questions and the stack you required us to make I used.

Another participant commented,

> I felt good after the training. Not too many questions and was really pleased that you reviewed how to open and close the program. I got back to my classroom and was able to open HyperStudio® and use my stack the next morning. I even added some more pictures I had saved to my computer.

An integral feature of our training program was *demonstration-practice*. The training session, supplemented by the accompanying online learning resource, figured to be an effective combination to facilitate integration. Therefore, we looked for evidence to indicate a relationship between teachers' comfort and knowledge of the program and the *demonstration-practice* online learning resource. The online learning resource was meant to supplement the initial face-to-face training and was available to all participants during the 12-week training/study. Separated into four specific tutorials, participants appeared to appreciate and use this material. One participant mentioned, “If I had to pick the thing that I liked best, I think that [the online learning source] would be it. I like having the written reference to use, for us for just that document or whatever you're working on then.” Another offered,

> Before this training, I had not used online tutorials. I found yours to be helpful. How did I use it? I went back to the tutorials several times because I had forgotten how to add buttons…. yes, I did visit the suggested links as well.

Besides program comfort, participants also remarked about the flexibility of the face-to-face training and how the demonstration followed by opportunities to practice addressed early fears and apprehensions. Many remarked that they had participated in several technology-oriented professional development activities in the past. For example, one stated,

> Yes, I have participated in technology workshops in the past. None were held here though and [the technology staff] was never allowed to be as involved with the hands-on training. Having you and [the technology staff] train us was nice. I know [the technology staff] and wasn’t afraid to ask questions.

Another participant added that being involved with fellow teachers increased her comfort level with the initial group training:

> I really enjoyed the January training. It was nice to have [other teachers] sitting next to me. I guess we know each other so well we didn’t feel stupid asking you and [the technology staff] questions. I know on my part I felt more comfortable leaving your training then past workshops I’ve taken.

When asked specifically about their ability to use HyperStudio® upon completion of the training, teachers responded positively about their comfort level with the stack they had developed. Many mentioned the use of the stack in their classroom instruction. One explained,

> Oh, I developed part of a timeline for a social studies lesson. I went back to my class and used it the next day, I think. I know [paraprofessional] used it with several of the students she helps me with.

Another offered,

> I was almost done with the stack that we worked on during the workshop. I developed a word tutorial for Charlotte’s Web, well at least started….yes, I finished the stack after the training. I ended up having to visit with [technology staff] to get it right.

When asked, all teachers who participated only in the introductory training responded in the affirmative that they were successful in developing a stack and had some use of this stack back in their classrooms.

Experimental group faculty. For the cooperating teachers, their experience with the half-day introductory training was similar to their counterparts in that the experimental group of teachers found the introductory training to be a positive experience. As we did with the first group, we looked for evidence in comfort with the application and an understanding of how to create stacks upon the completion of the first training. As mentioned earlier, we followed a *demonstration, practice and critical feedback* format to allow for participants to see HyperStudio® illustrations, to have time to interact and develop a stack relevant to curriculum while having two instructors available to offer constant support and feedback. Based on earlier feedback, we also asked participants about their perceived ability and comfort using the application upon completion of the workshop. All participants reported that they completed their stacks begun during the training as well as indicating varying degrees of use and implementation. For example, one teacher offered,

> By the end the workshop my stack was done. Well, almost complete. I did add two more cards. Both of you prepared us well for the workshop. Sending out information about what we were going to do and telling us to come prepared with a lesson idea worked extremely well…the timeline I worked on was helpful to all my students. Yes, [the technology staff] and I met prior to the workshop and she emphasized coming to the class with lesson plans. This and your instruction helped me complete a stack. I had almost all of it done by the end of the morning…it was not particularly good…it didn't have any sound and I hadn't figure out how to put pictures from the web in there yet.

Reflecting on the online tutorial, experimental group participants also expressed an appreciation for the tutorials, completed samples, and related web-based resources. One teacher offered,

> As you know, right before we finished [the technology staff] mentioned the Learning Objects and said she sent the web address to our e-mails. I think it was later that week that I went to the site and saved it as a Favorite…yes, I did use it and it was helpful.

However, it appears that the follow-up mentoring provided by preservice student teacher interns impacted the experimental groups perspective on the value of the online training packet. That is, all participants mentioned that their use of the packet was in collaboration with a student mentor. For example, one participant commented, "Yes, I used the online tutorial you all created. [A participant] actually printed off the tutorial and I arranged it in a notebook…it helped guide the tutoring sessions [participant] provided after your training." Another offered, "We used your online materials. [Participant] actually suggested we review your materials and we used the fourth tutorial (Add Text to Card) to guide us the first time we sat down together."

Comfort with Technology and Application to Learners with Special Needs

Of particular interest to this study was the comfort level of the teachers with HyperStudio® as an application and the teachers' use of this software with students with special needs. Included in this grouping were students with an identified disability and related IEP, students who were being observed for identification consideration, and learners who presented with learning challenges.

Control group faculty. Interestingly, teachers who participated solely in the introductory training initially expressed some level of comfort with HyperStudio® as well as an overall positive opinion towards what they had learned. As we have mentioned, they were able to complete and use their initial stack and felt that the training was conducted in a manner fitting to their learning style. However, on follow-up we found that these same teachers expressed challenges in using HyperStudio® for the express purpose of the training (e.g., meeting the needs of students with learning challenges). It appears their comfort level with the application decreased as the spring semester continued and they distanced themselves from the initial training. For example, one participant explained, "I finished my first stack, as you call it, but haven't finished any others…I think I waited too long to start me next project. By the time I tried to do a stack, I had forgotten some things." Another participant offered,

> I was surprised at how fast I forgot what [the technology staff] and you had shared during the workshop…when I tried to develop a stack for a word recognition activity for three of my LD [learning disabled] kids, I kept having to go back to the online place to remember how to add pictures…I think I spent three evenings one week playing with the stack and finally stopped because it was taking too much time.

A third offered,

> I really wanted to use audio from my kids. We [paraprofessional and the teacher] wanted to use HyperStudio® to have the students develop presentations. We thought this would be an alternative to a writing project I usually require that is often difficult for a segment of my class [including those identified with disabilities]. Now, my kids seemed OK with HyperStudio® but I didn't feel comfortable enough…I always want to make sure I have all my bases covered before I assign something and I don't feel that way with HyperStudio®. We still might use it for one last assignment this year but [the technology staff] will have to be here that week.

When asked for clarification, we found most teachers still believed they had the skills to develop a stack similar to the one they completed prior to the end of the introductory training. However, several participants expressed an unwillingness to use the program for class assignments because of their limited comfort and skill in developing what some deemed *instructionally appropriate* stacks to meet the needs of their learners. Several participants shared that they had hoped to use HyperStudio® with the student's that offer the most instructional challenges. At least this was how the workshop was explained to them and for many, this was the reason they were particularly interested in using the application. Instead, as a result of their limited comfort and knowledge, participants shared that they did not feel capable of developing effective projects or stacks. For example, one mentioned,

> [the technology staff] and you demonstrated this idea of an anchor, if I recall correctly. I liked that idea and wanted to developed projects with interactive timelines. I also hoped to get students involved, you know with their own voices and picture. Here is an example: we went to [historic site] a couple of weeks ago and we all took pictures. The pictures are great. If I were more comfortable with HyperStudio®, we'd be creating projects featuring those pictures. I could see a show where we use the pictures to illustrate a sequence of events…let me show you some posters we developed. These are the pictures that I ended up printing out and we just pasted them to poster board. It still works but wouldn't HyperStudio® been better?

Another participant offered,

> [technology staff] showed me a stack that someone created for the Roman Empire. It was great. There was this boat and it sailed around and across the Mediterranean. As it sailed, the map changed colors and a lined followed the boat. The idea was to show the students how the Romans conquered their empire. Now, for some of the kids in this class on IEPs, something like that would have been great this quarter…I couldn't begin to show you how [the technology staff] or whoever developed that project but that would have been great for me.

Experimental group faculty. Unlike their peers, the experimental participants offered insightful feedback on their comfort levels and specific examples of how they used HyperStudio® with challenging learners. While they admitted they had not mastered the application, all expressed confidence in their ability to use HyperStudio®. They also expressed confidence in their ability to support students in using HyperStudio® for classroom-based activities. It was clear in reading the transcripts that teacher comfort level steadily increased across the 14-week experience. For example, one teacher commented, "As we talked about, I felt OK when I left your workshop. I'd say I felt really comfortable about four weeks ago…the weekly sessions with [participant] did the trick."

Another participant offered,

> At the beginning it was a little confusing because we didn't have that direction. So, at first I was like what am I supposed to be doing. But the minute that we started meeting weekly with our students and working together and brainstorming, it just became more and more clear. It did take that getting together and sitting down and brainstorming to see where we were really going with it. At first it was a little confusing.

When asked for specific examples of what they did as a result of their increased comfort level, participants offered a variety of examples to illustrate use and overall comfort. Many offered specific examples to the various features of the HyperStudio® application. For example, one person stated:

> I hadn't been using it prior to this, so I've learned to add audio to every stack we've [student intern and teacher] created. My students know how to do this as well. Let's see, I can take a digital picture, crop it and get rid of red eye or anything we don't want and import it into HyperStudio®.

Another participant commented,

> At first I thought we were just supposed to go out and figure out a way to use this in the classroom. Later I realized that it would take time and just stick it in there and use it. So, I made sure I could put audio in every stack. Pictures—both from the web and one's we've taken using the digital camera—for me, it's become very easy and I guess I can do almost anything.

All participants described what they did in conjunction to what their student mentors offered. Many if not all of the project components were determined or at least recommended on the part of the student intern. This is not to say the student intern directed the projects, but instead, their knowledge of what was possible appears to have influenced what was actually developed. For example, one teacher explained,

> The second stack I, or we, developed was for Charlotte's Web. I wanted to help some of the students with word recognition practice in preparation for the readings. I knew what words and they type of practice that was needed, I've done this with [participant] for several years…[participant] offered what was possible through HyperStudio®. I told her what we needed to do and she came up with some great ideas of what HyperStudio® could do.

Comfort with HyperStudio® on the part of the teacher influenced the preservice student intern's ability to address specific learning needs of students with disabilities. That is, the experimental group of teachers agreed that the preservice student support enhanced their comfort level and allowed them to collaboratively plan for specific student needs. One teacher offered,

> I'd say all of our projects had a special education twist. What I mean is that we [student intern and teacher] really thought about my IEP students when we planned our stacks. Yes, I know I told you about the science fair and the exceptional things that several students created. I'm talking about the ones we developed.

Another participant commented, "Well, [student intern] wants to be a special educator so a lot of what we did was for them. She gave so many good ideas on how we could differentiate instruction using HyperStudio®." A third participant pointed out, "[Student intern] was wonderful. Our project involved the students from day one. They helped us develop projects that replaced a written assignment I usually require. My LD kids loved the change and thrived on the technology part."

Technology Use

By the end of the 12-week study, we found a difference between teacher confidence, competency, and their reported ability to integrate HyperStudio® into their current instruction. While both groups reported continued challenges with technology (e.g., printing problems, Internet connections), teachers who had access to, and were mentored by student interns reported a significant increase in overall technology use.

Reflecting upon their integration or lack of integration, teachers believed the ongoing mentoring had been effective in enhancing their understanding and ability to use HyperStudio®. Many participants acknowledged that they gained competency through the process. Differences were observed by the control group of teachers as they observed the participants in the mentoring process and viewed examples of HyperStudio® stacks completed by fellow teachers who had access to the mentor. Control group teachers expressed frustration in not having access to a mentor or another support person who could guide them through the development and integration of the stacks they had created or wanted to develop. They agreed that the available technology staff at the school was an option, however, scheduling tutoring sessions and arranging time to benefit from technology staff expertise was reported as problematic.

Control group faculty. As a group, control group teachers reported having some frustration developing stacks specific to their classroom content needs. While all expressed a comfort upon completion of the introductory training, control participants commented that classroom needs, teaching requirements, and related "realities" frustrated them and affected their ability to use the technology. One shared,

> I just didn't have the time. These last 12 or how many weeks required too much. Testing, IEPs, SIT (Student Assistance Team) meetings, and everything else got in the way. I'm sorry because I know you offered me so much during that January workshop. I still have that stack and I have one guy with a learning disability using that stack for a review exercise right now.

Another offered,

> I'd say not having the time and someone there to help me get things done were the major problems…I did use the first stack I made and we [paraprofessional] found that three of my kiddos on IEPs seemed to really enjoy it…time really prevented any other use.

A third offered,

> I don't know how everyone else did it. At the science fair last week several student groups shared their projects via HyperStudio®. They were wonderful but I don't know how [teachers] had the time. Even with [paraprofessional] we didn't have the time to make simple stacks.

Others expressed a concern about time as well as knowledge. Although time was a primary impediment, many questioned if they still had the ability to develop the type of product they would need for the classroom. Recalling relevant information and applying it to their specific needs appeared to be an issue several participants were unable to address. For instance, one teacher remarked, "Time was one problem. However, if I can't tell you for sure because I honestly don't recall everything you and [the technology staff] shared with us back in January. It has been quite a while and I've had a busy quarter." Another shared,

> I'm sorry for saying this but I can't remember everything from your workshop. I do want to thank you for what you did but I don't think it was of a great help…. if you forced me now, I really don't know what I would be able to make with HyperStudio®.

When asked about technology staff and why teachers did not rely more on their knowledge and expertise, teachers commented with the following. One stated, "[The technology staff] is wonderful...making time to meet with her was nearly impossible. She has her own classroom and her planning time was in the morning and mine in the afternoon." Another offered, "[The technology staff] and I tried for several weeks to get together. I canceled once because my son was home sick. I think she had car troubles another time. It just didn't work." A third mentioned, "Oh, [technology staff] and I met. She reviewed several of what I would call the basics…we even used your Learning Objects…our meetings weren't enough. I just couldn't do what I wanted with what I knew."

This last observation was an underlying theme many control teachers offered. The expressed inability to find and make time for the resources (some were provided) was a particular frustration for this cohort. Teachers voiced their frustration with perceived limitations developing *creative* and *instructionally applicable* stacks that would meet the diverse needs of all learners. For example, one teacher mentioned,

> The most frustrating thing for me was that I didn't have the time and even the understanding to develop projects I know are possible with this software. You know, when you shared examples with us I thought how great for my kids with disabilities. There is so much possibility with HyperStudio®…[Teacher] offered some great examples recently at a parent's night and I

know that if I had the time or if [technology staff] could have helped I could have done some good things.

The challenge for many of the control group faculty appears to be related to limited time and lack of innovation, possibly due to marginal comfort with the application. This resulted in minimal technology integration. The following quote captures the issue of innovation and what they felt unable to do:

> I know that several of us have spoken about this recently. We go to the science fair and the parent's night and see all these wonderful HyperStudio® projects. Some even created by students here. I'm amazed at what they were able to do…you ask about time and that was only part of it. Even if I had the time I couldn't have developed what I've seen.

Another participant commented,

> For me, [with technology] if I try to do something and it doesn't happen, I don't continue. I get frustrated and leave it. I look at the projects that others did over the last few weeks and really don't know how they did it or even really came up with some of the ideas.

Experimental group faculty. Teachers who worked closely with preservice teacher education interns offered a significantly different picture of their technology infusion experiences and their overall success. To capture this understanding, we combined feedback and findings related to the mentoring relationship as well as the aspect of personal one-to-one classroom-based technology training. One expects on logical grounds that one-to-one training in a familiar environment, regardless of the content topic, would impact the effectiveness of the related training. Therefore, we looked for evidence to indicate a relationship between the mentoring and participant comfort and ability with HyperStudio®. The most reliable evidence came from the participants and their responses to questions related to the mentoring experience. Responses indicate that teachers preferred the constant interaction between teacher and student intern, held in their personal classroom on their own computers. It was clear in reading the transcripts that all teachers felt that they benefited from the support of the student intern mentors. As expected, teachers reported the interaction supported their effort to learn the HyperStudio® application. It appears, however, a critical component did not rely on technology expertise but rather, the fact that someone was there to listen and offer ideas as they struggled to learn the instructional applications of the program. For example, "It wasn't that [student intern] was an expert. She constantly told me she didn't know everything. It was that we had a set time to meet and to do something on a regular basis. We worked towards a goal and did it weekly…that to me was the difference." Another teacher offered, "It was so relaxed…I didn't feel stupid asking question. She was so patient with me…when I had a question and she didn't know the answer she would find out." As teachers explained the significance of the student intern, they did so around a specific project that was developed. For example, one teacher offered,

> She [student intern] helped me with a lesson on the *Founding Fathers*. We made, I think, six or seven cards with a *Founding Father* on each one…the kids [students] added their own voice…oh, we included *Founding Mothers* as well like Abigail Adams and Betsy Ross.

Another participant mentioned, "We had several students make projects for the science fair…the feedback I've gotten from the projects is outstanding…[student intern] helped out tremendously in making this a success." By the end of the 14-week program, we found teachers increasingly competent, confident, and excited about their ability to integrate the HyperStudio® application into their current curriculum. Reflecting upon their development, teachers believed the student intern had been effective in enhancing their understanding and ability to use the application. Although many did not consider themselves experts, they expressed a competency. In the final week of mentoring activities, all experimental group teachers reported to the student intern and the authors that they were able to develop stacks, specific to their content needs and especially crafted for the needs of their diverse learners. More important, all participants expressed plans to continue development for future class instruction.

It should be noted, that after the 14-week program, several control group teachers commented on the need for access to student interns. Although they expressed an understanding of what we were attempting to find, many expressed frustration over not having access to and use of the student interns while their peers had. Plans to work over the summer were mentioned in hopes to develop additional collaborations during the fall semester.

Conclusion

Findings from this study indicate that the technology training program, complimented by student interns (mentors), led to successful teacher technology integration. An introductory training session supported by special education and elementary education student mentors appears to have supported teacher use of technology in their teaching, especially for students with disabilities. Similarly, teachers without this support expressed initial comfort but long-term use and an ability to apply initial training to instructional needs were not evident.

We expect further integration efforts as teachers continue to gain comfort and use of the application during the remainder of the school year and the subsequent semesters. Currently, the Midwestern elementary school has agreed to expand this training model to the teachers who will be placed with student interns in upcoming semesters (student teaching experiences). Additionally, the school is investing in two more computers per classroom to enhance student and teacher access. We expect increased access will enhance integration during future semesters.

Outcomes and Benefits

Preservice teacher education interns represent a viable means to support on-going efforts to assist practicing teachers enhance their use of technology in the K-12 environment. Used in conjunction with the student teaching experience, this structured mentoring will likely provide teachers with the necessary skills to integrate technology into their instruction. As found by previous research, mentors can support integration efforts; however, these findings extend previous research by employing technology novice student interns. More important, the use of special education preserves teachers as well as elementary education majors in an inclusive setting, appears to have enhanced the ability of veteran teachers to use a multimedia application to enhance the instructional capacity for students with disabilities.

The goal of this study was to examine whether special education and elementary preservice interns with technology experience could support teachers in their effort to learn and subsequently integrate technology, especially amongst students with specific learning needs. In general, the outcomes are positive to the effectiveness of this model in comparison to the control group teachers who were not exposed to or supported by the student interns. There has been an immediate integration of technology into classroom teaching and related professional activities. We should caution, however, that this integration appears dependent upon time, preparation, and support capabilities. Indications suggest that successful technology use involves the ongoing support and practice of the application.

Overall, teacher responses have indicated an increased comfort with the application and appreciation of the student intern mentoring. Because student teaching mentoring programs are relatively new, long-term results of this mentorship program are unknown. However, future training efforts hope to measure long-term and related benefits for technology integration in the K-12 classroom.

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Beyond Linear Syntax: An Image-Oriented Communication Aid

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Abstract: This article presents a novel AAC communication aid based on semantic rather than syntactic schema, leading to more natural message construction. Users interact with a two-dimensional spatially organized image schema, which depicts the semantic structure and contents of the message. An overview of the interface design is presented followed by discussion of its implications and limitations. Potential benefits of the new design include more fluid, expressive and efficient face-to-face communication for individuals with severe speech and motor impairments across a broad range of ages and linguistic abilities.

Keywords: Human-machine interaction, Communication aid, Semantics, Syntax, Image-oriented composition

Nearly two million Americans who have severe speech and motor impairments must rely on alternative and augmentative communication (AAC) systems to express their needs and desires. AAC aids include physical objects, picture symbols, sign language, alphabet boards, adapted keyboards, electronic interfaces with words and phrases, and a myriad of other cues or devices that facilitate expressive language (Beukelman & Mirenda, 1992). AAC users are a diverse group varying in age, motor and sensory abilities, cognitive abilities and linguistic abilities. The work described in this paper is focused on preliterate AAC users who require image-based communication devices yet whose cognitive and linguistic abilities show promise for significant future gains in expressive communication.

Image-based AAC devices provide users with a set of iconic symbols that can be combined to construct messages. With the introduction of affordable, portable computing technologies, numerous touch screen based devices have been developed that allow users to interactively select multiple symbols to construct messages. Virtually all image-based AAC devices of this kind use a similar strategy of message construction, which is based on the linear word ordering of English. For example, to generate "I want a large ice cream", the user must select symbols corresponding to 'I', 'want', 'large', and 'ice cream' in precisely this linear sequence.

Many AAC users have difficulties with this process of message construction. Their utterances are often limited to simple two-three word sequences (Udwin & Yule, 1990; van Balkom & Welle Donker-Gimbrere, 1996). In addition, the grammatical completeness and accuracy of messages is often impaired. Van Balkom and Welle Donker-Gimbrere (1996) documented that many AAC users employ unusual syntax in their constructions. For example, they may use girl + house + go (subject, object, verb) or house + go + girl (object, verb, subject) when trying to formulate "the girl is going home" (i.e., girl + go + home). We believe that part of the problem is in the message construction process imposed on users of current AAC systems. We do not believe that message construction is most naturally achieved through the linear concatenation of syntactic units. In this paper we describe a significantly different interaction process based on semantic rather than syntactic frames, and which takes advantage of the two-dimensional spatial configuration of icons, enabling a new form of message construction.

Our approach is inspired by the ideas underlying case grammars (cf. Fillmore, 1968). Case grammars focus on the functional relations between the verb of a sentence and other sentence elements. For example, in the sentence "I want a large ice cream" the main verb is 'want' which takes an agent ('I') and an object ('ice cream'), which in turn can take a modifier ('large'). Empirical (Griffin, 1998; Griffin & Bock, 2000) evidence also supports the notion of the verb as the central focus during sentence planning and execution. Structured by case grammar rather than linear syntax, our interface allows the user to construct messages by first selecting the verb, and then specifying the agent, object, and various other verb-dependent message components. The interface is designed for flexibility in the ordering of symbol selection. The case based approach provides a general framework for interaction.

Our second main innovation is in design of the display used during message construction. Again, our goal was to break out of the linear sequencing paradigm. Rather than displaying symbols corresponding to each word in linear order, we have developed a visual language in which thematic roles are translated into two-dimensional spatial relations between symbols (see also Ingen Housz, 1996). For example, the icon symbolizing the agent always appears above that of the verb, and the object appears to the right of the verb. Users can directly manipulate this two-dimensional display to edit and construct messages. The resulting message is a visual depiction of how the various message components interact.

In this paper, we describe the design of an image-based AAC communication aid that enables users to efficiently construct and deliver messages within a semantic schema framework that facilitates communicative expressiveness. Our goals were threefold: to (a) improve communication efficiency, (b) improve communication naturalness, and (c) facilitate improved expressive language skills.

We begin with an overview of the interface design, discuss the individual components, and elaborate on the rationale behind various interface decisions. We discuss the implications of this work on vocabulary selection, communication efficiency and seamless modifications to communication aids through the lifespan. We then discuss some of the obstacles encountered, and some of the planned future directions of this work.

Interface Design: Structure and Function

The communication aid runs on a touch activated tablet computer. It consists of two main areas: a sentence construction workspace, and a set of vocabulary panels (see Figure 1). The user composes a sentence by selecting lexical elements from the vocabulary panels, which the system inserts into the semantic schema in the sentence construction workspace. A second diagram in that workspace depicts the sentence-in-progress in a corresponding linear form, ready for output as text or speech. Figure 1 illustrates a fully constructed sentence: "I want another red cap."

The vocabulary panels are organized into three sections. The leftmost vocabulary panel contains verbs, the middle panel contains lexical categories, and the rightmost panel contains lexical items within a chosen category. The user first selects a verb. The system then displays a semantic template for that verb which is filled by selecting the appropriate vocabulary items from the lexical category and/or lexical item panels.

The interface also displays a set of message parameters, which the user controls to directly affect the contents and expression of each

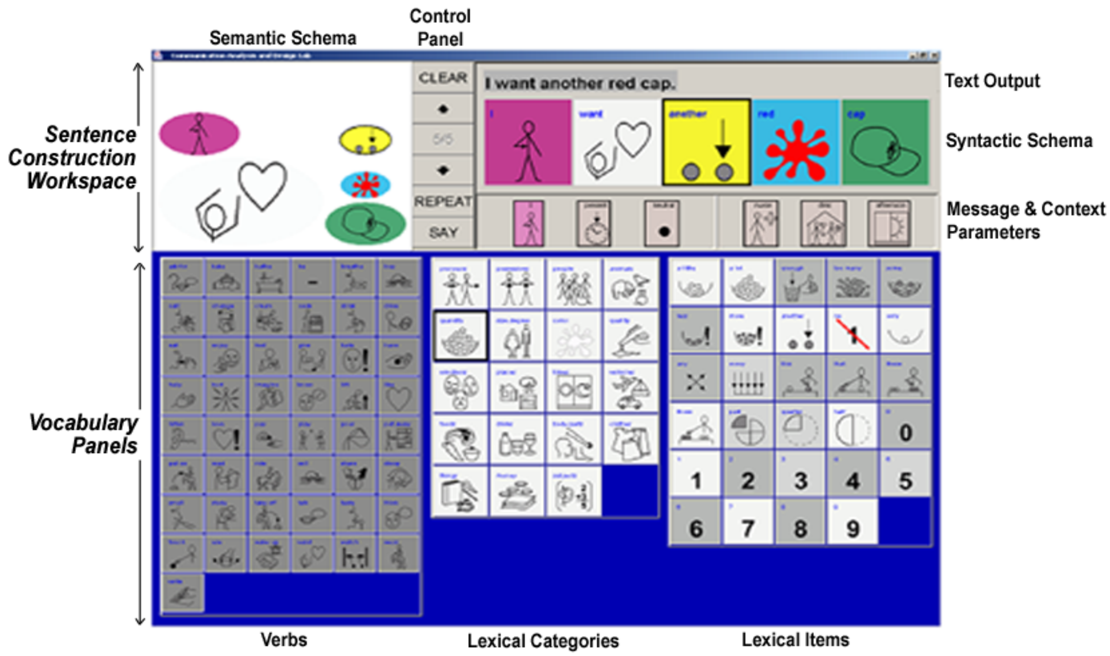

Figure 1. Image-oriented messaging interface.

sentence; a set of context parameters, which track sensed aspects of the communication environment to continually optimize context-specific vocabulary; and a set of messaging controls for working with and delivering constructed sentences.

All system components share a set of design elements. First, all representations of words, phrases, and parameter values are pictorial line drawings, with optional text labels. Second, all interface components and their individual elements have fixed, predictable spatial positions. The visual presentation of the interface can be dynamically adjusted on the basis of predictive algorithms that analyze usage patterns and context. Vocabulary items are differentially shaded along a discrete set of levels that range from white to dark gray, according to each item's predicted likelihood for inclusion in the current sentence frame. Likelihood measures are based on both linguistic and user-specific usage data. In the following sections we elaborate on each interface component.

Sentence Construction Workspace

A semantic schema with fillable slots is the primary focus of attention within the sentence construction workspace (see Figure 2). The user begins message construction by first selecting a verb. The system then generates a unique semantic schema associated with that verb. The pictorial representation of the schema includes the verb as the core meaning of the sentence as well as satellite slots than can be filled by lexical items that fulfill each argument role.

The number and type of argument roles vary across verbs, but each role has a predictable location within the two-dimensional semantic schema as well as a distinct color code. For example, the AGENT role is found to the upper left of the verb image, as a pink-shaded oval.

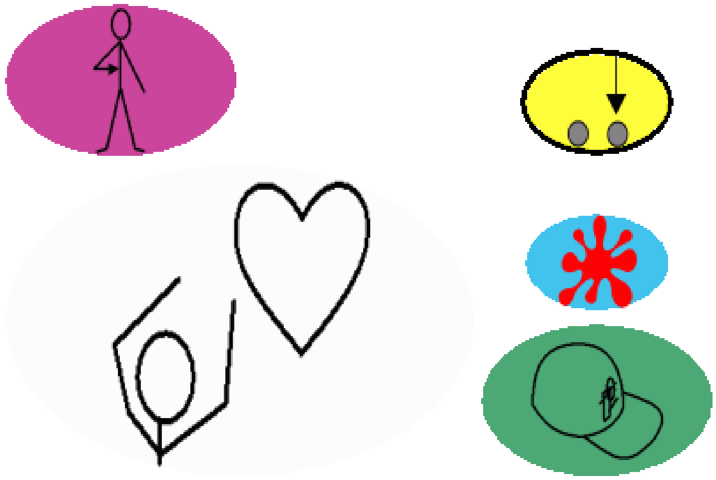

Figure 2. Semantic Schema for the verb 'want'.

To allow more expressive constructions, the semantic schema also includes sub-roles (as smaller ovals) associated with the main role arguments to the verb. For example, an OBJECT role may be filled with a noun, while its QUALITY sub-role might be filled with an adjective that modifies that noun. A black border around an oval slot signifies the current focus. For example, in Figure 2 the yellow COUNT sub-role has the focus. The user may select any slot to change the focus and override the default sequence of content specification.

Once the verb has been selected, the user continues constructing a message by using the vocabulary panels to select a desired category and then a desired lexical item for each role. Each selection fills the role with the chosen lexical item, and advances the focus to a vacant role.

Through the differential shading of the vocabulary items, the system encodes which lexical items within each category are most appropriate for each slot. Particular items are thereby highlighted or darkened — recommended or discouraged — but the user is ultimately allowed to put any lexical item into any slot. The user may opt to fill only some of the slots, and may even actively exclude a slot, whether it is filled or still empty. An excluded slot is depicted as superimposed by a translucent white veil.

A second, synchronized message construction representation parallel to the semantic schema is depicted as a linear sequence referred to as

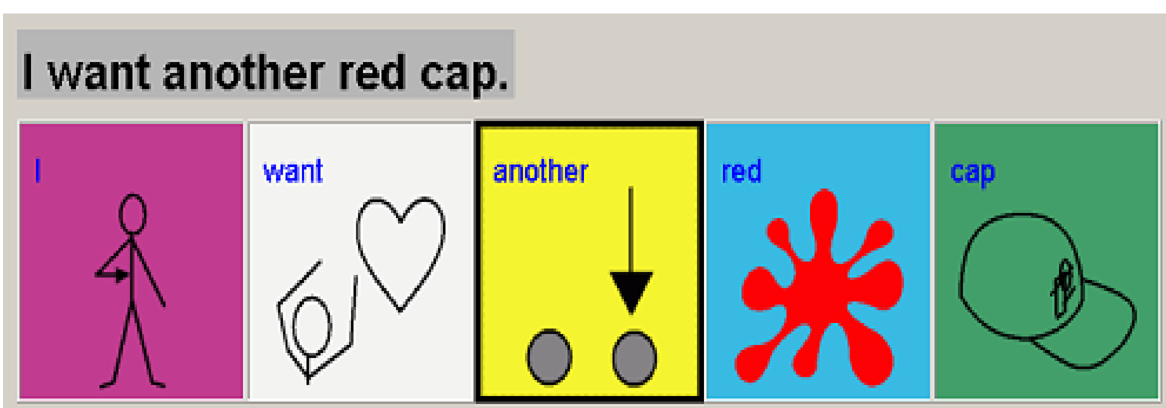

Figure 3. Linear diagram and text corresponding to semantic schema.

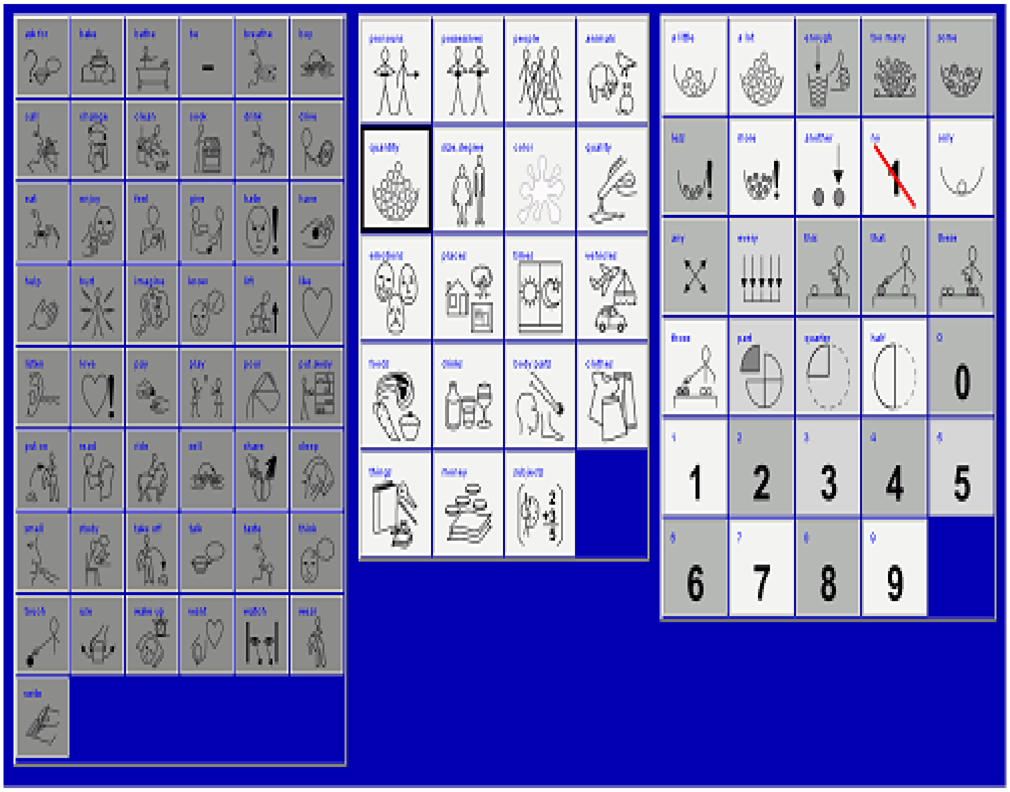

Figure 4. Vocabulary panels for verbs, categories, and the 'quantity' category.

the syntactic schema (see Figure 3). This serves as an intermediate representation between the semantically motivated message construction workspace and the syntax-governed form required for generating text and spoken sentences. The text of the sentence-in-progress is displayed above the syntactic schema.

While the semantic schema does not impose any particular sequence on slot filling, the syntactically-organized linear schema form requires a strict sequence. The user may manipulate either the semantic or syntactic schema interchangeably.

Vocabulary Panels

The verb and category panels have a fixed set of items (see Figure 4). The contents of these panels, however, can be customized to meet the needs of individual users. Once the user selects a category, it is marked by a black border (e.g. the 'quantity' category is selected in Figure 4) and its contents are displayed in a third panel. Items in the lexical panel are the only vocabulary items that come and go over time, as the user changes categories or as the system senses different contexts. The user selects a lexical item to insert into the current role slot. If the slot is already filled, its content is replaced. While the vocabulary panels currently have only two levels, we are exploring novel methods to visualize and navigate through multiply layered vocabulary.

Message and Context Parameters

The user can modify a fixed set of message parameters (i.e. reference, tense, utterance type) that directly affect the contents and expression of each sentence (see Figure 5). For example, when the reference parameter is set to 'I', sentences created with any semantic schema will by default adopt 'I' as the agent. All message parameters are *sticky* in that their values are carried on to subsequent sentences unless explicitly altered by the user (see

Todman, 2000) for time and effort savings benefits of sticky parameters). In addition, a set of context parameters (i.e., location, communication partner, time of day) can be set by the user or sensed by the system. These parameters are an additional means to enhance communication rate and relevance. We have previously developed methods for automatic sensing of situational context (Dominowska, Roy, & Patel, 2002). In the future we plan to integrate these two lines of work.

Session History

The user has access to a complete session history of both delivered and not-yet-delivered sentence workspaces, for browsing, editing, and re-delivery. This access is tightly integrated with the messaging controls for the current sentence workspace. The user may leave a workspace containing a not-yet-delivered sentence, to browse or create other workspaces in the history, and return to it at a later time. If a message has not been delivered, the system auto-copies it before editing to keep a complete work history.

Messaging Controls

The messaging controls allow the user to SAY (deliver via text and speech) the current sentence, or to REPEAT the most recently delivered sentence (see Figure 1). The user may also CLEAR the current workspace. In addition, the user can navigate UP (earlier) and DOWN (later) the session history to reuse previously constructed text or to repeat previous sentences. In future usability testing we plan to assess the added value of recycling sentence fragments and repeating previous text for maintaining dialog and improving communication efficiency and effectiveness.

Design Issues

Many design issues arise when developing a new interface, which pertain to the overall functionality as well as the characteristics and roles of individual components. Addressing these concerns will require extensive, well-designed and executed laboratory and field testing of device learnability and usability. Such testing is of course a long-term and ongoing process of discovery, interleaved with iterative design and development. Nevertheless, at this point we would like to clarify some initial design issues, and some choices we have made that we think will lead us in an informative and fruitful direction.

Semantic Schema

The use of a semantic schema is intended to reduce the linguistic demands of message construction that are imposed by syntactically ordered message construction systems. The aim is to move away from the linear ordering and into the realm of meaningfully structured visual images. Semantic frames provide scaffolding for users to compose complete sentences (cf. Fillmore, 1968; Levin, 1977, 1993; Van Valin, 2004; Kingsbury, Palmer, & Marcus, 2002). We believe that this kind of representation is more accessible to non-literate and pre-literate communicators, yet can also effectively serve linguistically skilled users.

A two-dimensional spatially-organized image can express semantic relationships between words and concepts that are often lost in the

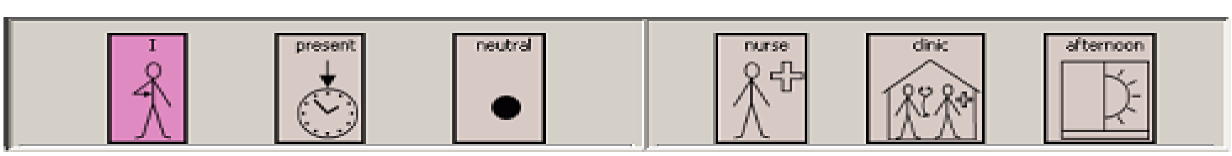

Figure 5. Message parameters (left side) and context parameters (right side).

linear organization of written text. The semantic schema is directly manipulable to give it a real-world "tangibility" which may provide an additional modality of communication.

We are initially working with roughly 50 verb frames, each with up to three main argument roles and up to four sub-roles that modify the main roles. These verb frames were chosen based on projected user needs for face-to-face interaction across a range of social contexts. While we expect the complexity and completeness of message construction to improve over time, our main goals are to promote learnability, expressivity, and communication effectiveness.

Symbol Set

The major lexical elements in our interface are visual symbols accompanied by text. This was an explicit decision in order to serve the needs of non-literate/pre-literate users. Several factors influenced our choice of a particular symbol collection. Within sentence constructions we use different color backgrounds to code roles, and within vocabulary panels we use different grayscale backgrounds. This led to a strong preference for line drawings, and minimal use of color. To reduce the learning curve for the symbol system itself, we decided that the standard symbol set should be pictorial, rather than abstract, and have no strong prior schema for composing elements that may conflict with our own semantic schema design.

We chose to use the Widgit Rebus Symbol Collection (Detheridge, Whittle, & Detheridge, 2002) as our base symbol set. Widgit's line drawings are relatively transparent and systematic in their representation of words and concepts. The collection has substantial field experience behind it, and also includes images for "parts-of-speech" beyond nouns, verbs, and adjectives. We work with a subset of the Widgit Rebus vocabulary, organized into our own categories.

Vocabulary Size and Organization

We currently have a small and simple vocabulary organization, designed to meet our immediate research and development needs. Besides verbs, we provide access to roughly 400 lexical items in roughly 20 categories. As we extend the vocabulary, our intent is to stay in the realm of face-to-face interaction. To this end, we are exploring vocabulary access techniques that minimize extensive navigation or re-arrangement of the visible layout given the increased cognitive burden they impose.

Session History

The session history is an essential feature of the interface given the immense cost of message construction for users of AAC devices. Rather than having to generate novel messages from the ground up, the user may access previous messages that fit their needs and use them as is, or make minor changes before use. Either way, many costly selection actions are saved by the use of an integrated message history buffer. Allowing immediate editing of any image in an on-line session history is a time-saving convenience whose usability and natural feel must be tested.

Input Modality

To adequately support pointing gestures on a touch tablet, we constrained the size of buttons and selectable regions. Furthermore, the geometric layout of elements is informed by common usage patterns. All selection operations are upon discrete elements, to allow the system to accept a variety of input methods. For example, a fully able communication partner might prefer to make selections by point-and-click operations using a standard mouse and screen configuration.

On the other hand, the system can be adapted for users with severe motor control disabilities, who cannot use a touch screen and thus require input from switch-controlled tabbing or scanning interfaces.

Discussion

In this section, we discuss several potential limitations to our approach, ways in which we plan to address these concerns, and future directions of this work. We conclude with a case example of a potential user and a set of testable claims as to the benefits of our interface on the end user.

Limitations and Future Directions

The interface requires some basic level of linguistic and cognitive functioning. While we believe it is less than that required in linear syntactic ordering, the user must nonetheless have symbolic reference and categorization abilities. To ensure that the interface has continued relevance over the user's lifespan, we plan to extend the interface complexity toward simpler and more immediate representations.

The visible vocabulary size of any image-based system is limited by the physical *real-estate* of the display. While layering images would enable access to larger vocabularies, there is an inherent trade-off between size and cognitive demands due to search, navigation, categorization, memory and attention load. While some symbol systems such as Blissymbols (Bliss, 1965) and semantic compaction (Baker, 1982, 1986) facilitate symbol combination, they are dwarfed by the generative power of orthography. We use Widgit Rebus symbols with our schematic layout to provide flexibility of meaning and message complexity from simple sentences through to highly modified and embedded clauses.

Though we try to minimize changes in vocabulary layout, some layering is unavoidable and may be visually distracting to some users. As we further tailor vocabulary subsets to track the changing context, we may make the visibility and placement of items even less predictable. To balance vocabulary and *real estate* trade-offs, we differentially shade items based on likelihood measures where others might spatially reorganize them. This changing matrix of shades, however, imposes its own cognitive load. As a start, we can disable shading or reduce the number of levels, for those users who see it as a distraction rather than a benefit.

In the long run, we envision an AAC device that is highly tuned and responsive to the patterns of activity and situational context of the user. As a step towards this vision, we are developing a set of situational context sensors that will allow the system to respond to real-time changes in the user's communication preferences as a function of sensed context. In this way we hope to emulate how human communication partners use their knowledge of the world and of given situations to facilitate conversation with an AAC user. Access to context-dependent vocabulary will enable users to construct messages about the here-and-now in an efficient manner, thereby increasing opportunities for more natural and satisfying communicative interactions.

Outcomes and Benefits

The AAC interface we have presented is designed with several major benefits in mind for the user. Many of these benefits hinge on our ability to provide a single interface that is accessible across a range of ages, accommodates to changing needs, and promotes and supports developing linguistic and cognitive abilities. Such an interface must be highly scalable to afford a seamless increase in sentence and/or image complexity, vocabulary size, and communicative functions. We provide a case of an example user and a set of testable claims that illustrate the potential benefits of our interface.

Paul is a 10-year-old child with spastic cerebral palsy. Although he cannot read yet, Paul demonstrates only mildly delayed cognitive abilities when compared to age matched peers. His mobility is seriously compromised requiring the use of a powered wheelchair. For the past two years, Paul has relied on a picture-based communication aid in which sentences are constructed by linear ordering of symbols as his primary means of communication. His rate of message construction is slow and labored and he often experiences physical fatigue after prolonged use.

The ease and rate of face-to-face dialog will be improved using ready-made templates, in the form of semantic schemas and Paul's own past constructions. The ability to reuse and recycle fragments and wholesale messages will have a significant impact on the appropriateness and timeliness of his responses. As a result of improved communication rate and appropriateness, family members, teachers, peers and other communication partners may perceive Paul to have greater communicative competence. The consequences of these perceptions are perhaps as real as his abilities.

Message construction will be more natural and easier to learn compared to Paul's current linear composition system. We believe the semantic schema framework emulates the process of message construction during natural message formulation, whether speaking or writing. Manipulating pictorial symbols in a spatially organized schema may provide a more direct link between the message Paul wishes to convey and how he goes about constructing it. For example, when Paul constructs the message, "I want another red cap", he can begin to see the visual correspondence between argument roles and the type of lexical items that can fulfill those roles. To fill in the satellite slots for the 'want' semantic schema, Paul must consider the following questions: Who wants the cap? What kind of cap? Whose cap is it? Does he have a cap like that already? etc. The spatial and color-coded organization of the semantic schema guide Paul in constructing a complete sentence.

The interface also suggests without enforcing, syntactically proper choices through highlighting the most likely lexical items. While the syntactic schema and the text output are useful for message delivery, they also promote Paul's expressive language and literacy skills. Over time he may internalize common patterns across semantic schemas such as the relationships between roles and the lexical items that can fulfill those roles.

Long-term experience with a single interface that grows with Paul's changing needs rather than having to migrate from image-sequencing devices to text-composing devices will have numerous financial, social, and educational benefits. Rather than expending time and energy into learning novel system rules and organization, he can spend his time learning to read and engaging in more fulfilling communicative interactions.

While the above scenario may seem idealistic, we believe it is possible. Usability testing of the interface with AAC users such as Paul is currently underway in our laboratory. Ultimately, generative and creative use of language within the semantic schema framework may better support Paul in achieving socially satisfying communicative interactions.

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CALL FOR PAPERS

Assistive Technology Outcomes and Benefits

Summer, 2005
Submission deadline: March 1, 2005

Assistive Technology Outcomes and Benefits is a peer-reviewed, cross-disability, transdisciplinary journal that publishes articles related to the *outcomes* and *benefits* 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.

Call for Papers for Volume 2:

Assistive Technology Outcomes and Benefits invites you to submit manuscripts of original work for publication consideration. Only original papers that address *outcomes* or *benefits* related to assistive technology 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.

The second issue of this peer-reviewed journal 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

For information on how to submit manuscripts see the *Guidelines for Authors* at http://atia.org/

Guidelines for Authors

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 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 benefits and outcomes of the assistive technology devices/services addressed in the article.

Specific preparation guidelines for preparing and submitting manuscripts may be found at the ATIA website at: http://www.atia.org/