Technology in Action

VOL. 3 • ISSUE 3 • MAY 2008

Technology Supports for Individuals with Autism Spectrum Disorders

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Many challenges faced by individuals with Autism Spectrum Disorders are being addressed through technology. This *Technology in Action* presents an overview of successful technologies.

The diagnosis of children with Autism Spectrum Disorders (ASD) has increased at an alarming rate, both in the United States and throughout the world. There are both an emerging body of research and promising practices using technology-based supports to target the core challenges—communication, socialization, and motivation—for individuals with ASD. These core challenges have a critical effect on participation in home, school, and community life.

Many of these challenges are being addressed successfully through technology (Bellini & Akullian, 2007; Cafiero, 2005; Mirenda, 2001, 2003; Mirenda, Wilk, & Carson, 2000). Advancements in technology also have supported access to information, tools, strategies, education, and training for practitioners and families of individuals with ASD.

This *Technology in Action* presents an overview of technology and media-based tools and strategies currently used by families, researchers, and practitioners for individuals with ASD as well as the tools used by individuals with ASD themselves. It considers strengths and needs of individuals across the Autism Spectrum—from those who are nonverbal and require augmentative and alternative communication for basic communication, to those individuals who are verbally and fully included with typical peers and who benefit from technology that enhances their social skills and social awareness—and describes selected technology-based supports that address them.

Autism Spectrum Disorders—Why Use Technology and Media-Based Tools and Strategies?

Individuals with ASD have strength in visual processing that supports the use of technology. Other learning characteristics of individuals with ASD—such as desire for sameness and interest in inanimate objects—also are well suited to technology.

Individuals with ASD also have certain difficulties that technology can address. Several common characteristics include:

- **Difficulty with communication**. Communication—one of the key qualities of life defining skills—is the core deficit in ASD (McGee & Lord, 2001). Technology offers communication tools in the areas of reading, writing, speaking, and using augmented speech supports.
- **Difficulty with complex cues**. Individuals with ASD have global sensory processing difficulties, translating into localized and fragmented processing of the stimuli around them (Burke & Cerniglia, 1990). These processing difficulties often are related to challenges in understanding multiple or complex cues. Technology offers the capability for creating a range of symbols, from simple single symbols to multiple and more complex symbols.
- **Difficulty with affective and social learning**. Affective and social learning occurs in relationships with others. Technology can act as a buffer and a bridge between communication partners.

Although these learning characteristics are framed as separate elements, in practice they affect, interact with, and are often components of one another. For example, the difficulty in processing multiple cues affects both academic learning and social learning. Social interaction involves processing multiple cues—spoken language, body language, facial expressions, and tone of voice.

Many technology-based activities have an appeal to people with ASD. For example, they can become engaged in isolation without the complexities of social interaction. Further, technology tools often are presented in a static, predictable, and/or visual format that appeals to individuals with ASD.

Some practitioners tend to think of technology tools to assist students with ASD in two main categories:

- Augmentative and alternative communication devices (e.g., computer generated graphic language systems created on two-dimensional communication boards, speech generating devices, and Internet communication).
- Other technology and media devices (e.g., computer learning software, PowerPoint, social narratives, video modeling, and virtual environments).

Examples of how technology can support individuals with ASD in the above mentioned areas of difficulty follow.

Difficulty with Communication—Technology Can Help

Communication is both receptive—what one understands—and expressive—what one generates to another. Communication skills, and in particular, functional spontaneous communication, are critical components of learning programs for students with ASD (McGee & Lord, 2001). Furthermore, it is of utmost importance that communication supports be provided as soon as there is a diagnosis of ASD.

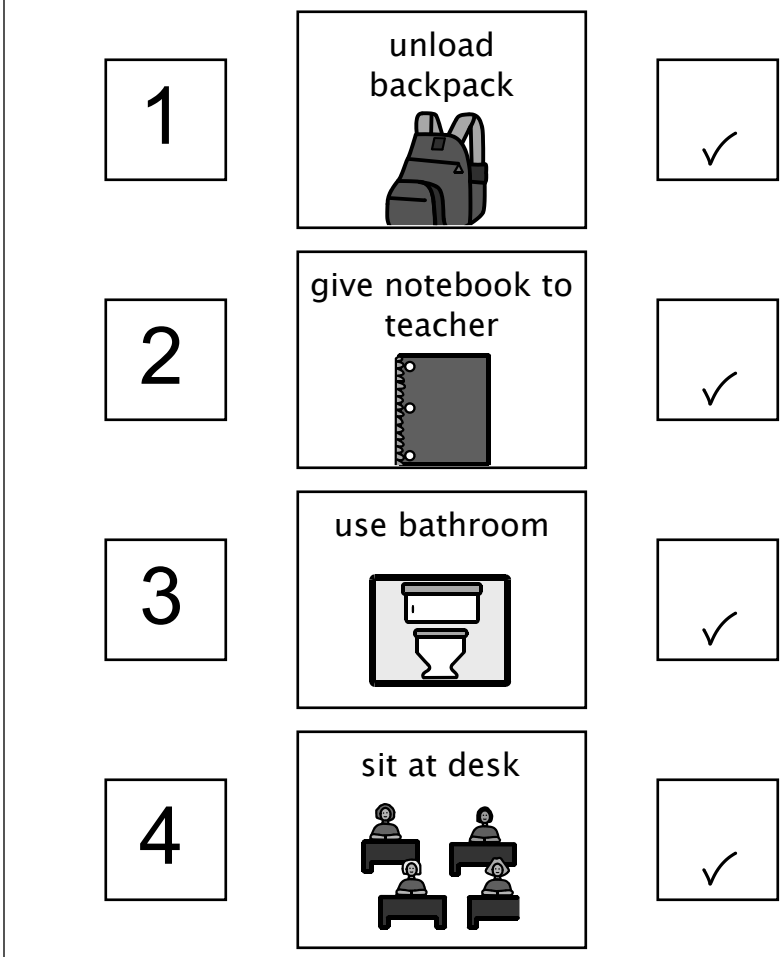
Augmentative and alternative communication (AAC) involves the use of technology for the creation of communication systems. Use of AAC with individuals with ASD can promote the generation of communication as well as stimulate the development of speech (Millar, Light, & Schlosser, 2006). AAC includes manual signs (unaided AAC) and aided AAC. Technology-based AAC is aided AAC and includes visual symbols, two-dimensional communication boards, and speech generating devices (SGDs). The SGDs range from simple battery operated tools with the capability for delivering a single message to sophisticated computerized devices that enable the person with ASD to say anything about anything at any time.

Communication is a partnership. Therefore, communication partners

must be active partners. The AAC tools require the speaking communication partner to provide visual and verbal input to the individual with autism. This is a critical feature in promoting communication in individuals with ASD (Cafiero, 2005). Following are examples of communication software.

One example is Boardmaker©, which generates Picture Communication Symbols© to augment, enhance, support, and develop existing language. Boardmaker© is used to create visual schedules and visual cueing for positive behavior support. Figure 1 is an example of an activity-schedule-based communication board using Boardmaker©. Notice that the vocabulary included in this AAC tool is both receptive—to facilitate understanding of receptive language—and expressive—to facilitate communication.

Figure 1. Schedule Communication Board



Picture Communication Symbols © 1981-2008. Used with permission by Mayer-Johnson LLC. **www.mayer-johnson.com**

Interactive communication between two communication partners can be facilitated by AAC technology. Communication overlays (e.g., two-dimensional graphic vocabulary tools) can be provided as "no-tech" on flat laminated card stock, "low tech" on a simple SGD, or "high tech" on a sophisticated computerized SGD with the capability for thousands of messages. Speech generating devices also have been used successfully by preschool children with autism (Schepis, Reid, Behrman, & Sutton, 1998).

Figure 2 is an example of an interactive communication board for Joe, a 16-year-old male who enjoys "Taco Night" with his family. Joe uses a SGD with the capability of generating 25 spoken messages in six different environments. His family and teacher have selected the vocabulary necessary for Joe to receive communicative input from his family and generate expressive language to them in return. Vocabulary on Joe's overlay for making tacos includes some words he does not yet know. Providing Joe with the experiences for this new vocabulary actually helps him learn it, own it, and use it spontaneously.

Communication software can be used to help students generate written communication. Written commu-

Figure 2. Interactive Communication Board: Taco Night

nication also can be enhanced with technology. Consider this example:

Jennine is a 10-year-old girl diagnosed with ASD. She is nonverbal and uses a 25 cell SGD programmed with graphic symbols. The SGD has five levels, meaning that it has the capability for generating communication with five different communication overlays for five different communication environments. Jennine's teacher would like to help Jennine write a daily journal describing her day in school. She uses a writing software called Pix-Writer©. This software allows the practitioner or parent to create a word bank of vocabulary needed to express the events of the day in journal form. The student clicks the symbols required and a sentence appears in the electronic writing frame. Figure 3 shows the writing frame and word bank that Jennine uses to generate her daily journal. When Jennine returns home she is able to read her journal entry to her parents as she points to each word and symbol. Not only can Jennine express the events of her school day, she also uses some speech, which is more intelligible when she is pointing to her journal entry.

Much of the communication software for students with autism is visual. It should have a capability for adjusting the number of symbols from one or two to many as the student learns to process more complex stimuli. The use of auditory feedback in AAC is student dependent and can be reinforcing for some students with ASD and distracting for others.

Literacy and communication may be mutually supportive. Keyboarding is a viable option for written communication, given the handwriting challenges often seen in individuals with ASD. Keyboards with speech generating features are AAC devices in their own right. Keyboard communication is not "real time" communication in that the individual with ASD types the message first, then activates the spoken component afterward. Some adults with ASD report that this type of communication involves fewer cues and supports more fluent communication (Smith, 2006). Adults with ASD who communicate online in the various Autism and Asperger's Syndrome discussion boards reveal a level of sophistication and complexity in communication that would not be evidenced in conventional person-to-person speech.

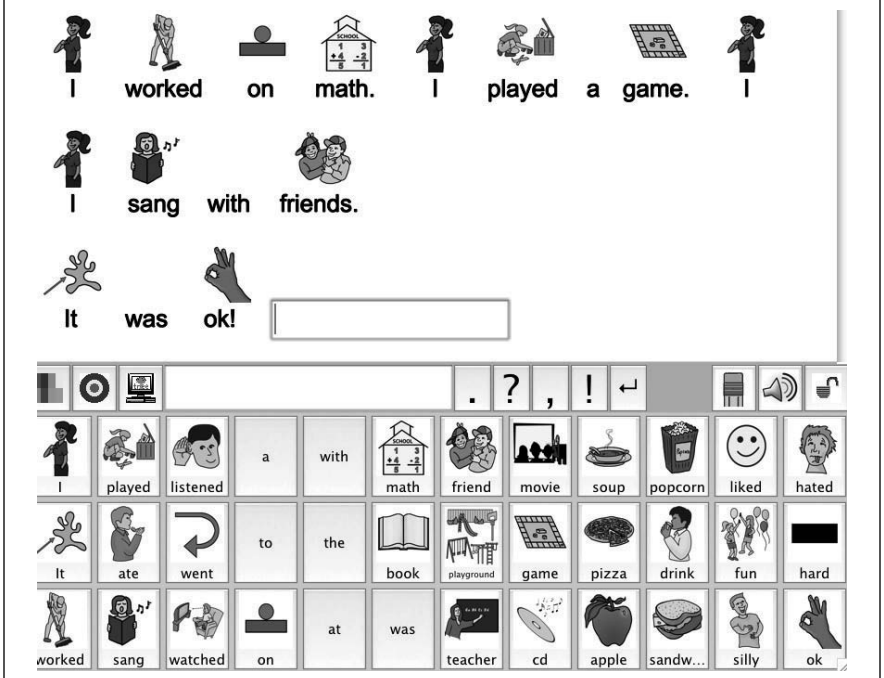
Difficulty with Complex Cues—Technology Can Help

Providing limited and static cues may help individuals with ASD in understanding and responding to their environment (Cafiero, 2005). One validated practice for ASD involves the use of visual cues as simple, focused stimuli to promote the understanding of instructions, transitions, and all communicative input (Cafiero, 2001). Visual cues may be created using the following technologies:

- Tangible objects (e.g., a cup can be a symbol to represent the desire for a drink).
- Computer generated symbol systems (e.g., Boardmaker©, Picture It©, Pix Writer©, and Writing with Symbols©).
- Photographs representing steps to complete a task.
- Text (e.g., single symbols indicating simple instructions such as "sit", "wait", and "quiet").

More complex scripts representing specific actions or activities can be visually augmented with graphic symbols to facilitate understanding of difficult social concepts. Figure 4 is an example of a visually augmented turn taking tool for group learning at a classroom computer station. Notice that as each student takes a turn, his or her personal symbol is shown. The practitioner serving as the communication partner speaks and points to each symbol, which provides visual and verbal communicative input to the student. These types of visual tools aid both language comprehension and the development of expressive language through modeling.

Figure 3. Home School Journal



PixWriter © 1998-2008. Used with permission by Slater Software, Inc.
www.slatersoftware.com

Graphic symbols on communication overlays are static and predictable, allowing the individual to rely on recognition, rather than memory, to process the language input. The difficulty in processing complex and multiple cues has an impact on academic and social learning. Technology may address this need in a variety of ways.

- **Communication technology**. AAC can be designed for the scaffolding of more complex communication cues by creating communication tools with simple single symbols, then progressing to more numerous and complex graphic symbols. A young child with autism may learn to request a cookie by pointing to the symbol for "cookie." As he or she learns to process more stimuli, he or she learns to point to two icons, "oatmeal" and "cookie" indicating not only a request but a specific choice.
- **Positive behavior support (PBS) systems**. Visual cues also can be used to design PBS for individuals with ASD (Mirenda, 1998). Figure 5 is an example of a computer generated PBS tool. Notice that each

Figure 4. Computer Turn Taking Communication Board

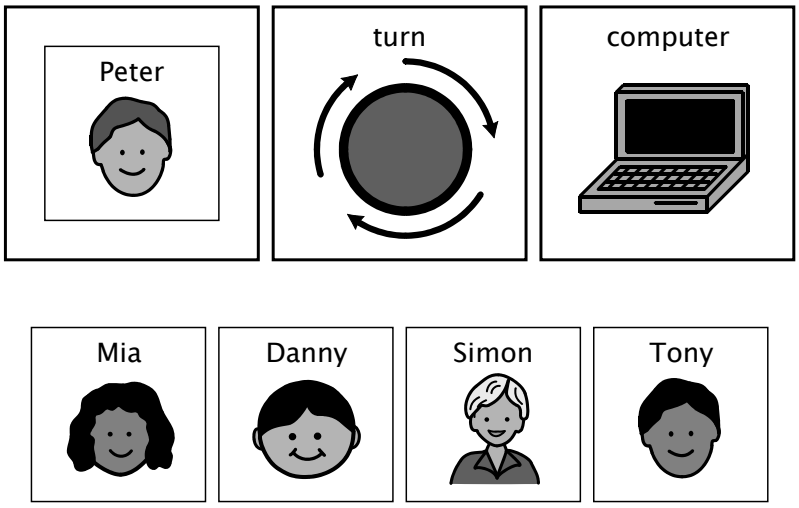
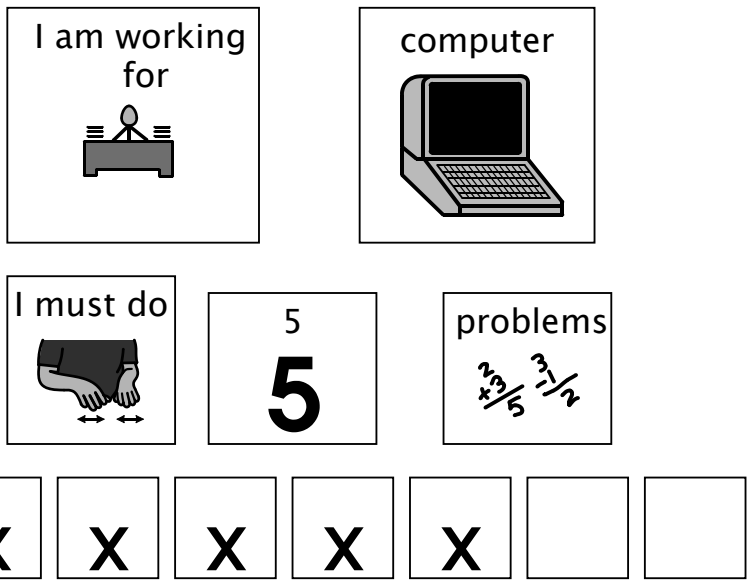


Figure 5. Computer Generated Positive Behavioral Support Tool



aspect of behavioral self-management is visually represented: what the student must do, how much he or she must do, and what he or she earns when he or she has completed the task. This system is designed to teach the student to self-monitor his or her own behavior. Tools such as this can be adapted to greater or lesser levels of complexity, according to the needs of the student. Word-based cues can be substituted for graphic symbols for the student who responds well to literacy cues.

- **Visual schedules**. Computer generated symbol systems are effective vehicles for creating visual schedules, activity schedules, and visual task analyses. Students with ASD who have literacy skills can benefit from text-based schedules as well. These schedules usually include a "visual closure system" in which the completed activity is removed from sight (placed in a "finished box"), checked off, or marked with some other visual indicator of completion. Figure 1 is an example of a software generated activity schedule designed to support self-management for a beginning morning school routine. There is a strong research basis for the use of visual schedules to support self-monitoring, transitions, and task acquisition. Students with autism can learn to engage in a series of activities for leisure time self-management, or to perform the steps in a task using the protocols for activity schedules. Individuals with ASD who have learned to do activity schedules have generalized these skills across people, environments, and activities (McClannahan & Krantz, 1999).

Difficulty with Affective and Social Learning—Technology Can Help

Technology and media-based tools for social skills training, executive functioning, and emotion recognition are promising practices in the field (Bellini & Akullian, 2007). Technology has great potential as a vehicle for delivering instruction in communication and socialization. Paradoxically, a tool with appeal as a solitary activity can be harnessed to address the very core social deficits in ASD.

Following are several examples of how technology can support affective and social learning.

- **The Internet and social interaction**. The Internet has become a vehicle for individuals with ASD to meet and discuss common issues. Some of these websites are open to those not on the Autism Spectrum and others are closed. Much of the eloquent and fluent communication that occurs on these online communities would not occur in a real time or face-to-face communication. The electronic ASD communication

Video Modeling

Video Modeling (VM) is a strategy that entails videotaping desired behaviors for the purpose of teaching those behaviors. The video subject of this intervention can be a peer, a sibling, an adult, or oneself (video self-modeling). Video self-modeling supports the belief that watching a model most like oneself increases attention and motivation. The modeling involves positive rather than negative behaviors, because that will increase motivation and attention to the desired behaviors. Video modeling utilizes the strong visual processing modalities of those with ASD.

In a review of 23 studies on video modeling, it was found that the following skills were successfully targeted: social-communication skills, functional and self-help skills, and positive behavioral skills (Bellini and Akullian). Skills learned through video modeling were maintained over time and generalized across other persons and other settings.

The practitioner may use conventional nonprofessional video editing software to create very individualized videos for teaching specific skills. These practitioner-crafted videos may involve a time intensive learning curve, depending on the skills of the practitioner. The advantage of practitioner-crafted videos is that they are highly specific, may use the student as his or her own model, and will use the real environment as the staging site.

Following is an example of steps that can be used to create an individualized video:

1) Select the skill. Choose a specific skill such as sharing; taking turns; listening to the teacher; interacting with others; using appropriate behavior in stressful situations; starting, maintaining, and ending a conversation or interaction with another; compromising; showing empathy; or playing a team sport.
2) Task analyze the target skill into its component parts.
3) Write a natural script incorporating each component of the skill. The script may or may not involve dialogue.
4) Identify environment, props, and players needed. Determine whether the intervention will be video modeling using a peer as the model, or video self-modeling using the student him or herself as the model.
5) Rehearse the script in order to iron out bugs and further refine the script and the protocols. Adjust the total time of the video according to the complexity of the skill and the ability of the student to attend to a video. It can be as short at 30 seconds or as long as 10 minutes.
6) Provide a revised and completed script to the players. Rehearse and videotape the skill sequence.
7) Edit the video. Retain all positive target skill behaviors and edit out negative behaviors as well as physical, gestural, or verbal prompts. The finished product should be a seamless and accurate enactment of the targeted skill.
8) Make this video available to the student randomly throughout the day and prior to when the skill must be demonstrated.

communities provide the features of low and focused stimuli, devoid of the complex cues that make real time communication challenging for those with ASD. Facial expressions, body language, and other ever present ambient stimuli are absent. These communities have facilitated the breaking of the isolation experienced by many with ASD. Examples of networking sites include: Aspies for Freedom (**http://www.aspiesforfreedom.com/**), WrongPlanet.net (**http://www.wrongplanet.net/**), and Autism Network International (**http://ani.autistics.org/ani-l.html**).

- **Online virtual reality and virtual environments**. Virtual reality through virtual online communities is available for individuals with ASD. In these virtual communities participants create their own virtual characters with identities (avatars). For example, Second Life (**http://secondlife.com/**) is an online, 3D digital world created by the participants who actually interact within it. Within Second Life are virtual private enclaves, one of which is for individuals with Asperger's Syndrome (AS) and the people that support them. This virtual community is called Brigadoon. Members of Brigadoon create avatars and environments, and interact socially within this virtual community. This provides an opportunity for people with AS to engage socially with others and practice social skills in a virtual environment.
- **Virtual reality software**. Virtual environments (VEs) have been used for individuals with ASD. VE software programs successfully target emotion identification, safety skills, and social skills (Mitchell, Parsons, & Leonard, 2007; Moore, Cheng, McGrath, & Powell, 2005). Video game consoles, such as PlayStation III™, X-Box 360™ and Wii™ allow for immersive role playing games in which the users create avatars. These avatars can engage other avatars in a variety of solo and interactive games. To date, there are no science-based studies on the effectiveness of video game consoles for individuals with ASD, but the degree with which their key features match with currently researched VR applications is notable.

Putting It All Together: Integrating Literacy and Communication Through Technology and Media

The story of Josh that follows highlights the objectives, tools, strategies, and outcomes measurement for technology and media-based literacy and communication intervention.

Josh is a 16-year-old young adult with autism. Josh has good literacy skills, although his spoken language is very limited. His ability to communicate using a keyboard communication device with voice output far exceeds his unaided speech. Josh uses multi-modal communication. His expressive language consists of speech when he is able and a keyboard SGD for more complex communication. Receptively, Josh can process some spoken communication, but he often requires visually augmented communication through print, writing, and keyboard communicative input. Josh is beginning a community job at the Down Under Internet Café in the historic downtown area of his hometown. His supervisor is Dave. Josh has a host of tasks he must learn: getting to work on time using the local bus, interacting with his boss and the customers, making various coffees at the café, and using the cash register.

Josh's school team visits the café to evaluate the environment and look for potential areas that may require extra support. Using the research principles of Video Modeling, they take digital photos of each step in the daily sequence of Josh's day, from getting on the bus to closing the cash register at the end of his shift. There is a particular focus on the communication skills that Josh will need to work in a public business—such as the language needed for interacting with the customers and his supervisor.

Josh's school team uses an integrated literacy planner to anchor Josh's program during his vocational activity and at school. The team creates both a digital and conventional book for Josh, detailing in text and photos the tasks, scripts, and interactions he must learn in order to be successful in the new vocational setting. Josh's digital book is embedded into presentation software that includes digitized narration of scripts and sequences. Josh is able to experience his upcoming work routines through

the digital tools. His IEP objectives are addressed in three areas: through his independent use of the digital work tools, within the vocational setting, and with his special education staff in the classroom setting. The target concepts and vocabulary are addressed in multiple settings for learning and generalization.

The team creates visual task analyses for the other activities: making coffee, accessing public transportation, and using the cash register, Each task narrative provides visual and auditory input, with the scripts and sentences read aloud. Josh can access these tools on a disc and

Integrated Literacy Planner for Josh

Theme/Anchor Book: Working at the Down Under Internet Café

Concepts and Vocabulary			
café	supervisor	cash register	greet
route	grind	key in	welcome
punctual	customer	receipt	enjoy

IEP Objectives Addressed	
Literacy:	Given five vocation related vocabulary words, will use each appropriately in independently generated journal entries.
Behavioral/Self-Management:	Given a novel task and a visual task analysis, will complete the task and self-monitor the execution of each individual component.
Communication:	Given a school/work situation and the presence of a new individual, will initiate an appropriate greeting.
Academic/Math:	Given currency (e.g., a 5 or 10 dollar bill), will key in correct amount on cash register.

Opportunities to Experience Concepts

Traveling to and from work on the bus, working at the café, interacting with supervisor and customers, reporting the events of the day in a journal.

Concept	Hands-on/Experiential Activity
Punctual	Planning trip to and from work.
Customer	Greeting and serving customer, reporting experience in journal.
Welcome	Using "welcome" as a greeting and in journal reporting.

Communication Opportunities Embedded in Activities

Activity	Communication Opportunities	AAC Tool
Planning to ride the bus to work.	Asking teacher to check bus route, time, and location.	Speech augmented with keyboard SGD.
Arriving at work.	Greeting supervisor, asking what needs to be done before customers arrive.	Speech augmented with keyboard SGD.
Serving customers.	Welcoming customers to café, asking for their orders	Speech augmented with keyboard SGD.
Reporting work activities in journal.	Giving verbal and written report to teacher and parents.	Keyboard SGD with print out of journal entry.

in hard copy format as a book. Josh learns to review each activity sequence on the computer in the classroom. Target vocabulary and concepts are addressed in paper-and-pencil worksheets and role playing using the vocabulary in actual contexts. Qualitative and quantitative outcomes measurement systems

Integrated Literacy Planner for Josh *(continued)*

Text and Scripts
Script: "Good Morning, Dave. What would you like me to do before the customers arrive?" AAC: Script maintained on keyboard SGD for ease of use. Prompt: Fading least to most (natural, point, model, partial physical).
Script: "Welcome to Down Under, Can I help you?" AAC: Not needed. Prompt: None.
Script: "The cream and sugar are to the right of the cash register." AAC: Script maintained on keyboard SGD for ease of use. Prompt: Fading least to most (natural, point, model, partial physical).
Script: "Thank you, enjoy." AAC: None. Prompt: Fading least to most (natural, point to a written cue, model).
Script: "It's time for me to go back to school. Thank you Dave, see you soon." AAC: None. Prompt: None needed.

Text: Supports Content and Social Scripts	
1.	I work at the Down Under Internet Café in downtown historic Middleburg.
2.	I have to be punctual. I take the #3 bus. It takes 20 minutes to get there from my school.
3.	When I arrive at Down Under I greet my supervisor, Dave. I say "Good morning, Dave." Then I say, "What would you like me to do before the customers arrive?"
4.	Sometimes I wash mugs. Sometimes I grind the coffee.
5.	When a customer arrives, I say "Welcome to Down Under. Can I help you?"
6.	I listen to the customer's order, then I write it down.
7.	I make the coffee. I tell the customer, "The cream and sugar are on the counter to the right of the cash register." Then I tell the customer the cost.
8.	I key in the amount and I take the customer's money. I give the customer the receipt and change.
9.	Then I say, "Thank you, enjoy."
10.	At 11:30 it is time for me to go back to school. I clean the counter and tell Dave, " It's time for me to go back to school. Thank you Dave. I'll see you soon."

Cross-Curricular Activities	
Math	Identifying size (small, medium, large) in context of coffee cups, measuring ingredients for specific coffee drinks, keying amounts into cash register, counting change per amount indicated on cash register.
Social Studies	Navigating the neighborhood within which he must travel.

are in place for all IEP objectives. Qualitatively, Josh's daily journal keyboard entries provide concrete evidence of literacy skill development in written communication. A systematic prompting hierarchy is used to teach Josh to complete each step of a task and indicate completion on a self-monitoring checklist.

Communication skills were fostered through this program by providing real contexts within which to use target vocabulary. Josh used his own speech with familiar scripts and uses his keyboard SGD for unfamiliar or more complex language. As Josh became more familiar with a particular phrase, he was more likely to attempt speech.

Josh's AAC device was always available to him and his communication partners. His communication partners at work and at school used it in conjunction with their spoken communication. Josh was better able to process communicative input when it was presented both aurally and visually. His keyboard SGD was viewed as a legitimate component of his voice by his peer and professional communication partners.

Data collection systems indicated that Josh not only mastered the discrete steps of the vocational activity, but also mastered the language and communication needed. He self-monitored his successful task completions with a checklist. He used his AAC device and acquired additional verbal language in the process. Weekly language samples were collected, graphed, and analyzed to ensure that teaching methods and tools were effective.

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Internet and World Wide Web Resources

ASD Identification and Intervention

The use of technology-based resources world wide has contributed to the dissemination of

information regarding the diagnosis and treatment of autism. Examples include:

- **http://firstsigns.org**—First Signs is dedicated to the early identification and intervention of children with developmental delays and disorders. Information is available online and an autism screening kit can be ordered.
- **http://www.kennedykrieger.org**—This website provides resources for diagnosis, symptoms, educational facilities, and parent and professional training.
- **http://www.childbrain.com/pddq2.shtml**—Childbrain.com is a pediatric neurology site with information on diagnostic criteria for ASD. There is an assessment scale questionnaire and information on how to score it.
- **http://www.aap.org/healthtopics/autism.cfm**—The American Academy of Pediatrics has a website specifically for physicians to help facilitate early identification of autism.
- **http://www.autismspeaks.org/video/glossary.php**—Autism Speaks and First Signs provide the ASD Video Glossary, a web-based tool containing more than 100 video clips designed to help parents and professionals learn more about the early red flags and diagnostic features of ASD.

Best Practices in ASD

Internet resources have aided significantly in the application of best practices and collaborative research in ASD. Examples include:

- **www.IANproject.org**—The Interactive Autism Network project is an online autism registry of people and families living with ASD. It provides information on research studies and a wealth of information enabling researchers to communicate and collaborate.
- **www.tinsnips.org**—Educational materials are available in PDF format that can be downloaded free or purchased outright. These materials include curricular adaptations such as worksheets, seasonal units, songs, and games.
- **www.sandbox-learning.com**—This site contains free stories and data collection tools.
- **www.do2learn.com**—This site contains free and for sale worksheets and academic and leisure games in math, identifying emotions, and sequencing events.
- **www.askability.org.uk**—This site contains free adapted text for reading, writing, and/or communicating. It includes news, games, stories, and jokes. Symbol users can post photos and comments in adapted texts.
- **www.mayer-johnson.com**—This is an online catalog of communication and curricular adaptations. It includes free online technology courses, samples of communication tools, and links to other sites.
- **www.symbolworld.org**—This site contains free online stories adapted for symbol users. Some stories are aligned with standard curriculum. There is a free monthly symbol-based newspaper with stories and activities for the home or classroom.
- **http://speech.jppss.k12.la.us**—This site includes free resources from teacher tips to adapted curriculum, including adapted literature, songs, recipes, and communication overlays for a variety of devices.

Online Autism Education and Training Sites

Examples include:

- **Autism Society of America**. [**http://www.autism-society.org/site/PageServer**] Free 30-minute online course covering an introduction to autism, treatment options and assistance, transitions to adulthood, and other information and resources.
- **University of Massachusetts, Lowell**. [**http://continuinged.uml.edu/online/autism.htm**] Online graduate programs in behavioral intervention in autism culminating in a graduate certificate.
- **Illinois State University**. [**http://www.autismspectrum.ilstu.edu/courses**] This is a three-credit-hour, graduate level training course for individuals who work and live with children and adolescents with ASD.
- **Johns Hopkins University**. [**http://education.jhu.edu/specialeducation/certificates/autism**] This is a 33-credit-hour Masters program. Students take courses in communication, classroom programming, behavioral interventions, and assistive technology.

TAM Technology in Action is a publication of the Technology and Media Division of the Council for Exceptional Children. **Cynthia Warger**, Editor. Editorial Board: **Christine Appert**, **Margaret Bausch**, **Gayl Bowser**, **John Castellani, Kyle Higgins, Brenda Heiman, Penny Reed** and **Windy Schweder**. TAM President: **Tara Jeffs**. Address correspondence to : C. Warger, P.O. Box 3836, Reston, VA 20195, **cwarger@msn.com**. For information on becoming a TAM member, visit the TAM website at **www.tamcec.org**.

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