# *Assistive Technology*

## Outcomes and Benefits

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***Maximizing the Benefits of Evolving Assistive Technology Solutions***

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# Assistive Technology Outcomes and Benefits
## *Maximizing the Benefits of Evolving Assistive Technology Solutions*
## Volume 11, Summer 2017



*Assistive Technology Outcomes and Benefits* (ATOB) is a collaborative peer-reviewed publications of the Assistive Technology Industry Association (ATIA).

Editing policies of this issue are based on the *Publication Manual of the American Psychological Association* (6th ed.) and may be found online at www.atia.org/atob/editorialpolicy. The content herein does not reflect the position or policy of ATIA and no official endorsement should be inferred.

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# Maximizing the Benefits of Evolving Assistive Technology Solutions

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# Assistive Technology Outcomes and Benefits
# Editorial Policy

**Aim and Scope**

***Assistive Technology Outcomes and Benefits***, published by the Assistive Technology Industry Association, is an open access, peer-reviewed journal that publishes articles specifically addressing the *benefits* and *outcomes* of assistive technology (AT) for Persons with Disabilities across the lifespan. The journal's purpose is to advance the AT industry by (a) fostering communication among stakeholders interested in the field of AT, including manufacturers, vendors, practitioners, policy makers, researchers, consumers with disabilities, and family members; (b) facilitating evidence-based demonstrations and case-based dialogue regarding effective AT devices and services; and (c) helping stakeholders advocate for effective AT devices and services.

***Assistive Technology Outcomes and Benefits*** invites for consideration submissions of original papers, reports and manuscripts that address *outcomes and benefits* related to AT devices and services. These may include (a) findings of original scientific research, including group studies and single subject designs; (b) marketing research related to AT demographics, or devices and services; (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; (e) project/program descriptions in which AT outcomes and benefits have been documented; (f) case-based reports on successful approaches to service delivery; and (g) consumer perspectives on AT devices and services.

**Submission Categories**

ATOB welcomes scholarly contributions. However, many stakeholders engaged in the field of AT do not have an academic background. ATOB offers a unique opportunity for these stakeholders to contribute their expertise and experience in the context of achieving successful outcomes and beneficial impacts. ATOB understands that many potential authors may lack experience in authoring papers for peer-reviewed journal publication. Therefore, the ATOB Editorial Board is pleased to offer assistance in preparing and refining relevant submissions.

**Articles may be submitted under three categories—**

*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. Submissions may include case studies, project or program descriptions, approaches to service delivery, or consumer perspective pieces. All submissions should have a clear message and be written with enough detail to allow replication of results.

*Voices from the Industry*

Articles submitted under this category should come from professionals involved in developing and marketing specific AT devices and services. Case studies, design, marketing research, or project/ program descriptions are appropriate for this category.

*Voices from Academia*

Articles submitted under this category should come from professionals conducting research or development in an academic setting. Submissions are likely to include applied/ clinical research, case studies, and project/ program descriptions.

**Types of articles that are appropriate include**
Within each of the voices categories, authors have some latitude regarding the type of manuscript submitted and content to be included. However, ATOB will only accept original material that has not been published elsewhere, and is not currently under review by other publishers. Additionally, all manuscripts should offer sufficient detail to allow for replication of the described work.

*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.

*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, demographic reports, and identification of AT trends and future projections. 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.

*Approaches to Service Delivery*
This category includes descriptions of the application of assistive technology in any setting (educational, vocational, institutional, home-life) to improve quality of life for people with disabilities.

*Consumer and Caregiver Perspectives*
This category offers an opportunity for product end users, family members, and caregivers to share their experiences in achieving successful outcomes and benefits through the application or use of AT devices and services.

**Mandatory Components of all articles**
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.

Authors must include a short description of the article's target audience, and indicate the article's relevance to that target audience. Authors may describe their work as it relates to more than one audience, and should specify the value that each group may derive from the work.

**Publishing Guidelines**
Each manuscript must reflect the style guidelines of the Publication Manual of the American Psychological Association (6th edition, 2009).

Manuscripts should be no more than 25 pages in length (double-spaced), including references, tables, and figures. Due to the electronic format of the journal, all submissions should be submitted as email attachments in a Microsoft® Word format.

See detailed *Manuscript Preparation Guidelines for Authors* for more information on formatting requirements and submission instructions.

**For More Information**

Please see ATOB's *Editorial Policy* at http://www.atia.org/at-resources/atob/ for details regarding the submission and review process, ATOB's copyright policy, and ATOB's Publication Ethics and Malpractice Statement.

# Assistive Technology Outcomes and Benefits
# Maximizing the Benefits of Evolving Assistive Technology Solutions
# Volume 11, Summer 2017

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# Introduction to Volume 11: Maximizing the Benefits of Evolving Assistive Technology Solutions

Jennifer L. Flagg, *ATOB Editor-in-Chief*
Carolyn P. Phillips, *ATOB Associate Editor*

Welcome to Volume 11 of Assistive Technology Outcomes and Benefits (ATOB). The theme for this issue, "Maximizing the Benefits of Evolving Assistive Technology Solutions" advances our vision for ATOB to be an effective tool for knowledge transfer, tracking trends, and highlighting new information on the outcomes and benefits of assistive technology (AT) for persons with disabilities. The theme was chosen following the Editorial Board's annual review of the ATIA Conference's research strand. We noticed that many of the 2016 conference sessions were focused on ways that mainstream technologies, such as tablets and smartphones, can be used both in place of and as complements to AT devices. At the same time, there were a number of sessions exploring new developments related to dedicated AT devices. As a result, this issue considers a full range of promising technology solutions employed by and for people with disabilities. Read on for details of the six articles featured here in ATOB Volume 11.

The issue kicks off with two voices from academia. First up is Darren Gabbert with his article, "Assistive Technology Outpacing Disease Progression: A Longitudinal Case Study." Mr. Gabbert describes a process that was used to determine appropriate workplace accommodations for an individual whose functional needs and job requirements were changing frequently due to progression of a disease. He explains how that process was used to identify the individual's functional needs and then find suitable solutions, taking advantage of improvements in available mainstream and assistive technology. AT specialists, employers, and people with disabilities will appreciate the systematic, cyclical nature of the AT assessment and evaluation process, which can be used it to address issues of increasing functional limitations and changing job requirements.

Next up is an article from Karen Erickson, Lori Geist, and Penelope Hatch entitled "Impact of Self-Regulated Strategy Instruction Integrated with SOLO Literacy Suite." The authors share results and insights from their study into how literacy software might combine with a self-regulated strategy development approach to improve educational outcomes for struggling writers in elementary classrooms. The authors' thorough discussion of their work and the positive outcomes the students achieved will be valuable for administrators and instructors seeking to integrate these or similar technologies and strategies in their classrooms.

The next two articles share perspectives from AT industry stakeholders. In "Opinion Paragraph Writing Intervention for Students with Significant Disability," Pamela Mims, Carol Stanger, Robert Pennington, Wendee White, Julie Sears, and Nancy Strickler describe a method for using reading and writing apps on tablets to improve the opinion-writing skills of students with intellectual disabilities. Teachers and AT specialists are likely to value the authors' detailed description of the implementation of the method in a classroom setting. Additionally, this article offers the reader an excellent example of a successful university-industry collaboration. Such partnerships can provide academics with funding for AT efficacy studies, while also supplying industry with objective evidence of a product's effectiveness, combined with valuable feedback from its end users.

The second industry perspective comes from Richard Steele, Lisa Haynes, and Leland Wheeler in their article, "Technology Benefits to Elderly with Infirmaries in a Functional Maintenance Program." This piece describes a collaboration between a rehabilitation services provider and an AT manufacturer, where online speech and language exercises were incorporated into existing functional maintenance programs at long-term care facilities. The authors' findings indicate that among older adults with cognitive impairments and communication challenges, improvements were seen in both expressive language and memory. Long-term care providers and facility managers will find this information useful for their patients, and family members of elderly long-term care residents may wish to use these findings to advocate for the adoption of this technique and technology for their loved ones.

Two voices from the field round out this issue of ATOB. Chris Klein's contribution, "Communication and Developing Relationships for People who use Augmentative and Alternative Communication," is a consumer perspective piece, written from his experience as a long-time user of an augmentative and alternative communication (AAC) device. Mr. Klein conveys the critical importance of communication in relationship-building and calls for a shift in the focus of current thinking in AAC, away from skill-building for the purpose of meeting educational mandates and towards the inherent benefits of social communication. To that end, he describes a service-oriented approach of mentorship by and for people who use AAC devices as one way to address the challenges involved in making that shift. Mr. Klein's article will be of interest to AAC device users themselves, their family members and friends, AAC product manufacturers, and AAC device service providers.

Lastly, Diane Bryen, Juan Bornman, John Morris, Enid Moolman, and F. Mark Sweatman contributed an article entitled "Use of Mobile Technology by Adults Who Use Augmentative and Alternative Communication: Voices from Two Countries." The authors describe their use of surveys to investigate how people who rely on AAC are using mobile technology and what barriers they face in doing so. Based on the survey findings, they present recommendations for researchers who may be interested in studying similar topics, for developers in both the mobile technology and AT industries, and for people who use AAC devices.

As you read, consider the distinctions and commonalities that emerge from this diverse set of papers. The surface distinctions are easy to discern; the contents vary from improving the writing ability of young students, to enabling social communication among users of AAC devices, to providing effective accommodations for individuals with disabilities in the workplace, to increasing positive outcomes of functional maintenance programs for aging individuals. You may notice, though, that from just beneath the surface, some commonalities shine through. By its nature, each investigation featured in this volume relies upon the use of advanced technology – computers, smartphones, and stand-alone AAC devices – regardless of whether the technology is considered mainstream or assistive. In all of these cases it is technology that is enabling people to move beyond functional limitations to engage in meaningful activities and to achieve their personal goals. AT is transformational. However, we must also remain mindful of the assessment and implementation strategies, the training, and the information dissemination approaches that allow us to maximize the benefits of these evolving AT solutions. The value of the Assistive Technology Industry Association in helping people to achieve these aims cannot be overlooked. It is through continued discussion and collaboration that we can see these positive outcomes spread throughout the AT community.

In that spirit, ATOB encourages AT stakeholders to read, learn and share, and to actively participate in this conversation. ATOB offers several ways to do just that. We continue to seek out authors who can share innovative practices, as well as people with disabilities who can give voice to their firsthand experience with assistive technology. Peer reviewers are also vital to ATOB's success, and we welcome interested individuals to volunteer for this role by emailing ATOBEditor@atia.org. Finally, as an open-access journal, ATOB encourages its readers to share these studies and stories with others. Let us continue the conversation and carry this positive momentum forward into reaching even greater milestones on the path toward inclusion and full access for all.

**Declarations**

This content is solely the responsibility of the authors and does not necessarily represent the official views of ATIA. The authors reported no financial or non-financial disclosures.

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# Assistive Technology Outpacing Disease Progression: A Longitudinal Case Study

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**Abstract**

Rapid growth in dedicated assistive and accessible mainstream technologies has heightened awareness of the critical importance of appropriate assistive technology assessment and training. This importance has underscored the need for technology assessment to be a dynamic, continuous process that maintains focus on functional deliverables. This paper presents a longitudinal case study describing keys to successfully accommodating a person with a severe mobility impairment over a 27-year period. Special emphasis is given to achieving levels of productivity conducive to competitive employment within an IT customer service organization. A cyclical methodology referred to as the *Assistive Technology Optimization Process (ATOP)* is defined, described and illustrated. As demonstrated by this case study, the ATOP offers much scaffolding to track, plan, and integrate changing technology to meet changing expectations in the face of *changing capabilities*. Several trends can be observed within the course of the study where *technology benefits outpaced disease progression.* For the study subject, his employer, and the field of assistive technology that is success!

***Keywords:*** assistive technology, assessment, mobility, muscular dystrophy, spinal muscular atrophy

## Introduction

The benefits of assistive technology (AT) largely depend on the successful matching of specific user needs to specific technologies. Every AT practitioner soon realizes this matching must be done amidst changing parameters. Advancing technologies, progressive user limitations, and evolving stakeholder expectations can all pose positive and negative implications on the AT assessment process. The University of Missouri's Adaptive Computing Technology Center has established a systematic approach geared toward the variable nature of making AT system recommendations. This cyclical methodology referred to as the *Assistive Technology Optimization Process (ATOP)* is defined, described and illustrated through a longitudinal case study. This study demonstrates implementation of desktop and mobile computer technologies using the ATOP to guide the process over a 27-year period for an individual with severe and progressive mobility limitations. Special focus is placed on change over time, including: a) meeting changes in user/technology performance expectations; b) compensating for progression of mobility limitations; and c) leveraging advances in mainstream and assistive technologies.

Many assessment methods in the field of assistive technology are non-standardized, lengthy, subjective, and require substantial clinical experience of a multidisciplinary team (Jenko et al., 2010). The ATOP is designed to overcome some of these weaknesses through a practice of continuous, functional-based evaluations. ATOP's focus on functional task performance keeps the process relevant to desired outcomes, while its continuous practice reveals trends showing either positive or negative efficacy of accommodations. Ineffective assessment practices lie at the heart of statistics which suggest AT device abandonment may be as high as 30% (Federici, Meloni, & Borsci, 2016; Mumford, Lam, Wright, & Chau, 2014; Phillips & Zhao, 1993). Some assessment methods attempt to remediate this by placing heavy emphasis on *user self-determination*. The theory being that enhanced self-determination leads to more positive outcomes (Wehmeyer, 2004). While this is a fundamental part of ATOP, self-determination must be supported by expert knowledge of AT best practices. The right parameters must be provided to ensure informed decision making. One strength ATOP offers is its capacity to trend redundant access methods which lead to user discovered best practices. For example, a one-handed typist might have an adapted keyboard, as well as, speech recognition as concurrent access methods. ATOP cycles should indicate which is used most, under what circumstances, and at what level of proficiency. This practice of "discovered best practice" is demonstrated repeatedly throughout the case study.

Another noteworthy assessment approach is based on the concept of *response efficiency*. Response efficiency supports AT selection by assessing four factors that have been identified as significantly influencing efficiency: response effort, rate of reinforcement, immediacy of reinforcement, and quality of reinforcement (Mumford et al., 2014). These criteria reflect some strong similarities to the six criteria used in ATOP, however, the ATOP is strictly tied to task performance. This results in the model's ability to address redundant access methods, which is a fundamental strength of ATOP.

## Target Audience and Relevance

The five-phase assessment cycle described in this paper offers an effective methodology for evaluating computer based technologies. The goal of maximizing benefits, while accommodating change in multiple factors is common to all disability types. While the degree of variability may differ from one user to another, the assessment cycle remains relevant to optimizing capabilities in all applications of AT. The ATOP offers both service providers and AT users a systematic approach to continuous improvement that can be easily documented. This approach also builds an AT user histories revealing best practices that may benefit other users with similar technologies.

## Assistive Technology Optimization Process (ATOP)

Two fundamental principles guiding the ATOP are: 1) setting task specific goals; and 2) exercising client self-determination. Regarding the former, you must know what the target is before you can aim for success. Too often AT providers (and even AT users) equate *computer access* with improved quality of life and increased ability. In terms of AT success, however, gaining access to technology is more of a beginning than an ending. Regarding the latter; technology only fosters self-determination if it achieves results that are meaningful to the end user. For example, setting a goal of providing speech recognition as a primary input method falls short of defining either the need or the aim. In contrast, a task specific goal of *using speech recognition to manage and compose emails in Microsoft Outlook* provides a measureable objective for success, a defined context for training, and a functional and empowering outcome for the user.

Determining the scope of goals to include in an AT assessment depends on self-determination factors such as the user's need for independence, their preferred methods of communication, and their education/employment performance expectations. While goals in any of these domains are influenced by numerous outside factors as well as personal

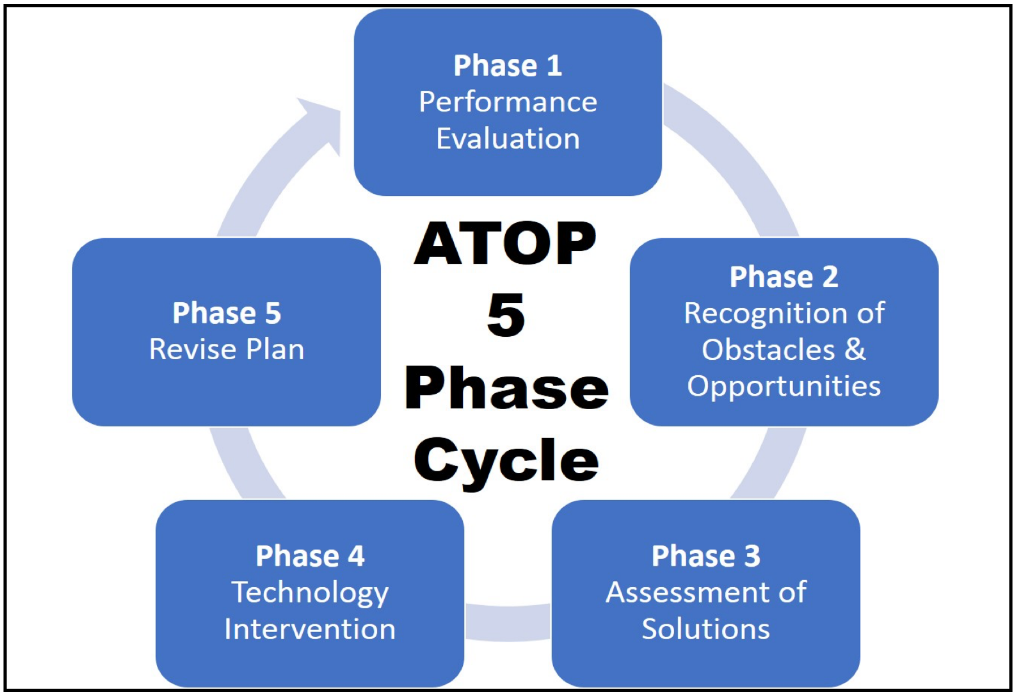


***Figure 1. Assistive Technology Opportunity Process (ATOP)***

factors, the centrality of self-determination is critical to both their definition and attainment (Steel, Gelderblom, & de Witte, 2012).

Using this foundation, we have constructed a five-phase, cyclical process (See Figure 1) to match and optimize AT to user goals. The first phase is the development of the initial performance plan. When this process is initiated, task specific goals are identified and defined by the AT professional and user.

*Phase 1 – Performance Evaluation* officially begins with a performance evaluation of the user/technology match. In reality, however, performance should be continually monitored and this phase should be invoked proactively. Undoubtedly, applying the model in a rigid, linear manner runs the risk of missed opportunities to respond to performance shortfalls outside of scheduled evaluations. Unmet user expectations in AT performance need to be recognized, communicated, and addressed in a timely manner to avoid user frustration and subsequent technology abandonment. For example, a departmental operating system upgrade would logically initiate a targeted performance evaluation of software compatibility. Changing performance expectations can likewise initiate Phase 1 of the ATOP.

Identifying measurable and meaningful evaluation criteria is a formidable challenge for individualized AT accommodations. Task-specific goals do, however, lend themselves to a fundamental measureable question: *Can the user accomplish a task?* But the ability to accomplish a task is not necessarily success. Six evaluation criteria that are particularly helpful in operationalizing successful task performance are *speed, accuracy, fatigue, load, consistency, and satisfaction*. While each of these attributes may be quantified with some precision, in many circumstances ordinal ratings such as low, medium, and high provide sufficient definition for the assessment.

Speed is the exception, however, and ratio scaling is best for tracking progress. A common example is text input rate, which is measured in words per minute; or, text-to-speech output rate for those depending on auditory reading. Speed should always be viewed alongside accuracy. An illustrative example would be high speed but low accuracy in text input. In this example the result may be a net loss of time and energy expenditure due to making corrections, thus diminishing overall efficiency and user experience.

User fatigue is another multicomponent factor, comprising both frequency and duration of the task. Load refers to the physical and/or cognitive demand associated with performing the task. Consistency relates to the user's ability to perform satisfactorily throughout the task and each time they undertake the task. And lastly, satisfaction constitutes a positive overall experience performing the task, using the technology.

*Phase 2 – Recognition of Obstacles and Opportunities* is a process that should be undertaken independent of possible technology solutions. Evaluation criteria for each task, changes in the user's abilities, new or modified performance expectations, and advances in mainstream or assistive technologies are all possible catalysts for AT system changes. Obstacles and opportunities from Phase 2 dovetail with *Phase 3 – Assessment of Solutions*, where solution and optimization options are studied. This assessment phase of the process includes: 1) Identifying recognized obstacles/opportunities that can be readily addressed; 2) researching solutions for unsolved issues; and 3) determining timing and feasibility for implementing researched solutions. When possible, multiple technology solutions should be introduced as redundant systems, thus permitting the degree and rate of technology adoption to follow inherent benefits. For example, someone with progressive mobility limitations may have a workstation with both speech recognition and eyegaze capabilities. Which, where and when each is used will be discovered by the user and optimized in future ATOP iterations. *Phase 4 – Technology Intervention* is the actual implementation of the technology solutions with appropriate testing, training, and adapting. And *Phase 5 – Revise Plan* brings the process back to the performance plan; documenting revisions and targeting a future date of the next evaluation.

## Case Study

### Subject Background

The subject in this case study is a 51-year-old male with an advanced form of Muscular Dystrophy called Type 2 – Spinal Muscular Atrophy. This genetic condition affects the nerves that control muscle movement. Type 2 of this disease is characterized by moderate onset and progressive weakness in arms, legs, lower torso, and respiratory muscles. The subject has used a power wheelchair for mobility since adolescence. Navigation was initially via a joystick controlled by his right hand. By 2005, disease progression had reached complete paralysis, with wheelchair navigation accomplished through electromyography (EMG) switch scanning. The subject has been ventilator dependent since 2013. The subject has a 4-year degree in Computer Science, and was hired into a full-time position with an IT organization in 1989. Subject continues to work within the same organization in a 50% full-time equivalent capacity.

### ATOP Iterations: 1989 – 2016

Listed here are six iterations of the Assistive Technology Optimization Process that were conducted with the study subject between 1989 and 2016. Each iteration presents highlights of all five phases of the process: Performance Evaluating, Recognition of Obstacles and Opportunities, Assessment of Solutions, Technology Intervention, and Revise Plan. Performance goals are listed as column headings within each iteration's Functional Goals Matrix. It should be noted that the subject's technical skills and aptitude from the onset of the study significantly contributed to continuous optimization. This is most clearly seen in the subject's comfort level with technology change. The responsibility to initiate ATOP iterations would fall more to the AT practitioner in instances where the

**Table 1**
***1989 Functional Goals Matrix for Keyboard and Mouse Modifications***

| **Functional Goals** | | 1. Place and receive calls | 2. Manage and compose email on a mainframe system; | 3. Compose written text and graphics for user support documentation; | 4. Access Apple and Windows operating systems (mouse) |
|---|---|---|---|---|---|
| **Evaluation Criteria** | **(Sp)eed** | | One-handed typing, 20 wpm | One-handed typing, 20 wpm | |
| | **(A)ccuracy** | | High | High | Low **(High)** |
| | **(F)atigue** | High **(Low)** | Medium | Medium | High **(Low)** |
| | **(L)oad** | High **(Medium)** | Medium **(Low)** | Medium **(Low)** | High **(Low)** |
| | **(C)onsistency** | Low **(High)** | High | High | Low **(High)** |
| | **(S)atisfaction** | Low **(High)** | High | High | Low **(High)** |

AT user possesses less computing skills.

***Accommodation (1989): Keyboard and Mouse Modifications***

*Phase 1 – Performance evaluation.* The subject seemed satisfied with one-handed typing on a standard keyboard, and demonstrated an input rate of approximately 20 words per minute (Sp) with high accuracy (A). Moderate drop in efficiency associated with fatigue was observed (F). Standard mouse was unusable due to restricted range of motion. Subject could dial standard push button phone, but could not lift handset.

*Phase 2 – Recognition of obstacles and opportunities*. Subject experienced significant difficulty answering and hanging up phone. Access to both Apple and Windows operating systems was hampered by subject's inability to manipulate the computer mouse. Opportunity existed to reduce keyboarding load by accommodating one-handed key combinations associated with modifier keys (e.g. shift, ctrl, alt).

*Phase 3 – Assessment of solutions*. The following issues were addressed:

- Work environment was not conducive to speaker phone conversation. Gooseneck arm with phone handset cradle could allow subject to drive wheelchair to position handset to ear/mouth. Needed to fabricate aluminum lever to allow user to easily open/close the phone line.
- Trackball could replace computer mouse, requiring significantly less range of motion. Because the subject had excellent fine motor movement, mouse pointer navigation could be further enhanced by trackball sensitivity settings (i.e. reduce the ball-to-pointer movement ratio).
- Installed Sticky Keys software utilities on both Apple and Windows workstations which allowed subject to press key combinations sequentially.

*Phase 4 – Technology intervention*. The following solutions were implemented:

- Introduce Gooseneck/lever phone accommodation.
- Introduce 2 Trackballs (Apple and Windows compatible) with sensitivity adjustment capability.
- Implemented Sticky Keys on both platforms.

*Phase 5 – Revise plan*. Changes resulting from this technology accommodation are indicated within parentheses in Table 1.

**Table 2**
***1993 Functional Goals Matrix for Transition to Discrete Speech Recognition***

| **Functional Goals** | | 1. Place and receive phone calls | 2. Manage and compose email on Microsoft Outlook Client; | 3. Compose written text and graphics for user support documentation; | 4. Access Apple and Windows operating systems (mouse) |
|---|---|---|---|---|---|
| **Evaluation Criteria** | **(Sp)eed** | | One-handed typing, 9 wpm (Discrete speech, pending) | One-handed typing, 9 wpm (Discrete speech, pending) | |
| | **(A)ccuracy** | | Medium | Medium | High |
| | **(F)atigue** | Medium | High **(Low)** | High **(Low)** | High **(Medium)** |
| | **(L)oad** | Medium | High **(Medium)** | High **(Medium)** | Medium |
| | **(C)onsistency** | High | Medium **(High)** | Medium **(High)** | Medium |
| | **(S)atisfaction** | Medium | Low **(High)** | Low **(High)** | Medium |

***Accommodation (1993): Transition to Discrete Speech Recognition***

*Phase 1 – Performance evaluation*. Progression of subject's neurological disease was seen in increased fatigue for all functional goals, which is inversely correlated with satisfaction. All criteria (Sp, A, F, L, C, S) supported an immediate intervention to address text entry (2, 3). Mouse control (4) was following same downward trend (F, L, C, S), though indicators showed continued viability (A, C, S). Telephone accommodation (1) was likewise losing ground (F, S), but continued to be effective.

*Phase 2 – Recognition of obstacles and opportunities*. Disease progression was causing weakness and shrinking range of motion. Advances in speech recognition offered a keyboard alternative on the Windows platform. Mouse control via speech recognition would be awkward. Availability of speech recognition on the Apple platform was very limited.

*Phase 3 – Assessment of solutions*. The following issues were addressed:

- Speech recognition technology was available for Windows platform, and would have strong potential to increase speed while decreasing fatigue. Subject's private office offered optimum speech recognition environment. Windows system was targeted for composing text (speech recognition offered awkward mouse control).
- Robust speech recognition technology was not available for Apple platform. Voice Navigator system did offer speaker-dependent, discrete speech system with a 1,000-word capability. This technology could supplement existing trackball capability with voice macros for repetitive keystrokes. Apple system was targeted for graphic design and internet browsing.
- Telephone accommodation was left unchanged with eye on future opportunity to integrate into Windows workstation after speech recognition transition.

*Phase 4 – Technology intervention*. The following solutions were implemented:

- Dragon Dictate for Windows (speaker-dependent, discrete speech) introduced as a hands-free access method.
- Voice Navigator added to Apple system for graphic design and internet browsing.

*Phase 5 – Revise plan.* Changes resulting from this technology accommodation are indicated within parentheses on Table 2.

***Accommodation (1999): Redefining Performance Expectations***

*Phase 1 – Performance evaluation*. As a result of disease progression and other health related issues the subject's performance expectations were reduced to coincide with a 50% full-time equivalent appointment. Telephone accommodation (1) had continued to show diminished efficacy (L, C, S). Composing text (2) via discrete speech recognition was approximately 18 words-per-minute (Sp). Redefined functional goals were aligned with applications supported the by Windows platform, thus removing the Apple technology from his performance plan. Because worksite location would be flexed between home and work, the need for mobile computing access was added to functional goals (3) and would be addressed in this cycle.

*Phase 2 – Recognition of obstacles and opportunities*. Integrating new telephone accommodation into the speech recognition system appeared to be the best fit. A wireless headset microphone could facilitate independent access to the home workstation. Access to a physical switch for toggling the microphone on/off would be needed to facilitate using one headset for both computer and telephone. Laptop with docking station could seamlessly allow the same system to satisfy both functional goals 2 and 3. Opportunity explored to increase speech recognition accuracy because of advances in this technology.

*Phase 3 – Assessment of solutions.* The following issues were addressed:

- Because of the subject's limited pulmonary function, upgrading from discrete to continuous speech recognition was not feasible. Accuracy for continuous speech recognition is heavily dependent on word context, thus requiring users to speak long phrases within single utterances. Trials showed poor recognition accuracy because the subject's breath capacity could produce only two or three words per utterance.
- A laptop with expanded RAM was identified to meet speech recognition system

**Table 3**
***1999 Functional Goals Matrix for Redefining Performance Expectations***

| **Functional Goals** | | 1. Place and receive phone calls | 2. Compose written text and manage information via Microsoft Office software; | 3. Manage information and email beyond home workstation |
|---|---|---|---|---|
| **Evaluation Criteria** | **(Sp)eed** | | Discrete speech, 18 wpm | |
| | **(A)ccuracy** | | Medium | **(Medium)** |
| | **(F)atigue** | Medium **(Low)** | Low | **(Low)** |
| | **(L)oad** | High **(Low)** | Medium | **(Medium)** |
| | **(C)onsistency** | Low **(High)** | High | **(High)** |
| | **(S)atisfaction** | Low **(High)** | High | **(High)** |

requirements and allow portability.
- Home workstation needed to permit the subject to come and go freely without requiring assistance to engage the system (e.g. subject cannot be tethered to workstation with wired headset microphone).
- Nanopac CINTEX4 system identified to provide hands-free control of the telephone via the same wireless headset used for speech recognition.
- A foot switch could be mounted underneath workstation desk and actuated by the subject elevating his wheelchair's power leg rests. Switch would toggle the speech recognition's microphone on/off. Speaking while the microphone is in a sleep state frequently causes the microphone to inadvertently wake up, an issue that would be exacerbated by the microphone's shared function between the computer and the telephone.
- A wired headset microphone with noise reduction capabilities could be used when laptop is undocked and mounted on the wheelchair's lap tray.

*Phase 4 – Technology intervention.* The following solutions were implemented:
- Primary workstation configured with a laptop and docking station, external monitor for increased desktop workspace, scanner for paperless workflow, and wireless headset microphone (rechargeable with 8-hour life);
- Nanopac's CINTEX4 hands-free telephone system integrated with speech recognition;
- Additional wired headset microphone with noise cancellation supplied for use when laptop is undocked and mounted on wheelchair lap tray.

*Phase 5 – Revise plan*. Changes resulting from this technology accommodation are indicated within parentheses on Table 3.

***Accommodation (2005): Transition to Continuous Speech Recognition***

*Phase 1 – Performance evaluation*. In light of the discrete speech recognition software no longer being supported, and growing concern over the likelihood of compatibility beyond Windows XP, continuous speech recognition was revisited. Advances in continuous speech recognition could offer improvements in both speed and accuracy (Sp, A), in addition to the numerous benefits associated with using a supported, feature-rich technology. Subject's mobile solution continued to show functional efficacy (Sp, A, F, L, C), but satisfaction was low due to bulkiness of the laptop and the prohibitive background noise associated with public settings. Alternative mobile solutions were studied. Telephone setup continued to be effective and satisfactory against all evaluation criteria.

*Phase 2 – Recognition of obstacles and opportunities.* An advanced feature within the Dragon NaturallySpeaking software allowed a pause between spoken words, which could facilitate access despite limited breath. Pocket PC/Smartphones were quickly becoming ubiquitous technologies, though largely unexplored for alternate access methods. Software developed in Switzerland existed that offered some degree of switch scanning access.

*Phase 3 – Assessment of solutions*. The following issues were addressed:
- Trials with the pause between spoken words set to nearly 1 second permitted the subject to inhale between pairs of words, thus simulating continuous speech recognition. Subject could dictate entire sentences that Dragon NaturallySpeaking would process as a single utterance with percent of recognition accuracy in the upper-nineties.
- NoHandCom software showed strong potential for effective switch access to Windows Mobile platform. Developer was willing to add functionality that would move toward all device features being switch

**Table 4**
***2005 Functional Goals Matrix for Transition to Continuous Speech Recognition***

| **Functional Goals** | | 1. Place and receive phone calls; | 2. Compose written text and manage information via Microsoft Office software; | 3. Manage information and email beyond home workstation |
|---|---|---|---|---|
| **Evaluation Criteria** | **(Sp)eed** | | Discrete speech, 18 wpm **(Continuous Speech, pending)** | Discrete speech, 18 wpm **(Single switch scanning, pending)** |
| | **(A)ccuracy** | | Medium **(High)** | Medium **(High)** |
| | **(F)atigue** | Low | Low | Low **(Medium)** |
| | **(L)oad** | Low | Medium | Medium |
| | **(C)onsistency** | High | High | High |
| | **(S)atisfaction** | High | High | Low **(Medium)** |

accessible. Mobile device could be accessed by the second switch output from the Tinkertron EMG switch. Triggering of this switch occurs when muscle activity is detected by a single electrode on the surface of the skin, and a trigger sustained for more than 2 seconds causes the switch to toggle between two outputs. In this case, switch output #1 being used for power wheelchair navigation and switch output #2 controlling smartphone single-switch scanning.

P*hase 4 – Technology intervention.* The following solutions were implemented:

- Transitioned speech recognition system to Dragon NaturallySpeaking, setup custom speech commands for telephone control, and expanded global commands to support complete hands-free computing.
- Introduced NoHandCom app on an HP iPAQ device running Windows Mobile.

*Phase 5 – Revise plan*. Changes resulting from this technology accommodation are indicated within parentheses on Table 4.

***Accommodation (2013): Transition to Single Switch Scanning***

*Phase 1 – Performance evaluation*. In January of 2013 the subject experienced a serious health event which resulted in a permanent tracheotomy. This, combined with the advanced level of his neuromuscular disease, eliminated his entire ability to speak. Another computer access method was needed to replace functional goals previously accomplished through speech recognition. Advances in mobile technology switch access had increased the subject's mobile capabilities to fully accessing all features of an Android smartphone. This ClickToPhone system (developed in Ireland) was unaffected by the subject's health event, and became the centerpiece of a radically changed performance plan. Because of the extent of quadriplegia, potential muscle sites for switch access were limited to up/down movement of eyebrows (moving together), strong twitch action of left pectoral muscle, strong twitch action of left cheek, and faint movement of right thumb. The left pectoral muscle was already dedicated to controlling the smartphone and navigating his power wheelchair via a dual output EMG switch. And the eyebrows

**Table 5**
***2013 Functional Goals Matrix for Single Switch Scanning***

| **Functional Goals** | | 1. Place and receive phone calls (Remove) | 2. Compose written text and manage information via Microsoft Office software; | 3. Manage information **(and communicate beyond home workstation)** |
|---|---|---|---|---|
| **Evaluation Criteria** | **(Sp)eed** | | Continuous Speech, 35 wpm **(Single switch scanning, pending)** | Single switch scanning, 5.7 wpm |
| | **(A)ccuracy** | | High | Hig |
| | **(F)atigue** | Low | Low | Medium |
| | **(L)oad** | Low | Medium | Low |
| | **(C)onsistency** | High | High | High |
| | **(S)atisfaction** | High | High | High |

were committed to the operation of the power wheelchair's emergency kill switch. This left the subject's left cheek as the most likely candidate for engaging another technology access method. A telephone/Skype accommodation was explored, in addition to smartphone communication options.

*Phase 2 – Recognition of obstacles and opportunities*. Subject could clearly benefit from several feature enhancements to the ClickToPhone system, chief among which was increasing scanning rate beyond 333ms. Smartphone could initially be primary augmentative and alternative communication device. Eyegaze technology and single switch scanning were the two most likely candidates for replacing speech recognition.

*Phase 3 – Assessment of solutions*. The following issues were addressed:

- Needed text-based Android App for augmentative and alternative communication. Alexicom app had capacity to support large, complex phrase collections with multi-platform compatibility.
- Smartphone SMS capabilities seemed to provide satisfactory communication and standard phone accommodation could be dropped from performance plan.
- Subject's comfort level with single switch scanning became the driving factor in choosing it over eyegaze technology as the subject's primary workstation access method. Though it had not seen a software update in years, Words+ EZ Keys was still the most efficient and customizable product available for single switch scanning. Compatibility with Windows 7 was confirmed.
- AbleNet's SCATIR switch was chosen for EZ Keys menu selections. Mounting scheme included placing the infrared sensor on an extended microphone gooseneck, allowing it to be positioned about 1 cm from the subject's left cheek. Optimum switch placement was aimed at maximum sensitivity for rapid triggering with minimum fatigue.
- Switch under workstation desk for toggling the speech recognition microphone was retrofitted to toggle SCATIR switch on/off

with wheelchair's power leg rests.

*Phase 4 – Technology intervention*. The following solutions were implemented:

- Alexicom AAC app installed on Android mobile device with cloud backup of custom phrase categories.
- Introduced Words+ EZ Keys with AbleNet's SCATIR switch and gooseneck mount as primary workstation access method.
- Adapted switch setup for wheelchair leg rests to toggle SCATIR switch on/off.

*Phase 5 – Revise plan.* Changes resulting from this technology accommodation are indicated within parentheses on Table 5.

***Accommodation (2016): Combined Single Switch Scanning and Eyegaze***

*Phase 1 – Performance evaluation*. Evaluation criteria showed strong efficacy for both desktop and mobile accommodations (1, 2). While 12.9 words-per-minute is an outstanding text entry rate for single-switch scanning, it was still a productivity limitation in view of the subject's high demand for written documentation. Eyegaze with switch selection could enable faster text entry. Likewise, any system enhancements for improving text entry rate on the mobile device was also considered. The growing demand for creating and delivering multimedia presentations should be added to performance goals (3).

*Phase 2 – Recognition of obstacles and opportunities*. Two disadvantages of eyegaze technology are 1) not integrating well with mainstream computing applications; and 2) fatigue associated with eye strain. Implementing eyegaze as a redundant, complementary input method alongside the single switch scanning mitigated these limitations. System configuration needed to allow the subject to easily, and independently, switch between the two access methods. Clearest opportunity for improving input rate on mobile device was to work with the ClickToPhone developer to increase the maximum scanning rate. Software solutions needed identified for meeting new performance expectation of creating and delivering presentations.

**Table 6**
***2016 Functional Goals Matrix for Combined Single Switch Scanning and Eyegaze***

| **Functional Goals** | | 1. Compose written text and manage information via Microsoft Office software; | 2. Manage information and communicate on the go | 3. Create and deliver multimedia presentations |
|---|---|---|---|---|
| **Evaluation Criteria** | **(Sp)eed** | Single switch scanning, 12.9 wpm (+eyegaze, pending) | Single switch scanning, 5.7 wpm | |
| | **(A)ccuracy** | High | High | **(High)** |
| | **(F)atigue** | Low | Medium | **(Low)** |
| | **(L)oad** | Medium | Low | **(Low)** |
| | **(C)onsistency** | High | High | **(High)** |
| | **(S)atisfaction** | High | High | **(High)** |

*Phase 3 – Assessment of solutions*. The following issues were addressed:

- Subject's workstation consisted of a Microsoft Surface Pro 3 and docking station with two 19-inch displays attached. Displays mounted vertically to accommodate subject's inability to turn his head side to side. Eyegaze control was targeted on the top display to accommodate subject's supine resting position.
- Optimum eyegaze calibration statistics were sought through adjusting position of camera, tilt of display, and angle of subject's eyeglasses.
- Determined optimum text entry rate would be reached through switch selecting eyegaze targets.
- ClickToPhone developer agreed to increase mobile device scanning rate from 200ms to 100ms. Soft start feature would also be added to enable better selection of first menu item in each row.
- In addition to Microsoft PowerPoint, Camtasia software was identified for creating multimedia presentations. Camtasia recording mode is compatible with Words+ EZ Keys control. All In One Remote Server (Windows) and All In One (AOI) Remote app (Android) were selected to allow subject to control PowerPoint presentations on the Surface Pro 3 remotely from his Android smartphone when away from docked workstation.

*Phase 4 – Technology intervention*. The following solutions were implemented:

- Introduced EyeTech TM5 eyegaze system. Mounted camera on top of lower display, with eyegaze control aimed at top display.
- Implemented trial with ClickToPhone scanning speed at 100ms and softstart feature at 125ms.
- Introduced Camtasia for multimedia development, and All In One Remote and Server for independently conducting presentations.

*Phase 5 – Revise plan*. Changes resulting from this technology accommodation are indicated within parentheses on Table 6.

## Discussion

The six ATOP cycles outlined in this paper clearly show evolving obstacles and opportunities resulting from changes in technologies, user abilities, and user expectations. It is interesting to note how many accommodations requiring an AT solution 20 years ago now have the needed functionality built into mainstream technology. The fundamental assessment process remains the same, but today many tools are immediately available and bundled in standard operating systems. For example, adjustable keyboarding delays and sequencing; mouse speed, sensitivity, pointer size and shape; screen magnification and text-to-speech; speech recognition and universal switch access are among the standard features of most mainstream technologies.

It is important to appreciate that the focus of each technology intervention is to maximize productivity. The evaluation cycle therefore would be beneficial to any computing technology user, with or without a disability, wishing to maximize their productivity. For example, enormous productivity gains can be realized through combined keyboard/speech recognition input. How this is implemented, however, depends on the functional goals and abilities of the user. The overarching principal should be to maximize the user's strengths and minimize their weaknesses, and to focus productivity on intentional goals.

To illustrate this principle, one can look at the initial (1989) Functional Goals Matrix (shown in Table 1). The subject's initial performance plan included four functional goals associated with his employment expectations. The subject's text input rate is arguably the most significant measure and we have extracted these data points to create Table 7. In

**Table 7**
***Text Entry Rates, 1989 – 2016***

| **Intervention** | | **Rate (wpm)** | **Fatigue** | **Input Type** |
|---|---|---|---|---|
| **1989** | Pre | 20 | Medium | One-handed typing |
| | Post | 20 | Medium | One-handed typing |
| **1993** | Pre | 9 | High | One-handed typing |
| | Post | 18 | Low | Discrete speech recognition |
| **1999** | Pre | 18 | Low | Discrete speech recognition |
| | Post | 18 | Low | Discrete speech recognition |
| **2005** | Pre | 18 | Low | Discrete speech recognition |
| | Post | 35 | Low | Continuous speech recognition |
| **2013** | Pre | 35 | Low | Continuous speech recognition |
| | Post | 12.9 | Low | Single switch scanning |
| **2016** | Pre | 12.9 | Low | Single switch scanning |
| | Post | *Pending* | Low | Scanning / Eyegaze |

Table 7, changes in text entry rate can be seen; a result of buffering disease progression with AT. Major technology interventions occur in 1993 and again in 2013, both of which were necessitated by significant losses in the subject's physical abilities. Between these two turning points we can observe 20 years of increased productivity marked by negligible fatigue associated with text entry.

With speech recognition technology, the subject was able to realize steady increases in his text entry rate, culminating at 35 words-per-minute via continuous speech recognition. In other words, the net result was improved because technology gains steadily outpaced the subject's disease progression. Mainstream technology and AT advance in tandem, but always at different rates of change. How this impacts decision making about technology interventions is most evident in the subject's 1999 and 2005 accommodations (see Tables 3 & 4). While discrete speech recognition continued to show strong efficacy and high satisfaction for the subject, it was becoming an obsolete technology. By 1998, Dragon Dictate for Windows was no longer actively supported by the developer. Advances in the Windows operating system posed a significant compatibility threat to this discrete speech recognition software that was no longer receiving upgrades. Furthermore, it would not be until 2005 that continuous speech recognition could offer the recognition accuracy and advanced customization features needed to accommodate the subject's compromised pulmonary condition.

The subject's text entry rate peaked in 2013 at 35 wpm. As noted previously, it was at this juncture that the subject experienced a catastrophic health event resulting in loss of speech due to a tracheotomy. Fortunately, the text entry method already being exercised with the subject's mobile devices offered a smooth transition to workstation access via single switch scanning. Though the subject was able to use single switch scanning with good efficacy, its maximum rate of input after two years only reached 12.9 wpm - a 63% drop from that reached with continuous speech recognition. Despite this setback to text production, the single switch scanning implementation offered low fatigue and eventually high satisfaction.

The final evaluation to date occurred in 2016, and reflects a return to ATOP's proactive intervention approach. At this point, a combined scanning/eyegaze access method was introduced. A key component to this system was the user being able to readily and independently switch between the two modes of input. Text entry speeds for eyegaze are typically constrained by dwell time (i.e. the time required to gaze at a target before it is selected). For example, a 1 second dwell time would result in an upper limit typing speed of 12 wpm (Majaranta, MacKenzie, Aula, & Räihä, 2006). Thus, because the subject had the option to trigger eyegaze selections with his switch of choice, it was hypothesized that the reduced selection time (between 100ms and 200ms per letter) would lead to a typing speed over 20 wpm. It was further hypothesized that the shared load with single-switch scanning would also mitigate issues associated with eye strain and eyegaze inefficiencies with mainstream technologies.

## Outcomes and Benefits

When we consider the outcomes and benefits of continuous and rigorous technology interventions that are aimed at maximizing productivity, we must understand the benefits of discovered best practice. Best practice discovery is a user-centered process that involves a technology configuration that is able to adapt to the user while the user is also adapting to the system. The aim is productivity. The means are many and varied. For example, the subject of our study began with access to both Windows and Apple workstations. Keyboard accommodations were made alongside integration of speech recognition. And later, single-switch scanning was combined with eyegaze control. These redundancies illustrate the benefit of allowing best practices to be discovered by the user, instead of being a hypothesis of the AT practitioner. Note, in addition to discovery of best practices, having redundancies built into the system offers off-loading in response to fatigue and increased system reliability. Specifically, the study subject's use of EMG switch technology is a good example (see Tinkertron Dual EMG switch description, included in the section on 2005 accommodations). The subject developed skill sets for both primary and secondary placements of the EMG electrode. Primary placement was above the left pectoral muscle, which offered high accuracy

**Table 8**

***Task / Load & Electrode Placement***

| **Task** | **EMG Electrode placements** | |
|---|---|---|
| | **Primary** | **Secondary** |
| **Power wheelchair navigation** | *Heavy* | *Light* |
| **Smartphone text entry** | *Light* | *Heavy* |

(trigger timing) and moderate fatigue (repetitive triggering). Secondary placement was on the left cheek, which offered less accuracy due to inadvertent triggering. Virtually no fatigue was associated with cheek-muscle triggering. Using these modes, the discovered best practice for EMG control was gradually established and is conveyed in Table 8. While the primary placement is ideal for heavy navigational use, the secondary placement still provides a backup in cases of muscle strain or injury. When the subject was away from his computer workstation, increased reliance of mobile device text entry could be accommodated through the secondary placement. This built-in redundancy results in healthier and more reliable use of the technology.

Ideally, when there are multiple access methods, there should be customization options that the user can modify independently. An example of this is single switch scanning parameters (e.g. keyboard layouts, scanning and pause rates, scanning patterns, etc.). Within this philosophy, user training includes or even begins with accessing the system's customization features.

Timely, user-driven adjustments can lead to outcomes that promote technology adoption. In our case study, keyboard and trackball use supplemented speech recognition. As a result of disease progression, however, speech recognition gradually replaced both for text entry and mouse control. But this happened naturally, with the user's abilities and preferences driving the change. Results are pending with regard to the subject's combined scanning/eyegaze technology accommodation, but the expected outcome should reveal when and for what purposes each method is most efficient for the subject.

User self-determination is an underlying principal of this cyclical evaluation process. This is not only true philosophically, but pragmatically: the efforts to provide redundant access methods create a mechanism that facilitates self-determination. Thus, it is reasonable to expect more positive outcomes to be derived from the enhanced self-determination being exercised (Wehmeyer, 2004).

Efficacy of the ATOP model should also be considered in terms of the culminating outcomes of the cycle over time. In the case study presented, these long-term benefits included:

1. A user mindset of continuous improvement;
2. A habit of proactive change; and
3. A continuum of optimal productivity.

## Conclusion

Assistive technology can be life-changing technology. The case study presented represents one of the most challenging scenarios in the practice of AT assessment and intervention. Severe and progressing limitations coupled with high performance expectations require the most AT can give. Change, both positive and negative, is a parameter that touches every aspect of life.

Through this case study, the Assistive Technology Optimization Process showed itself to be the needed scaffolding to track, plan, and integrate changing technology to meet changing expectations in the face of changing capabilities. As noted in the Discussion section, several trends can be observed within the course of the study where technology benefits outpaced disease progression. For the study subject, his employer, and the field of assistive technology that is success!

## Declarations

The content is solely the responsibility of the author and does not necessarily represent the official views of ATIA. No financial disclosures and no non-financial disclosures were reported by the author of this paper.

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# Impact of Self-Regulated Strategy Instruction Integrated with SOLO® Literacy Suite

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**Abstract**

Writing is a complex process with multiple components that require concurrent consideration. Self-regulated strategy development (SRSD) is an empirically supported approach for teaching students strategies for planning, generating and/or revising their writing. The current study investigated whether SRSD integrated with the use of SOLO® Literacy Suite would lead to gains in writing skills for students in grades 3 and 4. Paired samples t-tests were conducted to determine if there was a significant increase in student performance on subtests of the Test of Written Language–3 (TOWL; Hammill & Larsen, 1996). On average, students performed significantly better at posttest on a paper-pencil test when they had access to the SOLO® Literacy Suite during instruction than when they did not.

**Keywords:** self-regulated reading strategy, writing skills, SOLO® Literacy Suite

## Introduction

Writing is a complex process that requires attention to the mechanics of transcription as well as the composition, organization, and presentation of ideas (De Smedt & Van Keer, 2014; Harris, Graham, Mason, & Saddler, 2002). Writers must attend to spelling, grammar, and punctuation while simultaneously considering the content, form, purpose, and audience for which they are writing (Graham, McKeown, Kiuhara, & Harris, 2012). Skilled writers accomplish these tasks by taking time to plan, compose, and revise their work, applying strategies to manage these steps as they write (Baker, Gersten, & Graham, 2003; Santangelo, Harris & Graham, 2008). They also engage in self-regulation to monitor and direct their individual efforts while composing (Lane, Harris, Graham, Weisenbach, Brindle, & Morphy, 2008; Mason, Harris, & Graham, 2002).

Students who have difficulty writing, including those with disabilities, often lack knowledge about the characteristics and processes required for successful writing (MacArthur, 2000; Zumbrunn & Bruning, 2012). These struggling writers frequently approach writing tasks as knowledge telling exercises as opposed to composition processes (McCutchen, 2000; Santangelo et al., 2008; Troia & Graham, 2002; Zumbrunn & Bruning, 2012). Rather than taking time to plan, struggling writers write down everything they know about a topic using few strategies (Baker et al., 2003; Harris & Graham, 2013; Santangelo et al., 2008). Additional difficulties with mechanics often place a heavy focus on the transcription process or the act of putting words on the page. This combination of difficulties taxes the writer's working memory capacity and compromises a writer's ability to attend to the higher order skills used for quality composition and revision (MacArthur, 2000). The typical result is writing that is lower in both quality and quantity than that produced by students who do not struggle to write (Gersten & Baker, 2001; MacArthur, 2000; Zumbrunn & Bruning, 2013).

As they progress through elementary school, struggling writers, who may have initially been enthusiastic about writing, begin to develop negative attitudes toward writing (Harris & Graham, 2013; Mason et al., 2002). Their difficulties with writing can lead to reciprocal relationships between repeated academic failures, a poor self-image as a writer, low motivation, limited task engagement and persistence, devaluation of learning, and low productivity (Harris & Graham, 2013; Mason et al., 2002; Sturm & Rankin-Erickson, 2002). Adding to these problems, students who struggle with writing have a tendency to overestimate their abilities and approach writing tasks with unrealistic expectations (Harris & Graham, 2013; Harris et al., 2003; Mason et al., 2002). Students who face these challenges need explicit instruction that addresses the writing process through skill development, strategies for composition, and a positive view of themselves as writers: self-regulated strategy development is one evidence-based approach that meets this recommendation (Harris & Graham, 2013; Mason, Harris, & Graham, 2011).

## Self-Regulated Strategy Development

Graham, Harris, and their colleagues began developing and studying self-regulated strategy development (SRSD) more than 20 years ago. The aim of SRSD is to teach students strategies for planning and/or revising their compositions (De La Paz & Graham, 1997; Graham, Gillespie, & McKeown, 2013). The approach has been empirically validated in more than 25 studies involving a variety of individual, small group, and classroom settings (e.g., Graham, 2006; Graham et al., 2012; Harris & Graham, 2013; Harris et.al, 2003; Mason et al. 2002; Santangelo, et al., 2008; Troia & Graham, 2002). Recent meta-analyses (Graham, 2006; Graham, et al., 2012; Graham & Perin, 2007) found that SRSD is one of the most effective approaches to writing instruction. Of the 20 studies related to strategy instruction that Graham et al. (2012) reviewed, the 14 SRSD studies had larger average weighted effect sizes (1.17) than the 6 non-SRSD studies (0.59). Graham and Perin (2007) reported the largest average weighted effect size for SRSD relative to all other writing interventions included in their investigation.

SRSD has been used in multiple academic areas. When applied to writing, SRSD is intended to help students become more fluent, independent, goal-oriented, self-regulated, and reflective writers. The underlying premise of SRSD is that students who struggle to write need an integrated instructional approach that explicitly targets their affective, behavioral, and cognitive strengths and weaknesses (Harris & Graham, 2013; Harris et al., 2003). The three primary goals of SRSD are to help students develop knowledge about the writing process through the use of strategies, to use self-regulation procedures to monitor and manage writing, and to develop positive attitudes about writing and their ability to write (Harris & Graham, 2013; Harris et al., 2003; Troia & Graham, 2002).

These goals are important given that many students in the US, both with and without diagnosed disabilities, struggle with writing. According to national reports, approximately 15% of 4th grade students (National Center for Education Statistics, 2003, 2012a), 20% of 8th grade students, and 21% of 12$^{th}$ grade students are unable to produce writing at a basic level (National Center for Educational Statistics, 2012b). Moreover, 74% of 8th grade students and 73% of 12th grade students failed to demonstrate proficiency on national assessments of writing (National Center for Educational Statistics, 2012). Given these deficits, it is alarming to find that teachers often dedicate only 15 minutes per day to teaching writing and infrequently use evidence-based writing instructional strategies when they do teach writing (Gilbert & Graham, 2010). Given the flexibility of SRSD to be modified to meet the needs of both students and teachers, it is possible to integrate it with other literacy instructional approaches, including less explicit process approaches such as Writer's Workshop (Graham & Harris, 2003; Graham & Sandmel, 2011). The explicit instruction in specific self-regulation strategies and instructional components of SRSD can support the needs of individual students while being integrated into the framework of the whole class (Harris et al., 2003).

## Removing Barriers

The difficulties struggling writers with and without disabilities often have with the mechanics of transcription typically result in too much concentration on spelling, handwriting, capitalization, and punctuation, as well as reduced attention to planning and evaluating the overall quality of the writing (Graham, 1999). Revisions are often focused on error correction rather than qualitative improvements, and students sometimes inadvertently produce additional mechanical errors during the revision process (MacArthur, 2000). These issues result in mechanical barriers that make writing more challenging.

Removing the mechanical barriers struggling writers face related to spelling, grammar, punctuation and rate (Santangelo et al., 2008) is just one component of improving outcomes (De La Paz & Graham, 1997). For example, to eliminate barriers, De La Paz and Graham (1997) combined dictation with SRSD instruction focused on planning to improve results for middle grade students with learning disabilities. De La Paz and Graham assigned the students to four groups. Two received SRSD for planning and two learned about the characteristics of good essays with opportunities to read and revise model essays and write and share their work with peers. Half of the students in each instructional approach wrote their work while the other half of the students dictated, thus eliminating the challenge of transcription. The results of the study indicated that simply removing the mechanical barriers did not result in the highest quality writing. Instead, the most complete and highest quality writing came from the students who had the benefit of using dictation to reduce mechanical barriers combined with SRSD instruction in advance planning. The current study builds on this finding by combining SRSD with assistive technology that is designed to reduce mechanical barriers.

## Outcomes and Benefits: Computer Technology Support

Computers can provide important supports to writers (Cutler & Graham, 2008) and reduce many mechanical barriers that struggling writers face (De Smedt & Van Keer, 2014; Lewis, 1998; MacArthur, 2000). Students whose teachers regularly suggest the use of computers for drafting and revising work score higher on assessments of writing than those with teachers who suggest the use of computers less frequently or not at all (National Center for Education Statistics, 2012); yet reported use of computers in writing instruction remains low, with one random sample of 178 primary educators revealing that 42% never used computers in writing instruction (Cutler & Graham, 2008).

Word processing is a specific example of a use of computers that removes handwriting barriers and results in positive effects on the overall quality of writing (De Smedt & Van Keer, 2014; Graham et al., 2012; Morphy & Graham, 2012). However, there is variability in the effects of word processing alone as a support for writing (Graham & Perin, 2007; Morphy & Graham, 2012). Graham and Perin (2007) reported that the variability is not related to the specific interventions, characteristics of the students, length of the intervention, or other factors that would typically explain variations in the impact of educational interventions. They concluded that while word processors have an overall positive effect on writing, the impact of word processors alone varies based on factors yet to be determined.

While typing removes one obvious set of mechanical barriers, software programs can include supports geared specifically toward removing barriers associated with planning, outlining, and revision processes (Morphy & Graham, 2012). For example, Sturm and Rankin-Erickson (2002) investigated the effect of concept mapping on the expository writing skills of 20 middle school students with learning disabilities. All students received SRSD instruction for concept mapping, and the authors compared the effects of drawing maps by hand to using a computer software program. Both conditions yielded significant increases in quantity and quality of writing as well as carry-over effects to writing without the use of a concept map. An important additional finding indicated that students had a significantly more positive attitude toward writing when creating concept maps on the computer than when hand-drawing or not using concept maps. The combination of technology with SRSD resulted in both better writing and more positive attitudes toward the process.

Spell checkers may improve the revision process, particularly with respect to the identification and correction of minor errors, but there is a paucity of research providing clear guidance on use (Graham & Perin, 2007; Morphy & Graham, 2012). Furthermore, spell checkers have limitations with respect to target vocabulary not being presented on lists of suggestions to students, and misspellings of intended words not reliably detected, particularly for homonyms or typing errors that result in real words (MacArthur, 2000). Limitations aside, some students can improve their use of spell checkers by learning strategies to generate the target word with phonetic spelling, and proofreading their writing to see if the spell checker missed any errors (McNaughton, Hughes, & Ofiesh, 1997). For students with severe spelling problems, word prediction software may provide more support than spell checkers by improving spelling accuracy and increasing motivation, particularly when the available vocabulary is matched to the writing task (MacArthur, 2000). Similarly, speech synthesis capabilities that translate text into computerized speech can provide students with supports for listening to how their writing sounds to guide revision and editing work, but sufficient research is lacking to understand the full benefits of this technology (Graham & Perin, 2007).

## Target Audience and Relevance

Writing is a complex process that can pose multiple challenges for struggling writers across the grades (Harris et al., 2003; MacArthur, 2000; Zumbrunn & Bruning, 2012). Interventions intended to improve writing can focus on single components of the complex process such as using concept mapping during planning (Sturm & Rankin-Erickson, 2002) or multiple components simultaneously such as writing a story or an expository essay (Graham & Harris, 2005). When instruction involves SRSD, these interventions are more successful (Graham & Perin, 2007), and combining the SRSD interventions with technology (Cutler & Graham, 2008) or other approaches intended to remove barriers (De La Paz & Graham, 1997) improves student outcomes. The current study contributes to this growing area by investigating the combined benefits of SRSD and the SOLO® Literacy Suite (Don Johnston Inc., 2007), a suite of literacy software tools including text-to-speech, graphic organizer, and word prediction programs, with struggling writers in grades 3 and 4. Ultimately, the target audience includes educators, clinicians, and families striving to support students in grades 3-12 who are struggling or otherwise need to improve their ability to write paragraphs and/or narrative texts. The primary research question addressed was, *Does SRSD integrated with use of SOLO® Literacy Suite lead to gains in writing skills for students in grades 3 and 4?*

## Methods

Four teachers, two each in grades 3 and 4, were recruited for participation in the project. Once teacher volunteers were secured, all of the students in their classes were recruited to participate in the investigation. The original plan was to improve our understanding of the ways teachers used the tools in SOLO® to create assignments to support the implementation of the SRSD with their students. The original design was a quasi-experimental group design comparing researcher-made SOLO® assignments that integrated the tools in SOLO and teacher-made SOLO® assignments that may or may not have integrated the tools. As such, one teacher at each grade level was randomly assigned to a condition that would provide researcher created assignments in the SOLO® software. The other teachers, one at each grade level, were assigned to a condition that required the teacher to create the assignments. During the first week of the study the teachers in the SOLO® group with researcher created assignments shared the assignments with the other teachers. This was not part of the research plan, but the team did not learn about the sharing until the end of the second week when another round of ready-made assignments had been shared. As a result, the two groups were merged into one and are reported here as a single-group, pre-experimental, pretest-posttest design investigating whether or not SOLO® with ready-made assignments created by the research team to the specifications of the classroom teachers led to gains in writing performance for students in grades 3 and 4.

**Teacher Training**

The teachers all received training during a 90-minute after-school session on SRSD and the various writing strategies that can be taught using the SRSD approach. Each grade level then selected the specific strategy they wanted to address in the SRSD instruction with their students. The two teachers at each grade level taught the same strategy using the SOLO® assignments created by the research team. The two different strategies are described in Figure 1.

The four teachers had an average of 12 years of teaching experience (range = 3-30 years). All of the

**Figure 1.**
***Description of Writing Strategies Addressed at Each Grade Level***

**3rd Grade: Summary Writing Strategy**

1. Read the text.
2. Identify and write down the main idea.
3. Identify and write down the important things about the main idea.
4. Reread the text to make sure all of the important ideas are in the list.
5. Write a topic sentence.
6. Number the important ideas using 1 for the most important.
7. Turn the topic sentence and list of important ideas into a paragraph.
8. Reread the summary paragraph to make sure it makes sense.
9. Ask yourself, "Have I left anything out?"

**4th Grade: Narrative Writing Strategy**

SSCARE

- **S**ituation
- **S**etting
- **C**haracters
- **A**ction
- **R**eaction
- **E**nding

teachers had a master's degree. None of the teachers identified themselves as "very comfortable" with using computers in their teaching prior to the investigation. One teacher indicated that she was "very uncomfortable" using computers for personal use or with her students. The remaining three teachers reported that they were comfortable using computers for personal use and with their students.

Teachers also participated in a second 90-minute training focused on SOLO®. A member of the research team, who is an experienced school-based assistive technology service provider and who holds professional certification in assistive technology, conducted the training in the school's computer lab. During the 6 weeks of the intervention, members of the research team met weekly with the teachers (in the first two weeks it was with only one teacher at each grade level) to understand how they wanted to use SOLO® and create necessary assignments. The researchers then managed the distribution of all SOLO® assignments to the 26 computers in the school's computer lab and the 28 computers on the laptop cart for the teachers to use with their students. This research was conducted using a version of SOLO® that did not support network distribution of assignments or sharing of student files.

**Participants**

All students in the classrooms of the four teachers were recruited for participation regardless of writing ability, English language status, or disability. A total of 40 children (22 girls) participated in the study. Nineteen of the children were in 3rd grade and the remaining 21 were in 4th grade. Four of the children had identified disabilities, nine were identified as gifted, and thirteen received free or reduced price lunch. Thirty of the children were white, nine were African American, and one was Asian.

**Procedures**

The entire investigation lasted ten weeks. During weeks 1 and 2, children who were participating in the research completed pretests and teachers participated in the training sessions. During weeks 3 through 8, teachers completed eighteen 45-minute SRSD lessons with all of the children in their class whether or not they were participating in the research (see Appendix A for example lesson plans as provided for teachers). During weeks 9 and 10, children who were participating in the research completed posttests.

The Test of Written Language - 3 (TOWL; Hammill & Larsen, 1996) Form A was administered to all participants at pretest and Form B was administered at posttest. This assessment is a pencil and paper assessment, and all students completed the assessment without access to a computer or the kinds of software supports found in the SOLO® Literacy Suite. While some students may have benefited from access to accommodations while taking the TOWL, no accommodations or supports were provided at pretest or posttest for any of the students. The assessments were administered to small groups of students by members of the research team.

The two forms of the TOWL are reported to be equivalent (Hammill & Larsen, 1996). The difference in mean scores across the two forms was less than 0.5 of a raw score point across the two forms when they were administered in one testing session. The correlation coefficients across the two forms with immediate administration exceeded .80. As reported in the TOWL manual (Hammill & Larsen, 1996) test-retest reliability for the two forms also resulted in coefficients exceeding .80 for the Contrived Writing Composite Score ($r$ = .88), the Spontaneous Writing Composite Score ($r$ = .86), and the Overall Writing Score ($r$ = .89).

**The SOLO® Literacy Suite**

There are four separate software applications included in the SOLO® Literacy Suite. They are integrated in SOLO® to address the barriers and challenges faced by developing and struggling writers. For example, the first of the four applications is *Draft:Builder®*. This application supports outlining, note-taking, and draft writing. It has the potential to benefit struggling writers who rarely take the time to plan before writing down everything they know about a topic (Baker et al., 2003; Harris & Graham, 2013; Santangelo et al., 2008). Another application is *Co:Writer®*, which offers word prediction that supports spelling of individual words and the construction of grammatically correct sentences. This word prediction software has the potential to remove the mechanical barriers struggling writers face related to spelling and grammar (Santangelo et al., 2008). *Write:OutLoud®* the talking word processor included in the SOLO® Literacy Suite, has a spell-checker and easily accessible menus to change font size, foreground and background colors, and the synthesized voice that is used. This software has features that make it potentially useful as students work to identify and correct minor errors in their writing (Graham & Perin, 2007; Morphy & Graham, 2012). Finally, the suite includes an application called *Read:OutLoud,* which is a text reader.

There are several other software packages that include many of the features offered by SOLO®; however, the fact that SOLO® supported whole-class use and the type of ready-made assignments the teachers used to implement SRSD made it a good choice for this project.

**The Intervention**

All four teachers were provided with a sequence of 18 lessons that outlined the implementation of the writing strategy they were implementing at their grade level. The 18 lessons did not provide information regarding the implementation of SOLO®, but they did provide teachers with a framework to guide their implementation of SRSD. The research team provided the lesson sequence in the interest of maximizing the fidelity of implementation of the SRSD approach while studying the impact of the addition of SOLO®.

**SRSD Instruction.** The six stages of the SRSD instruction were built into the lessons. The first step emphasized building background knowledge and teaching pre-skills needed for learning and using the writing strategy at each grade level. In the case of the current study, lessons focused on building background taught vocabulary specific to the strategy (e.g., topic sentence, topic, main idea) and skills embedded in the strategy (e.g., writing a topic sentence, determining the main idea). The second step helped students learn self-statements intended to regulate strategy use, the writing task, or interfering behaviors. Self-statements supported problem definition (e.g., "What do I have to do here?"), focus and attention (e.g., "I need to concentrate."), encouraged self-evaluation and error correction (e.g., "Have I used all my parts?"), supported coping and self-control (e.g., "I can do this. Slow down."), and guided self-reinforcement (e.g., "I like my ending."). Self-statements also included statements related to a step in the strategy (e.g., "I need to write down my strategy reminder.").

The third step in the 18-lesson sequence required discussion of the strategy. As detailed in Figure 1, this step required discussing the summary writing strategy in both third grade classes and the narrative writing strategy in both fourth grade classrooms. The teacher explained the new strategy and each step. The teacher also defined the purpose of the strategy, the benefits of its use, as well as how and when to use it. Discussion also examined current writing performance and strategies used to accomplish specific writing tasks. These discussions served to encourage students to make a commitment to learning the strategy and working as a collaborative partner in accomplishing their goal.

The next step in the lessons required teachers to model the strategy and appropriate self-statements. The models teachers provided showed the students how to use self-instruction that included defining the problem, planning, applying the strategy, evaluating and correcting errors as needed. After building background, discussing, and modeling the strategy, teachers supported students in memorizing the strategy itself using the mnemonic as a support. Finally, the lessons guided teachers in supporting students in applying the strategy until students could apply it independently in their own writing.

**Integrating SOLO®.** Members of the research team met with teachers on a weekly basis, after the teachers had a chance to review the lessons and determine what materials they would use. During these meetings, teachers told researchers what they wanted to accomplish with SOLO®. For example, a third grade teacher wanted students to be able to use Write:Outloud, the talking word processor component of SOLO®, to support students in reading a short text they were going to summarize as a group. A fourth grade teacher wanted students to use Co:Writer, the word prediction component of SOLO®, to support her students' selection of "big" words that "they usually don't try to write because they can't spell." To support the third grade teacher, the research team typed the text provided by the teacher and loaded it onto all of the computers in the lab and on the laptop cart. To support the fourth grade teacher, the research team created a Topic Dictionary in Co:Writer that included all of the words with three or more syllables in the text they were reading and changed the user dictionary from beginner to advanced to ensure that the "big" words students were trying to write would be available. In this way, teachers had access to the ready-made supports they wanted in SOLO® without having to create the supports themselves.

**Fidelity.** Members of the research team observed teachers implementing the SRSD to ensure that teachers were implementing the lessons in the way they were designed. The emphasis was on the implementation of the steps of effective SRSD as outlined in the lesson plans and consistent use of the strategy selected for each grade level. Observation forms were created from the lesson plans and each step was marked as teachers completed it. Across 100% of the observations (at least three per classroom conducted by two separate members of the research team), teachers implemented the targeted steps of SRSD and focused on the strategy selected for the grade level with 100% fidelity.

## Results

A paired samples t-test was conducted to determine if there was a significant increase in student performance on the Total Writing score of the TOWL from pretest to posttest. On average, students performed significantly better on the posttest ($M$ = 66.75, $SE$ = 3.096), than the pretest ($M$ = 58.95 $SE$ = 3.03, $t(39) = -4.137$, $p < .001$, $r = .55$). This increase in raw score corresponds with an increase in overall percentile rank from the 12th percentile to the 23rd percentile and an increase in quotient from 82 to 89. Importantly, these gains on a paper and pencil test of writing were found across the two subtests of the TOWL, the Contrived and Spontaneous subtests. Paired samples t-tests were also run on these individual subtests. On average, students performed significantly better on the posttest administration of the Contrived subtest ($M$ = 39.43 $SE$ = 2.05) than the pretest ($M$ = 36.00 $SE$ = 1.77, $t(39) = -3.425$, $p < .002$, $r = .48$). This increase in raw score on the subtests that comprise the Contrived subtest corresponds with an increase in overall percentile rank from the 10th percentile to the 16th percentile and an increase in quotient from 81 to 85. Similarly, on average, students performed significantly better on the posttest administration of the Spontaneous subtest ($M$ = 27.33, $SE$ = 1.31) than the pretest ($M$ = 22.95, $SE$ = 1.62, $t(39) = -4.375$, $p = .002$, $r = .57$). This increase in raw score on the Spontaneous subtest corresponds with an increase in overall percentile rank from the 13th percentile to the 35th percentile and an increase in quotient from 83 to 94.

Descriptive statistics from the four students with identified disabilities suggests that they benefitted from the use of SOLO® with SRSD in a way that mirrored the whole group. For example, the mean Total Writing raw score for these students increased from 63.50 ($SD$ = 17.098) at pretest to 72.75 ($SD$ = 21.469) at posttest. Their scores on the Contrived subtest increased from 39.00 ($SD$ = 13.342) at pretest to 42.75 (*SD* = 13.226) at posttest, and their scores on the Spontaneous subtest increased from 24.50 (*SD* = 4.123) at pretest to 30.00 (*SD* = 8.287) at posttest. Each of the four students made gains from pretest to posttest on the Total Writing raw score. Furthermore, the increase in raw score on the subtests that comprise the Contrived subtest corresponds with an increase in overall percentile rank from the 16th to the 25th percentile and an increase in quotient from 85 to 90. On the Spontaneous subtest, the increase in raw scores on corresponds with an increase in overall percentile rank from the 20th to the 50th percentile and an increase in quotient from 88 to 100.

## Discussion

The evidence base supporting the use of SRSD with populations of students with and without disabilities is quite strong, but the evidence base for the use of software to support effective writing instruction remains limited. This study does not provide definitive evidence that using SOLO® improved outcomes students would have achieved after 6 weeks of instruction with SRSD, but it does suggest that SRSD resulted in positive writing outcomes even when teachers took the time to teach students to use software while they were learning strategies. Equally important, students made significant improvements on a standardized paper and pencil writing assessment even when they used a computer to write during the six weeks of instruction.

With the rapidly expanding availability of durable, portable and inexpensive mobile platforms, now is an optimal time to leverage the use of software to maximize the effectiveness of writing instruction. Given the reported underutilization of computers in writing instruction (Cutler & Graham, 2008), it is relevant to note that the teachers involved in the current study did not have advanced skills in using technology prior to implementing SOLO® in the classroom. None of the participating teachers reported being “very comfortable” using technology with their students prior to the investigation, yet with a 90-minute overview training and occasional consultation with the research team, they were successful in using computers as part of their everyday writing instruction.

The findings of this study do not provide information regarding which applications or features in the SOLO® Literacy Suite were most important to the teachers and students in the current investigation. It is possible that a different combination of applications or more emphasis on particular features would have resulted in even greater gains for the participants. Future research should employ designs that control for the use of each of the software applications and more directly measure their independent and collective impact.

This study adds to the literature by demonstrating that six weeks of instruction combining SRSD with the SOLO® Literacy Suite and custom-made assignments is associated with significant growth across the contrived (mechanical) aspects of writing as well as those required for spontaneous writing (organization, composition and presentation of ideas) when students do not have access to the computer. Although the current study is limited to a single-group, pre-experimental, pretest-posttest design, and does not allow for causal claims regarding the added benefits of the technology with SRSD, the outcomes data support that students demonstrated improved writing on a standardized test of writing as a result of instruction focused on a single strategy, delivered through an instructional approach built on SRSD that integrated the use of the SOLO® Literacy Suite.

## Declarations

This content is solely the responsibility of the authors and does not necessarily represent the official views of ATIA. The authors disclosed financial relationships with the National Center for Technology Innovation, Technology in the Works Competition, and Don Johnston, Inc. No non-financial disclosures were reported by the authors of this paper.

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**Appendix A**
Sample Lesson Plan Provided for the Teachers

**Lesson 13. Model It**

Purpose: Identifying the Main Idea and Important Ideas

a. Mini-lesson
- i. Read a short story to the students.
- ii. Think aloud while you show them how to write the main idea.
- iii. Reread the story, the main idea and other important ideas you've listed. Think aloud while you model the **self-statement**, "Have I written the main idea and all the important ideas?"

b. Student Writing Idea:
- i. Ask students to read a short story or portion of a story
- ii. Ask students to write the main idea and other important ideas about the story they read.
- iii. Encourage them to check what they've done and ask themselves, "Have I written all of the important ideas?"

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# Opinion Paragraph Writing Intervention for Students with Significant Disability

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## Abstract

Increasingly, technology has been used to provide access to academic curricula for students with moderate to severe intellectual disability. In the current pilot study, we used a multiple probe across participants design to evaluate the effectiveness of a technology-based instructional package on the opinion writing skills of three middle school students with moderate and severe intellectual disability. Findings suggest that the intervention resulted in improved performance across all three participants and that all participants maintained performance at levels greater than baseline. Limitations and implications for practice and future research are discussed.

***Keywords:*** writing intervention, assistive technology, autism, intellectual disability

## Introduction

A recent shift in the focus of instruction for students with moderate to severe intellectual disability has afforded new opportunities for participation in the general education curriculum. This change, precipitated by legislative calls for accountability (e.g., No Child Left Behind [NCLB], 2002; Individuals with Disabilities Education Improvement Act [IDEA], 2004) and the promise of an emerging body of research on the effectiveness of academic intervention for students with moderate and severe intellectual disability (e.g., Hudson, Browder, & Wood, 2013; Spooner, Knight, Browder, & Smith, 2012), necessitates that educators reconsider curricula for this unique population. That is, they must expand upon a well-established concept of functional curriculum (Brown et al., 1979) and adopt new expectations related to performance in academic contexts.

This expanded vision for educating students with moderate and severe intellectual disability includes the expectation that all students make progress in the general education curriculum and work toward achieving college readiness skills. Central to these aims is the delivery of high quality instruction in the area of literacy so that students can more effectively acquire and demonstrate their understanding of content knowledge through reading, writing, speaking, and listening (Kearns et al., 2010). Unfortunately, the majority of research on literacy instruction for students with moderate and severe intellectual disability has focused narrowly on reading sight words (Katims, 2000). Only recently have researchers turned their attention to other skills that are targeted during literacy instruction for students with moderate and severe intellectual disability. Several research teams have looked to the English Language Arts (ELA) benchmarks, as defined in the Common Core State Standards, for guidance (Conley, 2007; Kearns et al., 2010; Spooner & Browder, 2015) and have designed effective interventions for teaching a range of skills (e.g., Hudson et al., 2013; Hudson, Browder, & Jimenez, 2014; Mims, Hudson, & Browder, 2012). These important advances in the technology of teaching for students with moderate and severe intellectual disability further support the need for an increased research emphasis on intervention for this critical set of skills.

Despite the emergence of sound methods for the instruction of students with moderate and severe intellectual disability in reading, there has been little work in the area of written expression (Pennington & Delano, 2014). Written expression plays a critical role in the lives of all students as it serves a range of functions in educational settings. Students use writing to demonstrate their understanding of content across academic areas, to share their ideas about the world, and to engage in social interactions with peers. Furthermore, writing skills are essential to college and career readiness as they are necessary for success across a range of tasks in postsecondary environments. Unfortunately, data suggest that many students with and without moderate and severe intellectual disability have difficulty acquiring proficiency in written expression (U.S. Department of Education, 2011). Written expression is complex and involves the simultaneous execution of a constellation of skills to generate a specific message for a particular audience. This task is often more difficult for students with moderate and severe intellectual disability as they may present deficits in social communication, fine motor skills, reading comprehension, and perspective-taking.

Few research teams have investigated strategies for teaching writing to students with moderate and severe intellectual disability. Two reviews of the research literature on writing interventions for students with intellectual disability (Joseph & Konrad, 2009) and autism spectrum disorder (Pennington & Delano, 2012) indicated that the majority of investigations were applied to spelling and word construction tasks, but few involved the production of written narratives. The authors also noted that explicit instruction, assistive technology, and predictable writing routines were consistently applied as an intervention component. More recently, research teams have applied variations of these components to a range of writing skills including spelling (Purrazzella & Mechling, 2013), story writing (Pennington, Ault, Schuster, & Sanders, 2011; Pennington, Collins, Stenhoff, Turner, & Gunselman, 2014), using personal narratives within text messages (Pennington, Saadatzi, Welch, & Scott, 2014), and writing resume cover letters (Pennington, Delano, & Scott, 2014). Across these studies, researchers consistently applied response prompts (i.e., simultaneous prompting, system of least prompts, time delay) but employed disparate forms of technology (i.e., robot technology, commercial writing software, tablet personal computers).

The frequent application of technology-aided instruction (TAI) during writing intervention for students with moderate and severe intellectual disability is not surprising as it offers several advantages to the emerging writer. First, writers may use software that allows for the construction of written products in the absence of a spelling repertoire (Pennington, 2016). For example, students may select a word from a software array to complete a sentence about a picture, or select multiple words to construct a sentence about what they read. Second, the digital presentation of instructional stimuli about which the student is expected to write may be designed in such a way that relevant stimuli might be highlighted or repeated. This increased salience of instructional stimuli may facilitate student attention and stimulus control. Finally, some students' preferences for particular features of the technology may serve to reinforce their writing behavior (Pennington, 2010). Data suggest that some students prefer TAI in lieu of traditional teacher-delivered intervention (Moore & Calvert, 2000). In light of these advantages, future research in writing and moderate and severe intellectual disability will likely include innovations steeped in TAI.

The current literature on teaching writing to students with moderate and severe intellectual disability is promising and suggests a path forward (i.e., explicit instruction, technology) in developing more complex literacy repertoires for this population of students. Interestingly, the guidance offered by the literature reflects practice inconsistent with established guidelines for teaching writing; that is, the majority of research teams have focused on writing without consideration of ongoing reading instruction. Written expression plays a critical role in reading comprehension. When students are asked to write in the context of academic instruction, they are provided with opportunities to make decisions about and therefore, reexamine the content (Graham & Harris, 2016). In the current study, we sought to investigate the effectiveness of a technology-based instructional package on the opinion writing skills of three middle school students with moderate and severe intellectual disability. The package included the digital presentation of grade-aligned text and subsequent instruction on writing an opinion about the text. We addressed the following research questions: (1) Is there a functional relation between the use of a technology-aided intervention package and the percent of correct steps performed during students' opinion writing tasks? and (2) What is the effect of a technology-based, task-analyzed writing intervention on the social validity as reported by the teacher?

## Target Audience and Relevance

In light of a limited body of research to guide practitioners in teaching writing to students with developmental disabilities, this paper demonstrates an effective application of assistive technology (AT) within the writing process for students across grades 5 to 8. This paper may serve as a starting point for a range of practitioners (e.g., general and special education teachers, speech-language pathologists, assistive technology specialists) working with students with developmental disabilities in designing rich, grade-aligned ELA instruction that addresses skills in both reading and written expression.

## Method

### Participants and Settings

Three participants, ages 10 to 14 years, with moderate and severe intellectual disability participated in the study. All three students received special education services in a middle grades self-contained classroom ($5^{th}$ grade through $8^{th}$ grade). ELA instruction in the classroom, at the time of the study, focused on early literacy or early reading skill building using elementary aged books. Little to no grade-aligned ELA instruction occurred in the classroom. The participants met the following inclusion criteria: (a) educational eligibility for autism and/or an intellectually disability, (b) use of the select and drag feature on an iPad, (c) participation in state alternate assessment based on alternate achievement standards, (d) regular school attendance, and (e) visual and auditory acuity. All three participants had previous experience using an iPad in educational settings. Students selected their own pseudonyms.

Frodo was a 10-year-old Caucasian female in the 5th grade. Frodo was identified as having a moderate intellectual disability. Frodo used a combination of spoken words and picture symbols to make requests and had little to no exposure to grade-aligned text or grade-aligned ELA instruction (See Table 1).

Jay was a 14-year-old Caucasian male in the 6th

**Table 1**
***Participant Demographics***

| Student/ Gender/Ethnicity | Age/Grade | IQ Test Given/ IQ | Disability | Reading/ Vocal Verbal Ability |
|---|---|---|---|---|
| Frodo/ Female/ Caucasian | 10/5th | WISC-IV/50 | Significant Intellectual Disability | Non-Reader/ Vocal Verbal |
| Jay/ Male/ Caucasian | 14/6th | WISC-IV/<50 | Significant Intellectual Disability | Non-Reader/ Vocal Verbal |
| Shrek/ Male/ Caucasian | 14/8th | WISC/<40 | Significant Intellectual Disability | Non-Reader/ Vocal Verbal |

grade. Jay was identified as having a moderate intellectual disability and primarily used picture symbols to communicate. Jay had little to no exposure to grade-aligned text or grade-aligned ELA instruction (See Table 1).

Shrek was a 14-year-old Caucasian male in the 8th grade. Shrek also was identified as having a significant intellectual disability and used picture symbols to communicate. Shrek had little to no exposure to grade-aligned text or ELA instruction (See Table 1).

The interventionist was a graduate research assistant with five years of experience in working with students with multiple disabilities and behavior concerns. The interventionist and a graduate assistant (i.e., doctoral student in early childhood education), who conducted inter-observer reliability and procedural fidelity checks, were trained to conduct baseline and intervention procedures.

The researchers conducted the study in a rural public middle school in the southeastern United States. Sessions were conducted at least three times a week for five weeks of intervention. Sessions occurred in a room attached to the student's regular classroom. Each session lasted approximately 40 minutes.

**Materials**

**Adapted story.** An adapted version of *Outsiders* was read aloud via a standalone iPad app, *Access: Language Arts* (Attainment Company, 2016) with professional narration (a professionally recorded voice, as opposed to a text-to-speech 'robotic' voice). The adapted version of *Outsiders* was rewritten at 3.5 grade level, divided into five chapter pairings with reduced text and picture supports. Each chapter pairing contained two chapters (i.e., 1 and 2, 3 and 4, etc.) and ranged from 11-14 pages in length. Picture supports were used for key vocabulary words, primarily nouns and verbs, and characters. Each page held approximately 42 words and 10 picture supports, along with underlined vocabulary words. Each page was read aloud, via the app, and at the end of each page the student pushed the arrow to proceed to the next page. Students also were able to press the underlined vocabulary for definitions. Each chapter pairing took approximately 20 to 25 minutes to read.

**iPad app.** *GoBook* app *(*Attainment, 2015) was used to develop a writing intervention to accompany the *Outsiders* story. The *GoBook* app presented vocabulary words (e.g., brother, group), instructional words (e.g., setting, main character, conclusion), and an overview of the types of sentences required for writing a paragraph (i.e., introduction, opinion, fact, conclusion). The *GoBook* app used text-to-speech for the writing instruction and intervention, as opposed to a human recorded voice as was used in the adapted story.

**Writing intervention.** During the writing activity, *GoBook* presented a display with a statement and three options from which students made a selection by touching the choice on the iPad screen. We designed displays for the selection of identifying: (a) a writing topic, (b) an opinion on the chosen topic, (c) a fact that supported the identified opinion, (d) a second fact that supported the identified opinion, (e) a conclusion statement, and (f) an opportunity to change opinions. In addition, pages were created to address error corrections, as needed, and pages were created that allowed the students an opportunity to write their chosen responses by completing sentences through the use of drag and drop. More specifically, when presented with a screen with the question, “What will you write about?” three choices were presented including one distractor (i.e., a character, a big idea, or a random topic not related to the story). After choosing a subject to write about, the next display asked about which specific story topic the participant wanted to write. For example, “Who do you want to write about? Cherry, Pony-boy, or Michelle Obama.” Again, two correct answers and one far distractor were presented. Next, the student established an opinion about the topic selected. The next two displays were designed to identify the facts that backed up the student’s opinion. The display screen asked, “Which fact supports your opinion?” followed by a writing prompt that filled in the student’s opinion from the prior page (e.g., I think Pony-boy is nice because ______”). This prompt was followed by three response options including the correct answer, a response containing a fact that supported the opposite opinion, and a response that did not occur in the story. If the students chose the opposing response option, then they were directed to a page that provided them an opportunity to change their opinion or change their fact choice. Lastly, on the conclusion display, the screen asked, “What is the last sentence you want to write about?” A conclusion statement for the answer was given, (i.e., “In conclusion, I think Pony-boy is nice because…”) along with three choices.

Each display page had picture supports next to the choices and picture supports for key words such as sentence type and characters. If the student selected distractors, *GoBook* implemented error correction procedures, first informing the user that the selection was incorrect, then eliminating (graying out) the option. In addition, the fact question included a hint button located at the bottom of the screen. When students used this button, the screen went to the page of the story where the answer was located. The interventionist read this page aloud to the student, then went back to the fact question. Interactive drag and drop screens were placed in between each display question page, where students were to touch and move the sentences into the paragraph. After the interactive page came a completed paragraph with a task analysis chart showing sentence number and sentence type with check marks to indicate completion. The writing intervention took approximately 10 to 15 minutes to complete. See Table 2 for an overview of the intervention.

## Research Design

To pilot test and evaluate the efficacy of the writing intervention, the researchers used a preliminary concurrent multiple probe across participants single subject design (Horner & Baer, 1978). Baseline data

**Table 2.1**
***Writing Intervention***

| **Pre-Writing Activity Steps** | **Display Screen** | **Practice Utilized** |
|---|---|---|
| App reads story aloud to student, while student pushes arrow to advance pages | Chapter pairing of *Outsiders* adapted story | Read aloud |
| Paragraph vocabulary and instructional vocabulary | Four (4) vocabulary words students will see for choices (e.g. excited, horrible, disappointed, and unlucky)<br><br>Introduction, Opinion, Fact and Conclusion | Read aloud<br><br>Model, Lead, Test (My turn, our turn, your turn)<br><br>Student has read aloud |
| Paragraph structure | Introduction, Opinion, Fact, Supporting Fact, and Conclusion with Definitions | Read aloud |
| **Writing Activity Steps** | **Display Screen** | **Practice Utilized** |
| Introduction instruction | The introduction is the first sentence in your paragraph. In the introduction you tell who, or what, we are writing about. | Read aloud<br><br>Interventionist asks, “What is the first sentence?” |
| Introduction writing | What will you write about? A character and setting, a big idea, or a bird? | Time delay of 5s, error correction, least intrusive prompts |
| Introduction writing | Who/What do you want to write about? Ponyboy, Cherry, or George Washington? | Time delay of 5s, error correction |
| Drag and drop introduction blank | In this chapter, _______ is a main character. | Drag and drop with least intrusive prompts, time delay of 5s, read aloud sentence for review |
| Opinion instruction | In your second sentence, you will write your opinion. An opinion is a viewpoint. You share your thoughts, feelings, or beliefs about something or someone from the story. | Read aloud. Interventionist asks, “What is the second sentence?” |
| Opinion writing | What is your opinion of Ponyboy? I think Ponyboy is ______. Nice, trouble, or scientific | Time delay of 5s, error correction, least intrusive prompts |
| Drag and drop introduction and opinion sentences | Drag your introduction and opinion sentences into the box to start constructing your paragraph | Drag and drop with least intrusive prompts, time delay of 5s, read aloud sentence for review |

**Table 2.2**
***Writing Intervention***

| **Writing Activity Steps** | **Display Screen** | **Practice Utilized** |
|---|---|---|
| Sentence chart review | Now you have your first two sentences. Let's read your paragraph so far: In this chapter, Ponyboy is nice. I think he is nice because he looks out for his friends. Another reason… | Read aloud and review. Completed sentences and sentence types |
| Fact instruction | Next, you need to support your opinion with a fact from the story. A fact is a detail of piece of information found in the story. | Read aloud. Interventionist asks, "What is the third sentence?" |
| Fact writing | I think Ponyboy is nice because _______. He looks out for his friends, he snuck into the theater without paying, he likes to bake cakes. | Time delay of 5s, error correction, least intrusive prompts |
| Change opinion (only is wrong choice of opinion) | Sneaking in the theater without paying is <u>not</u> nice. Do you want to change your opinion of Ponyboy from "Ponyboy is nice" to "Ponyboy is trouble"?<br>Yes, I have changed my mind or No, I want to change my fact. | Student chooses. If selection to change opinion, go back to "What is your opinion of ____?" and repeat remaining options (only one time). If selects "No," allow to continue with writing paragraph. |
| Drag and drop fact sentence | Drag your fact sentence into the box to start constructing your paragraph. | Drag and drop with least intrusive prompts, time delay of 5s, read aloud sentence for review |
| Sentence chart review | Now you have your first three sentences. Let's read your paragraph so far: In this chapter, Ponyboy is a main character. I think Ponyboy is nice. I think he is nice because he looks out for his friends. Another reason… | Read aloud and review completed sentences and sentence types |
| Fact instruction | Remember, a fact is a detail, or piece of information from the story that supports your opinion. You wrote Ponyboy is nice. You need to find another fact to support your opinion. | Read aloud. Interventionist asks, "What sentence is next?" |

**Table 2.3**
***Writing Intervention***

| Writing Activity Steps | Display Screen | Practice Utilized |
|---|---|---|
| Fact writing | Choose another fact that supports your opinion that Ponyboy is nice. Another reason I think Ponyboy is nice is because ________. He made friends with the girls, he stayed out late, he has a bicycle | Time delay of 5 s, error correction, least intrusive prompts |
| Drag and drop fact sentence | Drag your fact sentence into the box to start constructing your paragraph. | Drag and drop with least intrusive prompts, time delay of 5 s, read aloud sentence for review |
| Sentence chart review | Now you have your first four sentences. Let's read your paragraph so far: In this chapter, Ponyboy is a main character. I think Ponyboy is nice. I think he is nice because he looks out for his friends. Another reason I think Ponyboy is nice is that he made friends with the girls. | Read aloud and review completed sentences and sentence types. |
| Conclusion instruction | The final step is to write the conclusion. The conclusion is where you summarize your paragraph. | Read aloud. Interventionist asks, "What is the last sentence?" |
| Conclusion writing | What is the last sentence you want to write about Ponyboy? I think it is good that ______. Ponyboy is nice, Johnny is Ponyboy' s friend, Ponyboy likes monkeys | Time delay of 5 s, error correction, least intrusive prompts |
| Sentence chart review | Well done! You have created a 5 sentence paragraph: In this chapter, Ponyboy is a main character. I think Ponyboy is nice. I think he is nice because he looks out for his friends. Another reason I think Ponyboy is nice is that he made friends with the girls. In conclusion, I think that it is good that Ponyboy is nice. | Read aloud and review completed sentences and sentence types |

were collected for a minimum of three sessions across participants. Once data were stable for the first participant, we introduced the intervention and collected data across the remaining story chapters. Once we observed a change in each participant, we introduced the intervention to the next participant and continued across the remaining chapters. We collected and graphed data on the percent of unprompted correct responses across baseline, intervention, and maintenance sessions.

**Dependent Variables and Data Collection**

The dependent variable was the percent of correct steps performed during students' opinion writing tasks. We scored steps as performed correctly if the student independently dragged a correct response in position to complete the sentence within 5 seconds. For topic and opinion statements, students were required to select one of two correct responses. For supporting facts and conclusion statements, students were required to select a single accurate response. During the baseline condition, the interventionist read each writing prompt and waited 5 seconds for a student response. A "+" was recorded for a correct response and a "–" was recorded for an incorrect or no response. During the intervention sessions, the interventionist scored the students' level of prompt needed to complete a response. An "I" was recorded for independent correct, "V" for verbal prompt, "M" for model prompt, and "P" for physical prompt.

To facilitate engagement during each session, the interventionist redirected the participant to look at the iPad and participate by turning the page. The level of engagement for each student was rated weekly using the following scale: 1) Does not participate at all (e.g., does not look at/in the direction of the iPad); 2) Passively participates (e.g., looks at the iPad or teacher as they respond, but makes no attempt to respond to teacher directions or iPad application directions without assistance); 3) Occasionally participates (e.g., looks at the iPad or teacher as they respond and makes attempts to respond to less than half of the questions asked); 4) Usually participates (e.g., looks at the iPad or teacher as they respond and makes attempts to respond to at least 50% of the questions asked); 5) Actively participates most of the time (e.g., looks at the iPad or teacher as they respond and makes attempts to respond to more than 75% of the questions asked); and 6) Actively participates all of the time (e.g., looks at the iPad or teacher as they respond and makes attempts to respond to all questions asked).

**Procedural fidelity and interobserver agreement (IOA).** A second observer scored 33% of the baseline and intervention sessions using an implementation fidelity checklist. We calculated procedural fidelity by dividing the number of steps delivered correctly by the total number of procedural steps and multiplied by 100. Procedural fidelity for baseline and intervention sessions was 98% (94%-100%). A third researcher collected IOA data on 66% of procedural fidelity observations. We calculated IOA by dividing the numbers of agreements by the number of agreements and disagreements and multiplying by 100. IOA was 92% (range of 85-100%).

We also calculated IOA on the number of correct student response data for 29% of the baseline and intervention sessions. IOA was calculated by taking the number of agreements divided by the number of agreements plus disagreements and multiplying by 100. IOA for baseline and intervention sessions was 94% (range of 91-100%).

**Social validity.** At the end of the study, the researcher collected social validity data on the purpose, process, and outcome of the study from the classroom teacher. The special education teacher completed a social validity questionnaire with 16 Likert scale items and several open-ended questions. Likert scale items included questions such as: "Was the application successful in engaging the student?" "Were the picture icons helpful?" "Were learning parts of the paragraph a valuable activity?" and "I noticed time on task increased for other classroom activities." Open-ended questions were in alignment with the Likert-scale questions to allow the teacher to expound on student observations. Teacher answers gave further insight to questions such as: "To what extent did your student show engagement?" "Were there too many or too few picture icons?" and "Do you like using your own system of least prompts and praise or would you prefer that to be built into the program?"

**Procedures**

**Baseline.** The interventionist and student sat side-by-side with the iPad placed between them. The students listened to a chapter pairing (in sequence) of the adapted text, *Outsiders* read by the *Access: Language Arts* app. After the read-aloud, the interventionist opened the writing activity in the *GoBook* app. *GoBoo*k presented the following series of spoken prompts: (a) What will you write about? (either a main character, big idea, or setting were presented as options); (b) Who/Where/What do you want to write about? (this varied depending on the topic chosen); (c) What is your opinion of _____? (filled in with specific who, what, or where identified from prior step); (d) Which fact supports your opinion? (e) Choose another fact that supports your opinion; and (f) What is your conclusion sentence? Three response options were presented with each prompt (e.g., I think Ponyboy was good because…. he was nice to Cherry; he was mean to Cherry; a bus). Between each of the above writing prompts, the student had an opportunity to drag and drop missing words from the sentence into the correct blanks. For example, the following sentence would appear "I think ______ was good because he was _____ to Cherry." and the student would have to drag and drop the missing words (Ponyboy; nice) into the correct blank space. Students were given 5 seconds to initiate a response for filling in the blanks. If the student responded correctly to a writing prompt, the interventionist scored a "+" on a data collection sheet. If the student selected an incorrect response or did not respond within 5 seconds, the interventionist scored a "-". Throughout baseline, prompting to promote a correct student response was not provided and reinforcement for a correct response or error correction for an incorrect response was not provided. Students were praised for attending behaviors throughout baseline.

**Intervention.** At the onset of each intervention session, the student listened to a reading of the targeted chapters from *Outsiders* in the *Access: Language Arts* app. Once the read-aloud was finished, the interventionist introduced the writing activity in the *GoBook* app. First, the interventionist presented five targeted vocabulary words associated with the opinion paragraphs (i.e., sentence, paragraph, fact, introduction, conclusion). *GoBook* presented each word and read each definition aloud. Second, the interventionist presented the five-sentence paragraph structure (i.e., introduction, opinion, fact, fact, conclusion) using *GoBook* and a model, lead, test procedure (Larkin, 2001). The interventionist modeled a five-sentence paragraph using a graphic organizer within the app. The interventionist presented the sentence description (i.e., "The introduction is the first sentence in your paragraph. The introduction tells who, or what we are writing about.") while touching the introduction button preprogrammed into the app. Then the interventionist and the student pressed the introduction button together. Finally, the student independently pressed the introduction button to state the rule. This instruction continued for the remaining parts of the paragraph. After instruction on the sentence type, the students applied their knowledge by creating their own five-sentence opinion paragraphs. *GoBook* presented the stimulus "What topic do you want to write about?" and presented three response options. If the student responded incorrectly, *GoBook* presented an error correction and an auditory prompt, "The (incorrect response) was not a part of our story." The app then repeated the step, but with the incorrect response option highlighted in gray and inactive. This process was repeated until the student selected the correct response or was left with a single correct response. If the student did not respond within 5 seconds, the interventionist implemented a system of least prompts procedure. First, the interventionist presented a verbal prompt and waited 5 seconds for the student to respond. If the student did not respond, the interventionist presented the next level of prompt in a predetermined hierarchy (i.e., verbal prompt, model prompt, physical prompt). After the student identified a topic, the next screen in the app presented an opportunity for the student to drag and drop their response to complete an introduction sentence (e.g., I want to write about ____________). Their newly created sentence was placed into a graphic organizer in the "intro sentence" spot as the first sentence. This same process continued until the student identified all sentences in the five-sentence opinion paragraph (i.e., their opinion, two supporting facts from the story, and a matching conclusion). Students were presented with the same chapter pair for three consecutive sessions, but had an opportunity to write about a new topic and opinion each time. Subsequently, we presented a single baseline probe on the next chapter pair before entering intervention with that chapter pair. We conducted these probes to assess whether students had generalized their paragraph writing skills to untrained chapter content. We collected maintenance data approximately two weeks after the students finished the intervention. Maintenance probes were conducted using procedures identical to those in baseline conditions.

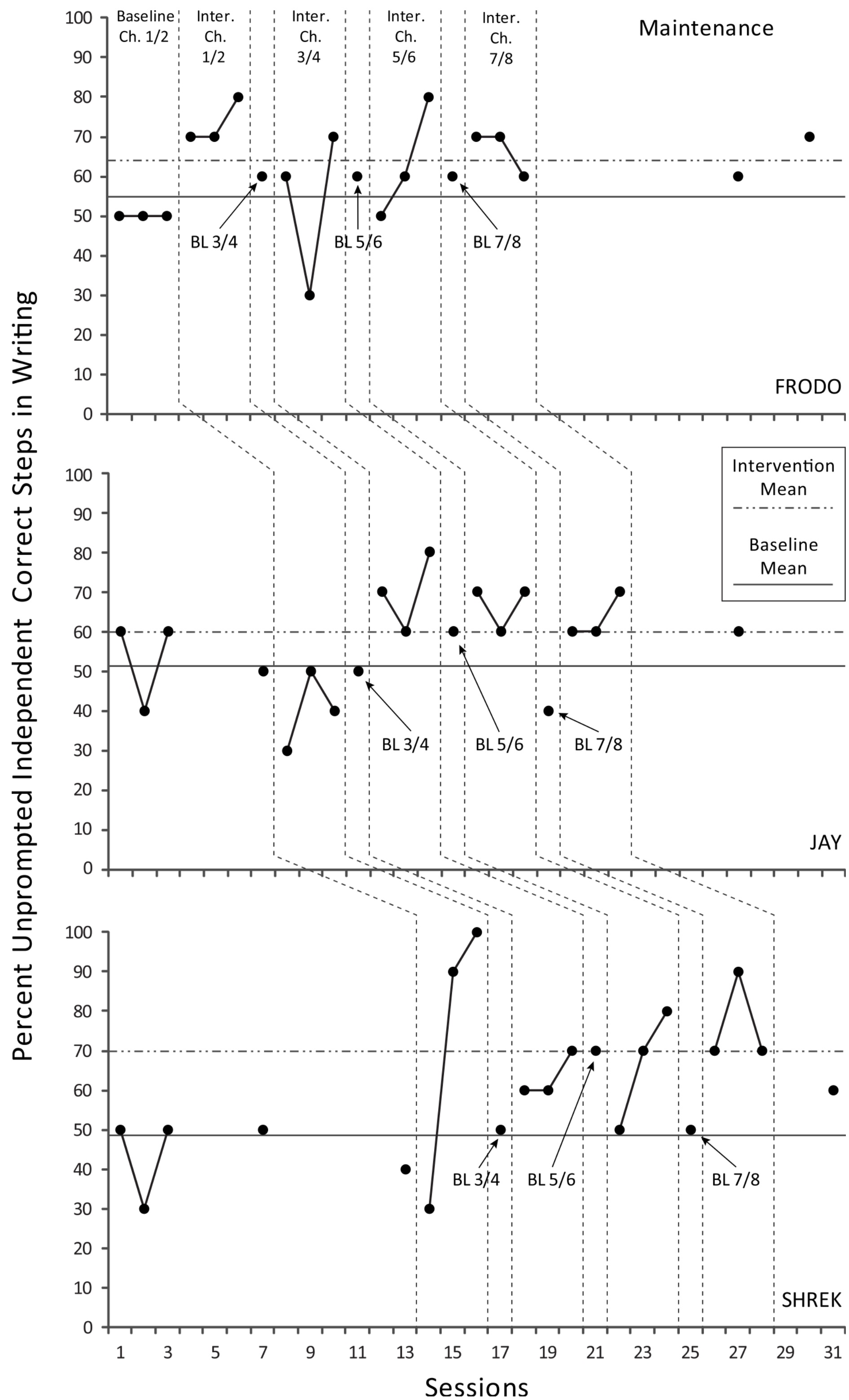
## Results

The percent of correct steps performed during students' opinion writing tasks during baseline and intervention sessions are depicted in Figure 1. Frodo's performance was stable during baseline sessions (i.e., 50% across all three probes). Following the introduction of intervention on Chapters 1 and 2, her performance improved to an average 73% of correct steps (i.e., 70, 70, 80%). Prior to intervention on Chapter 3 and 4, Frodo performed 60% of steps correctly. During intervention on Chapters 3 and 4, Frodo averaged correct performance of 53% of steps (i.e., 30, 60, 70). Prior to instruction, on Chapters 5 and 6, Frodo completed 60% of steps, whereas during instruction the average was 63% of completed steps (i.e., 50, 60, 80). Finally, prior to instruction in Chapters 7 and 8, Frodo completed 60% of steps. Following instruction, 67% of the steps (i.e., 60, 70, 70) were completed. At 4 and 5 weeks following intervention, Frodo completed 60% and 70% of steps, respectively. Overall, Frodo increased her mean performance from baseline to intervention conditions by 14% and regarding effect size, the percent of non-overlapping data (PND) were calculated at 86% (Scruggs & Mastropieri, 2001).

During baseline sessions, Jay completed an average of 52.5% of steps correctly (i.e., 60, 40, 60, 50). Following the introduction of intervention on Chapters 1 and 2, Jay averaged a 40% correct completion of steps (i.e., 30, 50, 40). Prior to intervention on Chapters 3 and 4, Jay completed 50% of steps correctly. During intervention on Chapters 3 and 4, Jay averaged correct completion of 70% of steps (i.e., 70, 60, 80). Prior to instruction, on Chapters 5 and 6, 60% of steps were completed correctly, whereas during instruction Jay completed an average of 73% of steps correctly (i.e., 70, 60, 70). Finally, prior to instruction in Chapters 7 and 8, Jay completed 40% of steps correctly. Following instruction, 63% of steps were completed correctly (i.e., 60, 60, 70). At 3 weeks following intervention, Jay completed 60% of steps correctly. Overall, Jay increased his mean performance from baseline to intervention conditions by 7.5% with a PND of 38%.

Shrek completed an average of 44% of steps correctly during baseline sessions (i.e., 50, 30, 50, 50, 40). During intervention on Chapters 1 and 2, Shrek averaged correct completion of 73% of steps (i.e., 30, 90, 100). Prior to intervention on Chapters 3 and 4, 50% of steps were completed correctly. During intervention on Chapters 3 and 4, Shrek averaged correct completion of 63% of steps (i.e., 60, 60, 70). Prior to instruction, on Chapters 5 and 6, 70% of steps were completed correctly, whereas during instruction an average of 67% of steps were completed correctly (i.e., 50, 70, 80). Finally, prior to instruction in Chapters 7 and 8, Shrek completed 50% of steps correctly. Following instruction, Shrek

**Figure 1**
***Percent of unprompted correct steps in opinion writing process across the chapter pairs of an adapted version of* Outsiders.**



completed 77% of steps (i.e., 70, 90, 70) correctly. At 2 weeks following intervention, Shrek completed 60% of steps correctly. Overall, Shrek increased his mean performance from baseline to intervention conditions by 23.5% with a PND of 85%.

**Social Validity**

Overall, the teacher reported favorable perceptions of the study components. On the Likert scale, the teacher scored five items as "strongly agree" including (a) the app was engaging to the students, (b) the read aloud of *Outsiders* was appropriate for the students, (c) the picture icons were helpful through the stories, (d) assessing the student's ability to correctly answer questions in a guided writing activity is valuable, and (e) the incorrect-answer pages (pages with corrective feedback) were useful in helping to re-direct students to make correct choices during their writing activity. The teacher scored 8 items as "agree." These items included (a) learning the parts of a paragraph was valuable for her students to learn about writing, (b) students showed an increase in vocabulary after the implementation of the intervention, (c) time-on-task increased after the app was introduced to the student, (d) the intervention was important and appropriate, (e) due to the app, her students had better access, (f) due to the app, she was more effective in teaching age/grade appropriate ELA curriculum, (g) the teacher was interested in continuing the use of the writing activity in her classroom, and (h) the hint feature was helpful to the students. The teacher scored one item as "neutral;" (i.e., the ELA app was more relevant than what was previously implemented for ELA instruction).

In addition, we asked the teacher to complete an open-ended survey related to the instructional package. Overall, the teacher's responses were positive. The teacher reported that students were increasingly more engaged as they became familiar with the app and activity. The teacher also suggested that the "right" number of picture supports were used in the read-aloud story and that she would prefer to continue using the app in the classroom. The teacher reported that the average lesson was an appropriate length (25-45 min). However, the teacher indicated the app might be more suited for a 1:1 instructional arrangement and suggested that "the paragraph definitions, paragraph structure, and story is a lot for more than one student to stay engaged in as a group." In addition, the teacher warned about careful selection of highly disparate distractors for future studies or implications for practice as she mentioned that some of these distractors were "fun responses and grabbed students' attention." The teacher offered several recommendations for the improvement of the writing intervention app including (a) incorporate more human-like voices, (b) embed additional positive feedback prompts within the program, (c) reduce the number of words per page, and (d) ensure that the distractor item did not include potentially reinforcing stimuli (i.e., food items).

**Engagement**

In addition to social validity, a weekly self-reported engagement rating was collected. While the engagement measure did not include a direct measure of daily baseline and intervention sessions, the interventionist self-reported high levels of engagement with an overall rating of 5.12 indicating that the students actively participated most of the time (e.g., looks at the iPad or teacher as they respond and makes attempts to respond to more than 75% of the questions asked). Frodo's and Shrek's average engagement scores were 4.75, (range=3–6) and 4.8 (range = 4-6), respectively. Jay showed very high engagement at 5.83, which indicated nearly 100% engagement through every session, with the exception of one session with a rating of 5.

**Outcomes and Benefits**

In the current investigation, the researchers demonstrated that students with moderate and severe intellectual disability could improve their skills in written expression, specifically opinion writing, when provided with appropriate assistive technology supports and explicit instruction. Participants used features of the *GoBook* app to circumvent challenges often consistent with moderate and severe intellectual disability to produce a permanent product detailing their opinion about an adapted and grade-aligned fictional novel. For example, *GoBook* permitted students with limited spelling repertoires and fine motor impairments to construct narratives by dragging whole words from a choice array to complete sentences. Furthermore, the *GoBook* package incorporated a range of supports for emerging readers including story narration, integrated vocabulary instruction, and hints for supported word selection. These factors may have contributed to the overall, interventionist reported, high levels of engagement by the students while using *GoBook*.

It is also important to note that *GoBook* incorporated research-based prompting procedures that minimized the need for an adult interaction during instruction. The use of increasingly autonomous instructional software is critical for students with moderate and severe intellectual disability as it may increase the time that students are able to work without adult assistance, perhaps promoting the view that persons with moderate and severe intellectual disability can be active participants in their own learning. In addition, this investigation targeted the selection and supporting of students' opinions. Though in the current study, opinions were directly linked to a specific and limited context, it is important to note the instruction of expressing an opinion is consistent with principles of promoting self-determination for persons with moderate and severe intellectual disability.

## Discussion

The purpose of this investigation was to evaluate the effectiveness of a technology-based instructional package on the writing skills of three participants with moderate and severe intellectual disability. Despite variability in performance across participants and instructional units (i.e., chapters), all participants improved their performance in writing tasks from baseline to intervention conditions and in a relatively short period of time. Furthermore, they maintained levels of responding above those during baseline conditions. These findings are promising in that they suggest that students with moderate and severe intellectual disability can benefit from TAI that simultaneously targets skills in reading and written expression. Interestingly, only Frodo demonstrated an improvement from pretreatment baseline probes to probes conducted prior to introducing a new chapter pairing. An increase in student performance on these chapter probes might suggest the generalization of writing skills to novel content. This lack of generalization across participants may have been a result of exposure to an insufficient number of exemplars (e.g. different reading passages) and/or the limited duration of the study.

The current intervention package reflects a departure from the extant literature on writing instruction for students with moderate and severe intellectual disability but is consistent with the development of written expression in general education settings whereby students continuously apply a range of writing skills across multiple areas of academic content. Students in the current study were taught a cluster of writing skills including vocabulary usage, sentence completion, paragraph organization, and opinion writing in the context of grade appropriate text. This complexity may have contributed to the limited improvement across participants while obscuring progress across skills independent of each other.

Furthermore, this investigation served to pilot a new software application for teaching writing skills to students with moderate and severe intellectual disability. Several applications have been developed for supporting students with disabilities during writing activities. The majority of these programs provide students with accommodations (e.g., text to speech) or modifications (e.g., word banks) during the production of text. Unfortunately, there are few programs that embed explicit writing instruction targeted for this population. The *GoBook* app provided controlled presentation of instructional stimuli, prompts, and feedback. These features are advantageous as they may result in fewer errors in instructional delivery and greater student independence from adult supervision during instruction.

Finally, the current study may serve to inform new innovations in the development of more comprehensive literacy software for students with moderate and severe intellectual disability. For example, teacher feedback and student performance indicate a need for the reduction of the amount of text displayed on each screen and an increased use of programmed positive feedback in order to encourage engagement. It is also important to note that the authors aligned instructional targets within the app to grade appropriate ELA standards. This feature may enhance the utility of the app, as teachers and peers without disabilities may find it easier to include students with moderate and severe intellectual disability in general education instruction. This alignment also poses new challenges for researchers and programmers in the development of TAI that is aligned from kindergarten to graduation.

Despite our overall positive findings, several limitations must be addressed. First, we conducted a single probe prior to the introduction of intervention for Jay and Shrek. Though these data were consistent with the patterns expressed in the first three baseline data points, it is plausible that these data may not have accurately reflected participants' steady level of responding. Second, we did not assess student's reading of the words and pictures used within the adapted text and app or the engagement with the underlined vocabulary words within the adapted text. Though all vocabulary was presented as text or pictures and in a digitized voice, variability in students reading repertoire may have impacted performance across chapters. Third, the amount of content (number of pages) programmed into the pilot *GoBook* app triggered instability, resulting in intermittent malfunctions in the software. These malfunctions required the student to wait while the program rebooted and potentially affected students' motivation and their success with the intervention during that session. Across at least five sessions, the program shut down and required the interventionist to reset the app and page through the app until the student was back to the location where they had been working. Fourth, it is valuable to note that two of three students demonstrated an effective intervention based on PND while the third demonstrated an ineffective intervention PND (Scruggs & Mastropieri, 2001). However, it is also noted that there are concerns over the use of PNDs to measure effect size in single subject design (Olive & Franco, 2008) and overall the third student did have a 7.5% change in mean from baseline to intervention. Therefore, the results of this pilot study serve as a first step in regard to available supports for opinion writing for students with moderate and severe intellectual disability. A fifth limitation was the use of a nonstandardized social validity measure. Although it is common in single subject research to use a researcher-created measure, a standardized measure would have been stronger. Finally, the small number of participants limit the generalizability of findings. In contrast to these limitations, when considered with the literature base on opinion writing for students with moderate and severe intellectual disability, the current study adds to the overall evidence for using this method with this population.

In summary, we evaluated the efficacy of an innovative TAI package for improving written expression for students with moderate and severe intellectual disability. The current body of literature in this area provides little guidance for teaching students with moderate and severe intellectual disability to perform complex writing tasks. Even less guidance is available on how to embed those tasks into ongoing academic instruction. We sought to address these issues by developing an intervention package aligned with grade-level skills, compatible with ongoing instruction in the general education curriculum. We feel this study serves as a pilot study that can be used to guide other work in this area. The development of written communication is critical to the success of all students and has vast implications across every aspect of one's life. Therefore, it is essential that researchers continue to investigate new and effective writing strategies that can be implemented in ways that reflect the ubiquitous nature of written expression in the natural world.

## Declarations

This content is solely the responsibility of the authors and does not necessarily represent the official views of ATIA. The authors disclosed financial relationships with the Department of Education, Institute of Education Sciences, and Attainment Company. No non-financial disclosures were reported by the authors of this paper.

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# Technology Benefits to Elderly with Infirmities in Functional Maintenance Programs

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### Abstract

We report an outcome study involving eight at-risk residents in long-term care facilities across four states. Residents were assessed in spoken and expressive language, memory, mental status, and mood before and after implementation of a Functional Maintenance Program that incorporated on-line interactive tools. Data analyses reveal small but meaningful improvements in expressive language and in memory, trending towards significance. They also show these non-robust participants' mean scores for mood and mental status remained stable. Findings are discussed in the context of stakeholders' considerations, including improving outcomes, conforming operations, securing revenues, and satisfying participants.

***Keywords:*** improved outcomes, on-line technologies, functional maintenance programs, long-term care

### Introduction

The United States has an aging population. Although life expectancy for U.S. citizens has grown steadily since the nation's founding, the rate of increase of adults over 65 – as a percentage of overall population – is currently at a record high, *circa* 0.3% per year. Moreover, it is projected to remain there for two decades. In consequence, older adults, who now comprise about 14% of the U.S. population overall, will, by 2040, grow to roughly 20% of the population, which itself will have increased by 19% in the interim (U.S. Census Bureau, 2014). In short, the United States of the future will contain record high numbers of elderly citizens.

As people age, vitality declines. Effects of decline may appear rapidly or slowly, evenly or unevenly, pathologically or naturally; but over time they are inevitable and ubiquitous, diminishing physical, cognitive, sensory, and other powers. The very range of problems often results in complex interactions between co-occurring health issues that can greatly complicate service delivery for positive outcomes (Kane et al., 2005). Effective maintenance of health in these circumstances assumes great importance (WHO, 2001; Haak, 2002; OHTA, 2008). For its geriatric citizens, the United States has a stake in identifying improved methods to exercise, maintain, strengthen, and even augment functional abilities across settings.

Arrangements to provide needed supports and interventions for elderly persons with infirmities lie at the heart of long-term care (LTC). The term 'long-term' reflects the fact that aging processes remain irreversible, and that provision of such care, once started, is likely to remain in force through end of life. The delivery of LTC is rationalized along a continuum. Where minimal assistance is required, *Home Health* delivers services in place to clients living in their own houses or apartments semi-independently. *Supported Living Communities* serve those who require more assistance, with recipients living in clustered home-like accommodations providing access to communal dining facilities, organized resident activities, and other beneficial services. *Skilled Nursing Facilities* (SNFs) are residential facilities serving those who require yet higher levels of daily assistance in common Activities of Daily Living (ADLs) such as transfer, bathing, dressing, grooming, and also Instrumental ADLs (I-ADLs), such as telephoning, doing laundry, and taking transport. Finally, *Hospice* provides all necessary end-of-life care for those with terminal conditions. Some people move systematically along this continuum, as health conditions change and support needs mount (Harris-Kojetin, Sengupta, Park-Lee et al., 2016).

Organizations that provide LTC may focus on a single tier along the continuum, or they may encompass multiple levels and be vertically integrated. In either scenario, they must focus on key business considerations, including securing revenues, conforming operations (e.g., assuring compliance, standardizing operations, etc.), improving health care outcomes, and strengthening satisfaction. All are important; but in practice, not equally. Revenues are foremost, as businesses must remain profitable to stay open; the other factors – improving outcomes, conforming operations, and increasing satisfaction – will be balanced in conjunction with their associated revenue considerations.

Technological innovations to improve delivery of services to elderly with infirmities and lower costs are in principle always of interest in LTC operations. In this paper, we report a study conducted by two companies – Hallmark Rehabilitation Services and Lingraphica® – that examined the effects of introducing on-line and technologically advanced interactive language exercise tools into existing operations that employ a *Functional Maintenance Program* (FMP) in LTC facilities.

## Target Audience and Relevance

This work is of relevance to individuals and institutions involved in geriatric healthcare, especially LTC facilities, associated reimbursement agencies, assistive technology providers, LTC residents' family members, other friends, and volunteers. The project was initiated with three related objectives: [i] to explore what is involved, practically, in introducing on-line, interactive speech and language exercises into ongoing LTC operations; [ii] to determine how the technology can enrich FMPs for non-robust residents within such facilities (Haynes & Wheeler, 2015a, b); and [iii] to identify the outcome benefits to stakeholders involved. In this project, *Hallmark Rehabilitation* serves as an example of a contract rehabilitation company that provides skilled personnel and services to SNFs; and *Lingraphica* serves as an example of companies that develop offerings for persons with cognitive and communication deficits (Lingraphica, 2016).

## Study Methods

### Design

The investigators designed a study that would engage staff, residents, and others in Skilled Nursing Facilities while minimizing disruption to on-going operations. Formally, it is an outcome study in which pre- and post-intervention data come from two complementary sources: (i) the National Outcomes Measurement System (NOMS), from the American Speech-Language-Hearing Association (ASHA, 2003); and (ii) Minimum Data Set measures (MDS), published in the Residential Assessment

Instrument (RAI, 2015a, b). By design, the study incorporated on-line, interactive language exercises into individualized FMPs. While the expertise of a credentialed clinician is required to set up FMPs, the following implementation may be handed off to care extenders such community volunteers, family members, or activities facilitators (ASHA, 2004). These latter generate either lower costs or no costs at all to LTC facilities, which makes this approach attractive to facilities from a revenue standpoint. In this study, duration of technology use by LTC residents was permitted to vary according to circumstances of facilities and participants.

**Participants**

The four participating SNFs – three in the Midwest and one in the West – were selected by this article's third author, Leland Wheeler, Director of Clinical Services at Hallmark Rehabilitation Services (Haynes & Wheeler, 2015a). At each facility, two residents were enrolled in the study, yielding a total sample size of 8. Local staff at each of the sites selected the participants, who were all non-robust. They were chosen on the basis of recent declines in scores on MDS appraisals, the presence of diagnostic risk factors such as cerebrovascular insult or progressive neurodegenerative conditions, and nursing referrals indicating intervention initiation. Those combined factors suggested these residents were at elevated risk for social and or communicative isolation absent intervention, such as an FMP. Such cases are challenging and usually involve complex interactions between cognitive, sensory, physical, and health management issues (Kane et al., 2005; Kociuba, Davidson, & Doninger, 2014). Table 1 gives detail on these subjects, locations, conditions, areas of particular concern, and length of participation in this study. Inspection shows they comprise a heterogeneous group with regard to diagnoses, deficits, issues, and goals.

**Interventions**

As Step 1, the clinical SLPs at the facilities used on-line therapy exercises that focused on four communication modalities – listening, speaking, reading, writing – to establish participants' baseline performance with these tools and materials. The program used was *TalkPath Therapy*, an offering that Lingraphica makes available to all, at no charge, as either an app downloaded onto an iPad, or as a web-based service accessed via a browser on a computer (TalkPath, 2016). The SLPs then initiated individualized treatment sessions with participants, with the dual goals of reducing communicative and

**Table 1**
***Participants***

| I.D. | State | Diagnosis | FMP Foci | FMP Wks |
|---|---|---|---|---|
| PD | KS | Dementia, depression | Functional expression | 13.0 |
| DR | KS | Dementia, depression | Auditory comprehension, verbal expression | 13.0 |
| RS | TX | Dementia, depression | Memory, comprehension | 12.0 |
| BH | TX | Hypertension, Intellectual disability | Naming, expression | [missing datum] |
| JD | CA | Dementia, altered mental status | Social communication, Problem-solving | 8.7 |
| LS | CA | Aphasia, chronic | Automatic speech, naming | 4.4 |
| DD | MO | Dementia, altered metal status | Problem solving, orientation | 13.0 |
| CW | MO | Altered mental status post-CVA | Orientation, reading, comprehension | 6.0 |
| | | | *Mean (SD)* | *10.0 (3.7)* |

cognitive deficits, while concurrently training participants in the use of the technology. Owing to the complex patient sample – many participants' diagnoses included dementia, past CVA, mental status change, depression and/or anxiety – individualized therapy goals were disparate. Foci included, for example, responsive naming, problem solving, memory, and reading comprehension.

When participants demonstrated adequate proficiency in using the technology, SLP activities moved to Step 2 – the transition to individualized FMPs for the eight participants, in accordance with ASHA-specified procedures for FMPs (ASHA, 2004). Once in place, FMPs may be carried out by care extenders such as family members, activity managers, or volunteers, after basic technology training. Importantly, there is no therapeutic dimension to an FMP. The core purpose is not to promote additional improvements over time, but rather to engage recipients in activities designed to help maintain mental sharpness and stave off functional declines that otherwise threaten to occur.

### Technology Training

Training took place on laptop computers. Each participant had his or her own account set up to access and use the language exercises, which could be adjusted by the supervising SLP clinician. The SLP, in turn, had a stimulus-response tool to use in therapy, a client management system, and data collection and reporting capabilities. The treating therapist used TalkPath Therapy tasks to establish a baseline in the areas of listening, speaking, reading, and writing, and concurrently to consider selection of tools, materials, and methods to be incorporated into the FMP that followed. The care extender could observe this initial treatment phase as well, to become familiarized with the program and consider its uses in the subsequent FMP implementation phase.

### Assessments

**Outcome measures.** Data for the Outcome Measures (OM) came from three domains of the Adult Functional Communication Measure in the ASHA NOMS, namely: (i) *Spoken Language Comprehension*; (ii) *Spoken Language Expression*; and (iii) *Memory*. Staff speech-language pathologists rated participants using the scale developed by ASHA, which assigns scores ranging from 0 (Most Impaired) to 7 (Normal Functioning). The initial ratings were done immediately before Step 1 of the TalkPath intervention, and the final ratings were done upon completion of activity in Step 2, the FMP program.

**Quality measures.** We employed two Quality Measure (QM) tools whose results are recorded quarterly in the MDS kept routinely on residents in LTC facilities throughout the United States, namely: (i) *Brief Interview for Mental Status* (*BIMS*); and (ii) *Residential Mood Interview* (*MOOD*). BIMS provides valuable data for monitoring residents' attention, orientation, and ability to register and recall new information. MOOD screens for symptoms of depression and generates a clinically useful severity score.

### Data Analysis

Raw scores were entered into Microsoft Excel v. 14.0.0 running on an Apple MacBook running Mac OS X ver. 10.6.8 for completing statistical calculations. To investigate changes over time, we calculated score means before and after intervention, and used parametric statistics to determine the existence, direction, and magnitude of differences for means at the two points in time, and to establish the statistical significance of those differences using matched t-tests (Hatch & Farhady, 1982; Frattali, 1998). These procedures were used to analyze all pre- and post-interventions data *(i.e., NOMS Expression, Comprehension, Memory, BIMS, MOOD*).

## Outcomes and Benefits

### From ASHA NOMS

Table 2 shows changes in NOMS outcome measures at the completion of FMP activity.

**Table 2**
***Changes following Period of Technological Intervention***

| **Item** | **N** | **Pre-(SD)** | **Post-(SD)** | **Δ** | ***p*** |
|---|---|---|---|---|---|
| Auditory Comprehension | 7 | 4.14 (0.69) | 4.43 (0.98) | +0.29 | 0.229 |
| Expression° | 7 | 3.43 (0.79) | 4.00 (1.53) | +0.57 | 0.086 |
| Memory° | 7 | 1.86 (1.07) | 2.43 (1.51) | +0.57 | 0.086 |

*°p < .10 (= trend towards statistical significance)*

All three NOMS items showed mean positive improvements following the intervention period of this study. The smallest change is in *comprehension*: on the seven-point scale employed by the NOMS, it showed a statistically non-significant outcome improvement of +0.29 points ($p$ = .229). Both pre- and post-comprehension scores registered at the NOMS rating level of 4 (4.14 –> 4.43), a level immediately below that of autonomous functional independence. Overall, spoken language comprehension must be considered effectively un-changed following intervention. The remaining 2 NOMS items – *expression* and *memory* – changed in more complex ways. Specifically: [i] both their means improved by +0.57 points; [ii] the decimal characteristics for both moved up to the next higher NOMS performance level (i.e. 3 –> 4 and 1 –> 2 respectively); and, [iii] both outcome improvements trended towards statistical significance ($p$ = .086). Given the quantitatively comparable and statistically significant NOMS *expression* improvement (Δ = +0.60, $p$ = .006) in an earlier outcome study that ran two weeks longer, enrolled one additional subject, and engaged SLPs rather than volunteers to work with subjects (Steele, Baird, McCall et al., 2014), one might imagine a larger sample size and/or longer intervention period producing improvements of statistical significance. Follow-on research should thus include attention to this issue, among others.

It is worth recalling here that this study's activities comprise two distinct, complementary phases: (i) an initial, relatively short phase of therapy conjoined with training on the technology; followed by (ii) the longer period of FMP activity, carried out by the care extender using the tools, materials, and methods that had be set in place for the purpose by the SLP before stepping back. Improvements documented here broadly parallel improvements found from previous comparable therapy research (Aftonomos, Steele, & Wertz, 1997; Aftonomos, Appelbaum, & Steele, 1999; Aftonomos, Appelbaum, Steele et al., 2001; Steele, Aftonomos, & Munk, 2003; Steele, Aftonomos, & Koul, 2010; Steele, Baird, McCall et al., 2014; Des Roches, Balachandran, Ascenso et al., 2015). It would be of value, in future research, to administer additional assessments, for instance, at the transition from Step 1 to Step 2, in order to characterize time courses of improvement vs. maintenance. Various longitudinal profiles are imaginable. The current study design did not generate the data that sheds light on this matter, but it is of potential importance and should be targeted in future research.

**From the Residential Assessment Instruments' Minimum Data Set**

**Mental status.** Figure 1 shows the Mental Status ratings of the 8 participants at the beginning and end of the calendar quarter containing most FMP activity.

In the mean*, overall BIMS scores* remained steady during this quarter. Although scores of 5 of the 8 participants went either up or down, the *mean score* at the end of that quarter, 6.63, was identical to the 6.63 mean score at the beginning of the quarter; and it places the participants in this study, generally, within the range of *severe cognitive impairment*. Indeed, visual inspection shows that 6 of the 8 participants received at least one rating of 7 or below, the boundary for severe cognitive impairment. This clearly was a group with challenging cognitive

**Figure 1**
***Mental Status, at Beginning & End of Quarter***

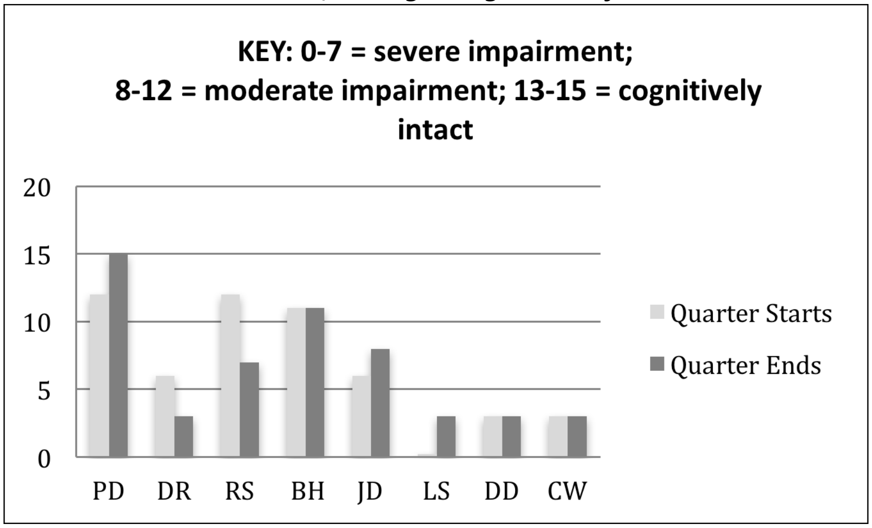
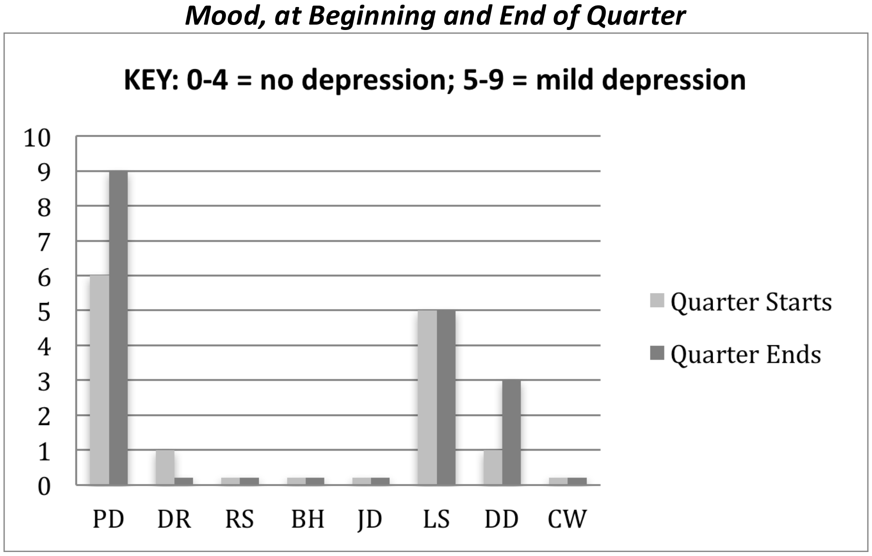



**Figure 2**
***Mood, at Beginning and End of Quarter***




issues; and some individual changes were striking. Participant PD improved from *moderate impairment* range to the *cognitively intact* range, and participant JD improved from *severe impairment* to *moderate impairment*; in contrast, participant RD declined cognitively from *moderate impairment* to *severe impairment*. The result was mean overall stability in BIMS scores in the presence of considerable individual variability. To understand how common a pattern this is, and its implications, future studies will be required.

**Mood.** Figure 2 shows the Mood ratings of the 8 participants at the beginning and the end of the quarter of most FMP activity.

*Mean overall MOOD scores* changed only slightly during the quarter during which the study activity took place. The mean score at the start of the quarter was 1.63, indicating minimal depression; by the end of the quarter, it had increased to 2.13, a non-significant change (*p* = 0.16) occurring about midway within the minimal depression range. This was a largely non-depressed group that stayed that way over the period of FMP activity. The largest movement was in participant PD, whose score rose from 6 – towards the low end of mild depression – to 9 – indicating the mild depression had intensified somewhat. Of note, PD was also the participant whose BIMS status moved to 'cognitively intact' by quarter's end; raising the possibility of her increased lucidity perhaps resulted in a greater awareness of her surroundings and circumstances, potentially causing the observed intensification within mild depression.

It should be noted that only long-term data collection and analysis will reveal the dominant patterns for MDS data that will ultimately be of interest to LTC facilities. These statistical MDS findings represent acceptance of the Null Hypothesis, i.e., that there is no significant difference between mean pre- and post- assessments. And indeed, MDS stability longitudinally will present precisely as periodically repeated absence of statistically significant differences. Only collection and analyses of data on larger scales and over longer periods will allow us to identify the profile properties of stability patterns, while flagging aberrant cases for closer scrutiny.

**Satisfaction Feedback**

Rather than develop a formal survey to probe participants' satisfaction for this initial study, the investigators drew on post-investigation observations from the third author, Leland Wheeler, who was Manager of Clinical Services at the participating sites. He retrospectively discussed what he heard from his subordinates on site during conduct of the study, and the full interview is available for audition online. We include quotes below from that source.

Leland reports that incorporation of the technology resulted in improved follow-through in the Functional Maintenance Programs, in part because the technology was found to be attractively simple to learn and easy to use. A key practical step was to designate an appropriate individual as 'champion' for the FMP at each site, who could come from disparate domains: at some facilities, restorative nursing staff supplied them; in others – activities staff; and in yet others – family members or speech pathology students. The important thing was that once the FMP had been set up with goals, procedures, and the customized technologies, any interested person could – following initial training – implement the program in practice. On rate of adoption, Leland says, "Once we established who these key players were going to be, the program really started to take a life of its own. We had a few patients really thrive with it just because of the encounters they were able to get one that skilled therapy had […] transitioned over […] to that repetitive stimulation program." On acceptance by clinicians: "They adapted to it very well, and were really asking 'Can I do this with more patients?'" And regarding adoption of the technology by all involved, "They really adapted to it extremely quickly. They liked that it was accessible, they liked that it was on different platforms, and … they had fun because it wasn't what they were used to doing" (Haynes & Wheeler, 2015c). While anecdotal, these comments do point to certain broad themes – empowerment of non-clinicians, convenience of program structuring, and enjoyment of novel interactions– that merit closer study in future research.

## Discussion

This study provides initial documentation that LTC residents of precarious health status can benefit in important ways from strategically integrated online interactive tools that exercise speech and language within a Functional Maintenance Program. The investigation was conducted in LTC settings in four states, following a design that accords with the clinical concerns, usual practices, operational constraints, and patient cohorts of such facilities in general. Study subjects were chosen locally, from among current SNF residents, and were selected on the basis of recent declines in health status, diagnoses that raised red flags, and rehabilitation nursing referrals. Of practical importance to hosting LTC facilities operationally, no alterations to staff, administrative workloads, or reimbursement procedures were required to conduct the work.

In this initial investigation of modest scope and brief duration, positive outcomes were documented in both the formally designated NOMS Outcome Measures (OM) of the study, as well as in the less tightly associated MDS Quality Measures (QM) for mental status and mood that are collected quarterly on all residents in such settings for Medicare reimbursement purposes. On the OMs, the LTC residents showed outcome improvements at the end of FMP activity with trends towards statistical significance in two of those three domains, namely, oral expression and memory. In each of these latter two, mean improvements were sufficient to advance the group as a whole to a qualitatively higher functioning level on final assessment: in spoken language expression, the group moved to the highest level just below independent functioning; and in memory, the group as a whole moved from being unable to recall anything to being able to recall personal information with requisite structuring and cueing. The third domain – auditory comprehension – was effectively unchanged. On the QMs, participants appeared to be essentially stable, with mental status showing no mean change whatever, and mood registering only a small mean decline that was without statistical significance. This relative QM stability, viewed in light of these participants' deficit etiologies and recent negative status changes, represents the desired finding. It suggests the intervention may contribute to QM status maintenance in such LTC residents.

Use of technological tools in a Functional Maintenance Program, then, appears to hold promise in the LTC domain. Such an approach represents an important opportunity for staff clinicians who have been providing clinically therapeutic interventions that are drawing to an end. Reimbursement for therapy is discontinued when client gains taper off, at which point SLPs benefit from having a transition option such as an FMP. The SLPs can be reimbursed for setting up the FMP, and the latter can then be handed off to less expensive care extenders – staff, family, or volunteers – for implementation. Once underway, SLPs' re-involvement is not required as long as recipients' functional levels are maintained. The care extenders benefit as well: family members or friends of LTC residents may be personally motivated to share time with the latter, and they crave tools that help them interact enjoyably and beneficially. LTC activity managers want activities that engage enthusiasms, promote social interactions, and help residents avert MDS declines. Community volunteers benefit from tools that are clear, easy and enjoyable to use, and engaging in content.

LTC facilities realize benefits as well. Their staff SLPs capture reimbursement for the skilled services of providing the technology training and associated therapy required to set up an FMP. Subsequently, facility economies are realized when the FMP activities carried out by care extenders who typically work for less or are volunteers. The ability of the treatment technologies to capture use data on servers for subsequent review extends available means of monitoring and managing compliance, and otherwise conforming operations. And the preliminary positive comments of participants reported above suggest user satisfaction levels that could support prolonged effective use. Consequently, means for enhancing revenues, conforming operations (e.g., documenting compliance), improving clinical outcomes, and leveraging user satisfaction have all been preliminarily probed in this initial study.

The study also suggests future work. We note, for instance, that participants' mean Memory scores improved despite the absence in this study of modules that target Memory explicitly: modules here addressed solely language modalities of listening, speaking, reading, and writing. This finding suggests potential additional benefit from the development and inclusion of materials explicitly designed to exercise and strengthen memory functioning.

Opportunities also exist to develop capabilities for tracking and reporting user engagement and success levels in reportable forms. Clinical supervisors within facilities, for example, in principle could review summary reports of who has been using which modules, for how long, with whom, and with what frequencies. In the same vein, summary reports of overall use patterns by facility types, by geographical region, by patient census variations, and the like could be valuable for officers at higher levels of responsibility within geographically distributed networks of facilities. Such capabilities can effectively be used to establish benchmarks, identify best practices, and support continuous quality improvement within such clinical operations.

The research here is preliminary, and conclusions will undoubtedly be subject to refinement after further research. The investigators acknowledge in particular the limitations associated with the study's small sample size. With few participants, intervention effects need to be both relatively large and relatively consistent to achieve statistical significance. This may well account for the finding of *trends* towards – without actual *achievement* of – statistical significance in two of the three outcomes measures (NOMS *expression* and *memory*). Future research should involve larger sample sizes to establish – with greater certainty – the loci, the magnitudes, and the likelihoods of therapeutic benefits to those who participate in this approach.

Outcome studies also have intrinsic limitations that require mention. For one thing, they do not permit the attribution of causality. This is because they do not contain a control group against which to compare change magnitudes and directions. Causality attribution requires a different design, that of a scientifically controlled prospective experimental study. To understand the specific contribution of the interactive technologies to the outcomes documented here, then, would require such a follow-on controlled study. For another thing, outcome studies conducted within ongoing clinical operations will invariably reflect some sort of sample bias. This is because the study participants will not represent a randomized sample of people in LTC settings, but rather, some specifically selected group – here, for instance, those LTC residents who were identified as vulnerable to declines in QM measures, yet who were willing to participate in the initiative. Again, the work points directions for further targeted research.

Preliminary as it is, this study nonetheless demonstrates the feasibility and acceptability of the approach generally. Participants in LTC facilities broadly embraced the technology, which was found to be both usable and enjoyable. Its introduction did not turn out to be problematic or burdensome. Its use engaged the attention and enthusiasm of participants in ways that promoted the FMP's effectiveness. Participating residents in the facilities arguably benefited from the experience in important ways. Such findings provide the encouragement for follow-on research, development, and program elaboration.

To conclude, with a growing segment of the American population moving into old age, and projections of record numbers of elderly citizens in two decades, it is important to prepare adequately to meet the challenges they will pose. Not all seniors will move into LTC settings, but many will. Improving LTC operations to yield more coherent and effective service delivery, improved outcomes, higher satisfaction levels, and lowered costs is imperative. Properly developed and utilized technology appears to be well positioned to contribute in important ways to achieving those results.

## Declarations

This content is solely the responsibility of the authors and does not necessarily represent the official views of ATIA. The authors disclosed financial relationships with Lingraphica and Hallmark Rehabilitation Services. No non-financial disclosures were reported by the authors of this paper.

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# Communication and Developing Relationships for People Who Use Augmentative and Alternative Communication

Chris Klein
*BeCome AAC*

**Abstract**

Building meaningful relationships is one of the most important things a person can do in his or her lifetime. It also is one of the most difficult things a person can do. Communication is a necessity to build relationships, so a person with a communication disability has a very difficult time building relationships. There are various publications that are calling for relationship building in the field of augmentative and alternative communication (AAC). As a person who has used AAC for over 36 years, I have experienced this first hand and feel this is a discussion that gets forgotten about all too often. It also is a discussion led by clinicians, professors, and manufacturers. This is why I feel it is important to give my perspective on this topic.

***Keywords:*** consumer perspective, AAC, communication, building relationships

## Introduction

Today in augmentative and alternative communication (AAC), we see folks with a wide range of communication disabilities. Some, like me, mostly have physical limitations. Many have cognitive issues as well. People with autistic spectrum disorders may not understand that interpersonal communication can be one of the most enriching aspects of life. Nevertheless, many people that use AAC are not different from the rest of society. They want to build and maintain relationships. However, lack of communication often times becomes a major barrier to building relationships. We are living in a fast-paced society where people seem to have little time to stop and have a genuine conversation. These conversations still happen on occasion, but it takes effort to get people to stop and truly engage in a conversation. I have seen people say hello to somebody and walk away before even getting a response from the person they just said hello to. People seem to want the person to respond that instant, so that they can go on their way. This is why often times people with communication disabilities have a difficult time getting into a conversation. When a person can't effectively communicate, he or she has limited opportunities to interact with others.

## Differing Communication Goals

Participation in school often becomes the focus of the teacher, family, and speech-language pathologist. Participation in class by answering specific questions like “What do we call the process of cell division?” (Mitosis) can be part of academic life for an augmented communicator. However, answering such questions regularly puts a burden on teachers, therapists, and family members to supply such "homework words" on a weekly or even daily basis. Such activity also tends to replace learning how to communicate as an interesting person with one's classmates, family, and friends.

In my experience, social isolation is a common factor for people who use augmentative and alternative communication. People who use AAC tend to have limited access to common, everyday language, which prevents them from building relationships. It isn't enough to give a person an AAC device if it is pre-programmed with phrases and sentences. As I have discussed among my peers, we want to have the ability to say anything we want to say as quickly as possible. When we are able to share anything, we are able to share the intimate struggles that are going on in our lives. Sharing these struggles and consoling one another is how long lasting relationships are built. This is why it is so important an AAC device gives them the proper access to everyday language. People who use AAC need access to at least 150 core words, so that they can start to learn how to develop sentences.

A primary responsibility of a speech-language pathologist working with a person with a communication disability is to advocate for and promote the use of AAC systems that allow the person to communicate to their best of their abilities. However, the question then becomes, "Where do we go from here?" We have so many different influences that decide this direction that we lose sight of what is important to the person who is going to be using the AAC device.

This is where the influences or decisions become the dictator. They become the end goal and all of a sudden communication becomes something different. It doesn't become about his or her language abilities; it becomes about meeting the educational standards or simply using important features of the device.

But, are we expecting people with communication disabilities to grow their language skills? Are we expecting them to be able to build relationships? Parents, teachers, and speech-language pathologists are faced with these two questions. However, the educational standards usually take precedence over any other skills. By doing this, we aren't giving the student the tools to communicate effectively enough to build on their language skills.

I acknowledge some people with a complex communication disability have a language barrier that also hampers their language development. This can make assessing their language skills very difficult. However, if a speech-language pathologist doesn't give them access to everyday language on their device, assessing their language skill is more difficult.

I am speaking from personal experience because I was born with cerebral palsy and I have a complex communication disability. I remember how frustrating it was trying to express myself without being able to just say the words I wanted to say. I felt like I was trapped inside myself, and this feeling is overwhelming. I understood everything that was happening around me, but I couldn't show anybody because I didn't have access to everyday language.

## Framework for Considering Goals and Improving Communication

The question becomes "What are the tools of communication?" Janice Light defines adequacy of communication as an adequate level of communication skill to function within a certain environment. She states it does not imply a total mastery of the art of communication (Light, 1989). I believe this is a good definition of adequate communication. Light gives us four competencies underlying this definition of adequate communication. These four competencies are linguistic, operational, social, and strategic. She breaks down these into two sections. The first section is labeled as the knowledge and skill in tool use, which includes the linguistic and operational competencies. The second section is labeled by Light as the functional knowledge and judgment in interaction, which includes the social and strategic components. Let's take a look at each of these competencies.

**Linguistic Competence**

The linguistic competency, in my opinion as an AAC user, is crucial in developing progress in communication. If you don't have simultaneous access to a broad range of core words, you aren't going to be able to communicate effectively or develop adequate language. One of the most important things to a person who uses AAC is to communicate to the best of their abilities. We need this linguistic component to be there on whatever device he or she decides to use.

Janice Light breaks the linguistic component down into two sections. A person with AAC has to have mastery of their native language. A person using AAC also has to develop a way to progress through the linguistic code found in his or her AAC device. The central tool in achieving these four competencies, for the AAC user, is automatic processing in the micro-skills (reading, writing, listening, and speaking) of language mastery. Mastering language can be viewed as automatic processing concerning what you want to say, having motor plans well mapped out for accessing your communication aid, and strong familiarity with core vocabulary, core syntax, core morphology, and core pragmatics. In practice, mastery of these skills can translate into an increased rate of communication, which is critical to successful communication and relationship building.

Communication rate became an important aspect of my life at a very young age. It was frustrating for me trying to play a guessing game with my family. Every time I wanted or needed something, the guessing game began. At times, I became so frustrated that I would curl up in a ball and cry. Nobody could understand me, even after I tried to point and gesture to the object that I wanted or needed. For myself, it was very frustrating, yet it was even more frustrating for my communication partner. They didn't know what I needed or wanted, so they were equally as frustrated. This is where my speech-language pathologist gave us a picture board to solve the problem of communication. It had pictures of the bathroom, a mom, a dad, a way to say I love you, I want a drink, and those types of things. It did solve a little of the frustration, but I was a child who wanted to say more than that. I had other things that I wanted to say and I couldn't do it with a picture board.

Communication with a picture board and gestures wasn't enough for me, but how would they ever know that. I couldn't exactly tell them what was happening in my mind, so I tried to communicate with what I had and what I knew. It was at six years old that I received my first augmentative communication device. It was a word-based system, which had four levels of words on it. Also, on the fourth level of it, it had three rows of phonetic letters. You could sound out any word that you wanted to say. The system here allowed me to say anything that I wanted to say.

**Operational Competence**

I was sent home with that device on a Friday, and by Friday night, I was already talking in complete sentences with it. My speech-language pathologist gave me words for the first time in my life, and I could finally tell my older brothers and sisters to leave me alone. I could say what I wanted to say for the first time in my life, and that is why I used it quickly.

Communication devices have been known to use pre-programmed sentences and words that are nouns more. In my experience, many people believe people who use AAC need to answer a question in class, order food, tell somebody what they need, and those types of things. I don't believe they are looking at the bigger picture. A communication device has the opportunity to give a person a chance to develop language skills. By being able to develop language skills, it gives the person a chance to build relationships. In order for that communication device to do that, it has to give the person the chance to say anything he wants to say.

The idea of a communication device is to have conversations with people. In order to have conversations with people, the person needs access to everyday language on his or her device. This allows the person to learn language, while the person is learning how to communicate. It allows the person to go through the stages of language development, which allows them to build upon their vocabulary. Yet, the most important aspect is it allows the person to build and develop the long lasting relationships that we all desire.

The device that my speech-language pathologist gave me had everyday language on it. I was able to say anything that I wanted to say. I could tell my brothers and sisters to leave me alone for the first time. My teachers were able to see me build sentences, which showed them that they weren't challenging me enough. They were able to correct my grammar and syntax, which allowed me to grow in my language skills.

This helped everybody to assess my language skills. I was put in special education, but once I was able to express myself properly, they were able to see that I needed to be challenged. I was put in the regular classroom starting in third grade.

The teachers taught me like all of their other students, giving me a chance to answer their descriptive questions about a subject. We had a word of the day contest, which we would have to define. Whoever defined it correctly first received a prize for that day. This was to help build onto our ever-expanding vocabulary, but also help us build our language skills by having us describe the word, instead of just naming it. This was the key to my success because if I didn't have the same opportunities to learn, I was going to be far behind my classmates.

I don't remember ever programming homework words into my device. My teachers asked me descriptive questions, such as "What is Photosynthesis?" I was able to answer, "It is the process of how plants use the sun and light to make food." I was learning about what photosynthesis was, but I learned how to describe it with everyday language.

It is important to build onto a person's vocabulary with these educational vocabulary words. However, we don't have to program these words into their device. A person can describe these words by using everyday language. This is better for him or her because the parent, teacher, or student aide can correct syntax and grammar. This is how the person is going to build on his or her language skills and thus, become a more effective and efficient communicator.

**Social Competence**

While the educational side of things is important to concentrate on, the social aspect of life is just as important. If you think about it, we are designed to be social. It is in our nature, so it is just as important we give people with complex communication disabilities the same opportunities.

People who use AAC often don't get to interact socially, so using an AAC device feels like homework to many of them. This is why it is so important we give people with AAC an opportunity to interact socially. If we are going to have success with people who use AAC, we need to create opportunities for them to interact with people without making it seem like work.

It begins with the family unit. This is where we get a lot of our interaction, so we need to have activities set up so that the person who uses AAC is included in the activities. These social interactions will develop their language skills because it will help develop what they have been learning to do in school and therapy. The family unit can help correct syntax and grammar, all while having fun together. It is going to help them get mastery of everyday vocabulary.

This also is where a person learns social skills. A person needs to be able to learn how to listen, take turns, and reply properly within a social setting.

They can have achieved all of the linguistic and operational components, but if a person with a complex communication disability can't use them in a social setting, the communication goal won't be achieved (Light & McNaughton, 2014). If you are socially isolated, you aren't going to learn how to use these vital tools. It isn't only language that builds relationships; it's learning how to properly interact with others and respond appropriately. The family unit is a great place to start learning about these social skills.

**Strategic Competence**

The strategic competence involves the use of AAC devices throughout a variety of settings and for a range of purposes. Light has expanded the definition of adequacy of communication to include motivation of the person, attitude of a person and his or her support team, confidence of a person, and the resilience of a person (Light & McNaughton, 2014). If an individual isn't motivated to communicate, it isn't going to happen. If the family, teachers, and other professionals aren't willing to embrace AAC, the individual isn't going to want to use it for communication. Failure to be supportive and create motivation will affect their confidence and resilience to use AAC. This is logical, and yet we're still wondering how to get individuals to embrace AAC and become efficient communicators.

My family embraced my communication device, so we came up with our own games to play with it. We played a lot of Uno, Monopoly, and other board games. I had to say things like pick up that card, or move my guy over there, and so on. However, I learned how to talk during games too. I learned how to take turns, listen to them, ask questions, and even trash talk during the game we were playing.

I had a one-on-one aide through lunch for third and fourth grade. My one-on-one aide would write all of my tests, and also help me with the personal care stuff. After lunch, students would help me complete the rest of the day's schoolwork. They would take turns helping me, which made them more comfortable interacting with me. These interactions soon developed into friendships. I would have friends of mine volunteering to do recess with me, which was either playing a game inside the classroom or playing soccer on another area of the school's playground. These social interactions were so important to my development that we fought to keep me in the same school district for my middle school years. I believe without this social interaction in these early years, I wouldn't have been as equipped as I was when I went to college. I believe my social development started this early, which we need to recognize, too!

While language skills are taught and learned at the educational level, they are mostly learned when we play and are social with our peers. It is difficult learning language without a communication disability. It is even more difficult when you are learning how to use an AAC device as well. This is why we need to incorporate social activities when a person is learning how to use an AAC device.

This is why I am encouraging clinicians to make learning AAC less about work, and more about fun. Learning language skills isn't supposed to be easy, but it also isn't supposed to be a grind. You're supposed to have fun as you are developing language, and in my experience this fun part is getting left out.

**New Opportunities for AAC Users**

The implication of social media has changed the landscape of options of socialization for people with complex communication disabilities. In order to use social media effectively, an individual needs to have advanced use of functional linguistic skills, as well as advanced use of operational skills (Light, McNaughton, 2014). Social media can be a great tool for somebody using AAC, but they need to know how to read and they need to know how to gather and post meaningful pictures.

In some ways, social media has taken down the social barriers for a person who uses AAC. They can interact with people on Facebook, Twitter, Instagram, etc. without having the stigma of having their communication partner waiting for the response. Social media does have some advantages and I would argue that social media is a great way to keep in touch with people you already have relationships with, but it isn't a place to build long lasting relationships. In my experience, long lasting relationships are built with face-to-face conversations. This is where an individual learns those sociolinguistic skills that are needed to build those long-lasting relationships.

As I have traveled around to different places, events, and conferences, I have noticed that many professionals working in AAC are focusing on meeting the educational standards. It's the logical thing to work on and I would say it is the easiest thing to work on. However, teaching people how to communicate socially has been overlooked. We don't know how to teach this and thus we work on the things that we know how to do best. However, by doing that, we are limiting the person. The goal of AAC should be to say anything that you want to say. It isn't about telling a person what you need and/or want. It's about becoming an effective communicator, so you can build relationships. Building relationships helps you to network, which helps you become anything that you want to become.

This is why we need to change our approach regarding AAC. We need to make it more socially oriented because that is how most people learn to build on their language skills. There is one activity that I wish I would have had myself growing up. I wish I would have had a mentor to talk with and to ask questions to. I believe a mentor and mentee relationship would be beneficial to everybody involved. It would give the mentee an opportunity to ask questions to somebody that has been there already. This would be an important connection because the mentor could help the mentee with different types of issues. Plus, the mentor could help guide them through different scenarios they are going to go through. This is why I have started a mentor program.

**BeCOME: AAC- Building Connections with Others through Mentoring & Education about AAC**

BeCOME: AAC is committed to assisting persons with speech disabilities to live in fulfilling ways. We believe that the cornerstone to a full life is derived from the ability (1) to participate in meaningful relationships with others and (2) engage in everyday social interactions as a fully ratified participant. In order to address this primary objective, BeCOME: AAC is focused on providing tools and services to people who use AAC in order to enable and enhance communication leading to social integration and community building. Specifically, BeCOME: AAC will develop and distribute educational materials, facilitate mentoring relationships, and provide resources to support life transitions for people who use AAC, all with the specific purpose of relationship and community building.

BeCOME: AAC wants to help every community develop a social group that would get together and do fun activities together on a weekly or monthly basis. These activities would be social activities, which would allow people who use AAC the opportunity to interact with other people. We want to have activities that allow the person not only to be social, but also help them give something back to the community.

**Mentors**

This is where BeCOME: AAC feels having a mentor who uses AAC is very helpful. Our goal is to match up people who are successful using AAC with beginners using AAC, so that they can have a mentor who knows what they are going through. The mentor can help the person learn how to take turns, listen, etc. These are all important skills to learn, and these skills can be learned in the context of a social interactive activity.

Mentors set up a time to meet with their mentee one-to-one. This is where they can work on actively listening to each other and taking turns responding to each other. Children and adults who are first learning how to use an AAC device don't have many opportunities to get into a one on one conversation. When this doesn't happen, they have a difficult time learning how to take turns listening, and taking turns responding to one another. In this setting, the mentor and mentee can talk about something that interests the mentee, which is going to help them learn how to take turns. As this is happening, they are still developing their language skills while being more motivated to talk. This begins to help develop their confidence, which will make them more resilient.

**Group Activities**

A mentor also could set up a group activity. This activity should make the group be social, so that they have to interact with one another. As this activity is going on, each mentor can observe a mentee interacting with other people. The mentor can work on social interactions within the group setting.

One activity could be having a group of people go to an animal shelter, and help the shelter by interacting with the puppies and kittens. As they are learning to play with the puppies, telling them to sit down, come here, lie down, stop it, etc., they are doing it in a social setting. They would have to work as a team, which would make them socialize with each other, as they are helping train the puppies. This would allow the group of people to interact with one another, but also it would give them a sense of purpose. They would be helping the community out by coming and giving an hour to play with animals.

It is a great thing to have a buddy to communicate with. Actually, sometimes a buddy can get more out of the person, so this is an activity that is very useful. This will help promote language, which will help her or him develop more tools for life.

You can organize a support group. You can bring together a bunch of people who use AAC, so that they can support one another. This would be another way to do a group activity together. The group can pick an activity they would like to do together, and go do it. They could practice using their core vocabulary together, which would help them enhance their language skills.

**Setting the Stage for Future Opportunities**

These relationships that are being developed are so important, not only for their language skills, but also for their life and leadership skills. Networking is a vital aspect in getting employment and being put into a leadership role. Without the ability to network, a person will have a difficult time finding a role in leadership. This is why building relationships with co-workers and committee members is so vital. They need to have those connections because without them it is going to be difficult for them to learn how to be a leader. It is going to be difficult for them to find a leadership role without a relationship with a committee member or somebody already in a leadership role.

In my experience, leadership skills are hard to achieve for many augmentative communicators in general. Everything that has been discussed up to this point would be very helpful in developing leadership skills. It would be an appropriate task for a camp or a support group to appoint officers of the group. Each officer would have the opportunity to plan an activity for the group, which would be voted on by everybody in the group. It would give everybody a taste of what it is like to be a leader, which would help them develop another skill.

The fact is we need more people who use AAC to become leaders. I don't believe our voice is heard enough, so we need to rectify that problem. Manufacturers, speech-language pathologists, and others in this industry need to understand what we desire. The thing that some AAC users, such as myself, desire the most is the ability to access common everyday language, so that we can develop other skills. By giving us the opportunity to develop our automaticity using core vocabulary, automaticity in using core syntax, automaticity in core morphology, and automaticity in core pragmatics, you are giving us a chance to contribute to society.

All these activities are great to promote and I believe every activity will help the individual develop language, which would lead to developing leadership skills and building relationships. The goal in doing this is to stop the social isolation many people with AAC experience. Everybody needs to feel like they are a part of something, especially a part of a community. People who use AAC are needing and wanting that as well.

It starts by giving them access to everyday language. When they have access to everyday language, they can learn how to build sentences. Those sentences can lead into developing relationships. When a person can build relationships, they can accomplish any goal they set.

## Declarations

This content is solely the responsibility of the author and does not necessarily represent the official views of ATIA. No financial relationships were disclosed by the author of this paper. The author disclosed a non-financial relationship with USAAC.

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# Use of Mobile Technology by Adults Who Use Augmentative and Alternative Communication: Voices from Two Countries

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**Abstract**

Mobile technology – cell phones, smartphones and tablets – has expanded communication and social interaction, commerce, and access to information for many people with disabilities. Little is known about the use of these mainstream technologies by adults who use augmentative and alternative communication (AAC). Information comparing their use by adults who rely on AAC from both high-income and low or middle-income countries is nonexistent. This article presents data on the use of mobile technology by 38 adults from the United States and 30 adults from South Africa who use AAC. Results, focusing on outcomes and benefits, indicate that most of the participants from both countries use some form of mainstream mobile technology. Most report that their mobile devices are important, but some find it difficult to use requiring a variety of modifications. More than 50% of participants from each country used their mobile devices for text-messaging, web browsing, keeping a directory of contacts, voice calling, sharing photos or videos online, listening to music, and social networking. Recommendations are made for industry and people who rely on AAC.

***Keywords:*** augmentative and alternative communication, AAC, cell phones, mobile technology

## Introduction

Use of mobile technology – cell phones, smartphones and tablets – has grown dramatically. By the turn of this century, cell phone use had reached a majority of the population in Canada, the United States, Australia, Germany, Singapore, the United Kingdom, and Italy (Bryen & Moolman, 2015). Although Africa had only 15 million cell phone users at the turn of the century, this grew to 387.7 million in 2011, becoming the second largest mobile phone market in the world after Asia (Dlamini Zuma, 2014).

According to the Pew Research Center (2015), cell phones (portable telephones that use cellular technology) are as common in the United States (a high-income country) as they are in South Africa (a low- and middle-income country). Smartphones (cell phones that run complete operating systems and that can access the Internet and applications ("apps") with features such as calendars, media players, GPS navigation, and web browsing) are not as widely used due to cost, but are rapidly gaining popularity (Bryen & Moolman, 2015). Slightly more than 34% of South Africans own smartphones compared to 64% in the United States (Pew Research Center, 2015).

Cell phones and, more recently, smartphones and tablets have become increasingly ubiquitous because they are portable and make personal or work-related communication possible from almost anywhere (Stock, Davies, Wehmeyer, & Palmer, 2008). Access to mobile technology, a subset of the larger information and communication technology (ICT), has expanded communication, social interaction, and commerce, and has improved access to information via the Internet. Furthermore, mobile technology is not dependent on costly infrastructures required for the use of landline telephones and desktop computers where penetration in sub-Saharan Africa is close to zero (Pew Research Center, 2015).

## Mobile Technology and People with Disabilities

The potential of mobile technology to improve the lives of people with disabilities remains largely untapped (Scope, 2013). According to the Center for an Accessible Society (2014), mobile technology has potential to substantially broaden the lives and increase the independence of people with disabilities. Increasingly, they can now log in and order groceries, shop and pay for appliances, research health questions, participate in online discussions, navigate cities, travel and catch up with friends, or make new ones at any time and from anywhere.

Internationally, the importance of mobile technology in equalizing opportunities for people with disabilities has been reinforced by the United Nations Convention on the Rights of Persons with Disabilities (CRPD). Article 9 of the CRPD notes that information and communication technologies, including mobile technology, enable people with disabilities to live more independently and participate more fully in all aspects of life (United Nations, 2006). Despite these benefits, people with disabilities still have more limited access to mobile technology than their non-disabled peers with only 35% of persons with disabilities in North America having access to these technologies compared to 75% of people without disabilities (Duchastel de Montrouge, 2014).

## Mobile Technology for People Who Rely on Augmentative and Alternative Communication

The CRPD recognized the importance of mobile technology for the approximately 1 billion individuals with disabilities worldwide, including those with complex communication needs who require augmentative and alternative communication (AAC) approaches. Nguyen, Garrett, Downing, Walker, and Hobbs (2008) demonstrated that when mobile phones were interconnected with the individual's AAC device, they were able to effectively use the phone in its many modes of operation, resulting in a greater sense of independence, safety, and security. The use of mobile phones also contributed to improving their communication skills, resulting in greater self-confidence in conversation and social interactions.

Smartphones and tablets are increasingly used to mediate other areas of social interaction beyond interpersonal communication. Shane, Blackstone, Vanderheiden, Williams, and DeRuyter (2012) noted that modern consumer technology is used for searching for information, online services such as banking, entertainment (books, news, video), education, health and safety, personal organization tools such as address book, calendar, clock, and customer services like airport check-in. Smartphones, consequently, offer great opportunity for people who use AAC to access the world, while simultaneously creating challenges to ensure that AAC users are not left behind as mobile technology advances. Finally, mainstream mobile devices are more stylish, which has resulted in them becoming fashion accessories compared to AAC devices, which lack the "cool factor" and often look as if they were designed for children or carry other markers that signify disability in some way (Foley & Ferri, 2012).

Despite the potential benefits of mobile technology, little information has been available on the actual use of these technologies by adults with complex communication needs who use AAC, how they select and adapt them, and their experiences using them. Early research found that adults who rely on AAC had limited access to cell phones (Bryen, Carey, & Potts, 2006). A gap was reported in cell phone use (20% for their sample of adults who use AAC compared to 57% for the non-disabled US sample). Later research by the Rehabilitation Engineering Research Center on Wireless Technology (Wireless RERC, 2014) found that adults who relied on AAC used mobile devices at substantially lower rates than their peers from other disability groups, such as those who have visual or hearing disabilities. Morris and Bryen (2015) provided a more positive picture about the use of mobile technology by adults in the US who rely on AAC. However, respondents in their study continued to lag behind respondents with other disabilities as well as behind the general population in their use of these mainstream technologies. Given the worldwide expansion in the use of mobile technology and the increased need to make these powerful technologies more accessible to people with disabilities, the question remains whether adults who use AAC in both high-income and low- or middle-income countries are using them at similar rates and for similar purposes and activities.

### Purpose of the Study

The purpose of this research is to describe the use of consumer mobile technology by adults who rely on AAC in the United States (a high income country) and South Africa (a low- or middle-income country). By studying this rapidly growing and important means of communication, we will have a better understanding of current use, barriers, and needed changes from two different cultural, contextual, and socio-economic perspectives. Based on the results of this research, recommendations can focus on both local and international initiatives needed to ensure equal access to mobile technology for individuals with disabilities who rely on AAC technologies.

## Method

A descriptive survey design (McMillan & Schumacher, 2010) was used to describe the responses of 38 adults from the United States and 30 adults from South Africa who rely on AAC using the Survey of User Needs (SUN4) (Morris, Mueller, Jones & Lippincott, 2014).

### Materials

The Survey of User Needs (SUN) was originally launched in the United States in 2012 by the Rehabilitation Engineering Research Center on Wireless Technology, also known as the Wireless RERC. The SUN has been updated three times in order to keep up with the rapid pace of technological change and to ensure that data particularly relevant to people who use AAC were included (Morris et al., 2014). SUN4 can be viewed at http://www.wirelessrerc.org/content/projects/sun-overview. SUN4 has four parts. Part 1 covers demographic variables (i.e., age, gender, ethnicity, highest educational level attained, annual household income, living conditions, type of employment, and whether the survey was completed independently or with help). Part 2 focuses on the participant abilities and disabilities, as well as the types of mobile technology devices used. Part 3 focuses on the participant use of mobile devices, for example whether they own a mobile device, the types of mobile devices they use and the activities they were used for, satisfaction with their mobile device, how the participant decided on the particular device, as well as the types of changes that were made to it. Finally, Part 4 focuses on the various activities and functions for which the mobile devices are used and how often they are used. Questions also focused on social networking activities and the use of mobile apps.

The content validity of SUN4 was established by conducting interviews with subject matter experts in the mobile device and service industries and regulatory agencies, accessibility and assistive technology experts, advocates for people with disabilities, and people with disabilities themselves, as part of the development process. A few items were adapted from other established survey research, including the National Health Interview Survey (NHIS) conducted by the US Centers for Disease Control and Prevention (CDC), and the Pew Research Center's on-going research on mobile device use (Duggan & Smith, 2013). Finally, the typology used to identify respondents' functional abilities was adapted from the American Community Survey (ACS).

Five adaptations focusing on ensuring cultural, contextual, and metric equivalence were made to the SUN4 for use in the South African context. These were: (a) changes to the ethnic categories used, (b) changes to the categories in which highest level of education was described, (c) categories used to describe household income and the metric used (South African Rand not United States Dollar), (d) the examples of mobile technologies and service providers specific to the South African context were included as well as a category for low technology AAC (communication boards), and (e) metric used for the costing of apps was changed (Bornman, Bryen, Moolman, & Morris, 2016).

**Participant Recruitment**

For the United States sample, convenience sampling was used to obtain a sample of adults with complex communication needs who rely on AAC for face-to-face communication. Study participants were recruited through the Wireless RERC's Consumer Advisory Network, a nationwide network of consumers with disabilities. Recruiting was also done by asking individuals working at national, state, and local organizations to disseminate the invitation to participate to their networks of people with disabilities who rely on AAC. Finally, information about SUN4 was posted to the Augmentative Communication Online User's Group (ACOLUG), an international listserv for people who use AAC, and was sent to individuals working at national, state, and local organizations. As a result of these recruitment efforts, a total of 38 adults with complex communication needs who use AAC completed SUN4.

For the South African sample, three recruitment strategies were used: recruitment from (a) an empowerment project for adults with complex communication needs who use AAC, (b) e-mail targeted at this population, and (c) outreach to institutions for individuals with severe disabilities. From this recruitment process, a total number of 30 South African adults with complex communication needs who use AAC were identified and contacted. Inclusion criteria for both countries were the same. To be eligible for this study, participants had to (a) be adults, 18 years or older; (b) have complex communication needs, (c) rely on some form of specialized AAC for face-to-face communication, and (d) provide consent. Details about the South African and the United States samples are provided in Tables 1 and 2.

**Procedures**

In South Africa, human subjects research approval was obtained from the University of Pretoria. All

**Table 1**
***United States (US) and South African (SA) Participants' Demographic Information***

| *Demographic information* | % of US participants (*N*=38) | % of SA participants (*N*=30) |
|---|---|---|
| *Completed SUN4 on their own* | 68% | 13% |
| *Mean age (in years) and SD*<br><br>*Gender (% female)* | 42<br>(*SD*.=16.4)<br>39% | 33<br>(*SD*=12.0)<br>37% |
| *Race* | | |
| • Black or African American | 13% | 33% |
| • White | 74% | 67% |
| • Asian/Pacific Islander | 3% | NA |
| • Hispanic/Latino | 3% | NA |
| *Household income (above $35K / 60K Rand)* | 38% | 40% |
| *Education* | | |
| • Not applicable or no schooling | 3% | NA |
| • Attended primary school | 5% | 10% |
| • High school diploma or GED | 16% | 14% |
| • Post high school education | 76% | 17% |
| • Attended special school | NA | 59% |
| *Employment status* | | |
| • Employed full time | 29% | 3% |
| • Employed part time | 21% | 13% |
| • Retired | 13% | 3% |
| • Unemployed | 32% | 80% |
| *Living setting* | | |
| • Urban/suburban area | 79% | 90% |
| • Rural area | 21% | 10% |
| • Lives alone | 19% | 7% |

***Note:*** **The 2015 official poverty levels for a household of four were based on the *Federal Register* by the U.S. Department of Health and Human Services under the authority of 42 U.S.C. 9902(2) for the United States and from http://theconversation.com/how-current-measures-underestimate-the-level-of-poverty-in-south-africa-46704 for a household of four in South Africa.**

potential participants received detailed information about the study making it clear that participation in the study was voluntary and that there would be no negative consequences if they declined participation or withdrew at any time. Potential South African participants completed an informed consent form. All potential participants consented. In the United States, because of the non-invasive nature of the survey questions and the inclusion of only adults, the research received a waiver of documentation of informed consent from the review board at the researchers' institution for the participants from the United States.

In the United States, participants completed the survey via SurveyMonkey®, a web-based survey service. Although all participants were offered alternative methods for responding (e.g., email, phone, or

**Table 2**
***Type of Difficulty Experienced by Participants from the United States (US) and South Africa (SA)***

| *Type of difficulty* | *% US participants (N=38)* | *% SA participants (N=30)* |
|---|---|---|
| Frequent worry, nervousness, or anxiety | 24% | 17% |
| Difficulty concentrating, remembering, or making decisions | 21% | 27% |
| Difficulty seeing | 21% | 13% |
| Difficulty hearing | 34% | 7% |
| Difficulty using arms | 61% | 60% |
| Difficulty using hands and fingers | 66% | 70% |
| Difficulty walking and climbing stairs | 66% | 73% |
| Difficulty speaking so people can understand | 82% | 100% |

***Note:*** **Percentages add to more than 100% because several participants experienced multiple difficulties.**

face-to-face interview), none was requested. In contrast, most South African participants relied on someone to record their responses -- either their primary caregivers or trained research assistants.

**Data Analysis**

Descriptive statistics were used for the data analysis given that this research was exploratory in nature. Information from the survey was coded in SurveyMonkey® and frequencies and percentages were calculated for each country. Due to some differences in the recruitment of participants and data collection procedures between the two countries, inferential statistics were not used.

## Results

Despite geographic, demographic, and economic differences between the United States and South Africa, there were many similarities between the two samples. Table 1 shows that the gender and ethnic membership in the two samples were similar with more male than female participants. Participants mostly lived in urban or suburban areas, lived with others, and had incomes below their respective official poverty levels. The two samples were both over-represented by participants who are white, despite the fact that Black South Africans are a numerical majority.

Education levels and employment status did differ between the samples from the two countries. In the United States sample, 92% reported completing high school, obtaining a GED, or having some post high school education. In contrast, only 31% of the South African participants reported completing high school, obtaining a GED, or having some post high school education. Furthermore, 50% of the participants from the United States reported being employed either full or part-time. This is in contrast to 80% of the South African sample reporting being unemployed.

As shown in Table 2, participants from both countries reported experiencing multiple disabilities. More than three-quarters of both samples reported having complex communication needs (i.e., difficulty speaking so people can understand). The majority of respondents from both countries also reported having difficulties using their arms, using their hands and fingers, and difficulty walking and climbing stairs. This finding shows that participants from both countries reported having multiple disabilities, not just complex communication needs. A small percentage of participants from each country reported having difficulty with nervousness and anxiety,

**Table 3**

***Percentages of Specialized Assistive Technologies Used by Participants from the United States (US) and South Africa (SA)***

| *Type of specialized assistive technology* | *US participants (N=38)* | *SA participants (N=30)* |
|---|---|---|
| Screen reader | 16% | 7% |
| Screen magnifier | 5% | 3% |
| Hearing aid | 26% | 3% |
| Speech-generating AAC device | 100% | 57% |
| Text-to-speech software | 45% | 53% |
| Fabricated AAC communication board | NA | 50% |
| Wheelchair | 61% | 70% |
| Crutches, cane, or walker | 21% | 7% |

***Note:* Percentages add to more than 100% because several participants used more than one type of assistive technology.**

remembering, decision-making, and seeing.

Participants from each country were asked about the types of specialized technologies they use to address their disabilities. Results shown in Table 3 indicate that the majority of participants from each country use high-tech AAC devices, either specialized speech-generating devices (SGD) or text-to-speech software. A high percentage from each country also reported using wheelchairs. Given the moderate rate of hearing difficulties among the participants from the United States, it is not surprising that they also reported using more hearing aids than those from South Africa. The types of specialized assistive technology used by participants from each country reflect the functional difficulties previously reported in Table 2.

Data presented in Tables 4 and 5 illustrate mobile technology device ownership and describe the source(s) used to select this technology. When asked about their ownership and use of mobile technology devices, the majority of participants from both countries reported ownership. It is interesting to note that for both samples, the highest percentage of ownership was that of smartphones -- 67% for South African participants and 49% of those from the United States. Both countries reported smaller percentages of ownership of basic cell phones and tablets.

As shown in Table 5, participants reported using a variety of sources to select the particular mobile device they use. The largest percentage reported that their selection was based on recommendations from family members or healthcare professionals. Participants from the United States also relied on online consumer sources such as blogs and listservs, with 50% of participants from the US selecting their devices based on recommendations from online consumer sources. This potential resource was not used at all in South Africa. Websites of mobile service companies were used less frequently by participants from the United States (39%) and even less by South African participants (7%). The device package labels with the list of features, as well as information provided by a salesperson, were also used infrequently in both countries. It is important to note from Table 5 that many of the participants from each country used more than one resource to select their mobile device. Finally, almost one-third of the South African participants reported receiving their mobile technology as a donation, gift, or as a loan.

**Table 4**
**Percentage of Participants' Ownership of Mobile Device in the United States (US) and South Africa (SA)**

| | *% US participants (N=33)* | *% SA participants (N=30)* |
|---|---|---|
| Owns a mobile device | 85% | 100% |
| • Basic cell phone | 6% | 23% |
| • Smartphone | 49% | 67% |
| • Tablet | 21% | 10% |
| • Other (e.g., laptop) | 9% | 0% |

**Table 5**
**How Mobile Technology was Selected by Participants from the United States (US) and South Africa (SA)**

| *Sources of information* | *% US participants (N=28)* | *% SA participants (N=30)* |
|---|---|---|
| Recommendations from friend, family, healthcare professional | 61% | 33% |
| Package label with list of features | 18% | 13% |
| Salesperson | 18% | 13% |
| Online consumer sources (blogs, listservs, news, etc) | 50% | 0% |
| Website of mobile services companies | 39% | 7% |
| Website of mobile device makers | 25% | 30% |
| Advertising on TV, radio, or in magazines or newspapers | 29% | 13% |
| Other (e.g., donation, gift, borrowed) | 21% | 30% |

***Note:* Percentages add to more than 100% because several participants used multiple sources of information.**

Data presented in Table 6 summarizes participants' overall purpose for using their mobile devices, their importance and satisfaction, ease of use, and changes made to their mobile technology. The majority of participants from the United States reported using their mobile devices for both professional and personal uses while the South African participants reported that their devices are used primarily for personal purposes. This finding reflects the differences between the countries in the employment status of participants (refer back to Table 1). Regardless of the purpose, there was almost unanimous agreement among participants from both countries that the use of mobile technology was important. This was not the case for satisfaction and ease of use with these mobile technologies. Several participants from each country shared some level of dissatisfaction with their mobile technology, noting difficulty with the ease of use.

When asked about changes/modifications made to their mobile device, almost half of South African participants reported that no changes or additions were made to their mobile devices (47%). Respondents from the United States provided a slightly different view with only 14% reporting not making any changes to their off-the-shelf mobile devices. Exploring the nature of the changes, the following modifications were made to their mobile

**Table 6**

***Use, Importance, Satisfaction, Ease, and Changes Made to Mobile Devices by Participants from the United States (US) and South Africa (SA)***

| *Use of mobile device* | *% US participants (N=28)* | *% SA participants (N=30)* |
|---|---|---|
| *Purpose for use of mobile technology* | | |
| • Professional use (work or school) | 0% | 3% |
| • Personal use | 28% | 67% |
| • Both professional and personal | 61% | 27% |
| • Emergencies only | 11% | 3% |
| *Importance of use of mobile technology* | | |
| • Very important | 89% | 83% |
| • Somewhat important | 7% | 13% |
| • Not very important | 4% | 3% |
| *Satisfaction with mobile technology used* | | |
| • Very satisfied | 29% | 50% |
| • Somewhat satisfied | 54% | 33% |
| • Neither satisfied nor dissatisfied | 10% | 10% |
| • Somewhat dissatisfied | 7% | 0% |
| • Very dissatisfied | 0% | 7% |
| *Ease of use of mobile technology* | | |
| • Very easy to use | 29% | 43% |
| • Easy to use | 36% | 30% |
| • Somewhat hard to use | 25% | 17% |
| • Hard to use | 3% | 0% |
| • Can't use it without help | 7% | 10% |
| *Changes/additions made to mobile devices* | | |
| • No changes or additions | 14% | 47% |
| • Physical accessories added, such as protective skin or case, headset, Bluetooth device, screen overlay, lanyard, stylus | 61% | 33% |
| • Assistive devices added, such as head switch, EMG switch, AAC device, neck loop, TTY | 32% | 7% |
| • Software added, such as a third party text-to-speech, screen reader, screen magnifier, app store downloads | 39% | 27% |
| • Improvised solutions, such as hand strap, Velcro, wheelchair mount | 32% | 7% |
| • Other, such as larger font, different screen glass for head pointer, protective screen | 18% | 10% |

devices:

- Physical accessories were added, such as a protective skin or case, headset, Bluetooth device, screen overlay, lanyard, or stylus;
- Assistive devices were added, such as head switch, switch, AAC device, neck loop, or TTY;
- Software was added, such as a third-party text-to-speech, screen reader, screen magnifier, or other app store downloads;

- Improvised solutions were made, such as hand strap, Velcro, or wheelchair mount; and
- Other changes were reported, such as larger font, different screen glass for head pointer, or protective screen.

The robust features and functions built into mobile devices make them especially attractive for individuals who rely on specialized AAC devices. Table 7 shows the types of activities in which the participants engaged when using their mobile device. Most of the 18 activities listed in the survey were engaged in by some of the participants from each country. More than 50% of participants in each country engaged in text messaging, web browsing, keeping a directory of contacts, voice calling, sharing photos or videos online, listening to music, and social networking. Based on the combined percentage being greater than 100% in each country, it can be noted that more than one activity was used by at least some of the participants from each of the two countries.

Finally, all participants were asked to indicate if they had experienced any of 11 distinct situations using their mobile devices in the previous 30 days. As shown in Table 8, the experiences identified by the largest percentage of participants were "Making plans with others" (79% for the United States, 67% for South Africa); "Getting information that I needed right away" (68% for United States, 47% for South Africa); and "Using for entertainment or when I was bored" (45% for the United States and 63% for South Africa).

**Table 7**

***Use, Importance, Satisfaction, Ease, and Changes Made to Mobile Devices by Participants from the United States (US) and South Africa (SA)***

| *Type of activity* | *% US participants (N=28)* | *% SA participants (N=30)* |
|---|---|---|
| Text messaging | 93% | 80% |
| Web browsing | 79% | 57% |
| Email | 71% | 37% |
| Keeping a directory of contacts | 75% | 73% |
| Downloading apps | 71% | 43% |
| Keeping a calendar of appointments | 71% | 43% |
| Social networking – Facebook[2], LinkedIn[3], Twitter[4], etc | 71% | 57% |
| Voice calling | 57% | 50% |
| Navigating or wayfinding (using GPS and/or maps) | 61% | 23% |
| Sharing photos or videos online | 57% | 67% |
| Using voicemail | 54% | 13% |
| Watching videos | 50% | 40% |
| Listening to music | 50% | 60% |
| Playing games | 43% | 33% |
| Video calling | 39% | 3% |
| Shopping | 39% | 0% |
| Recording voice notes or reminders | 29% | 10% |
| Monitoring your health | 25% | 0% |
| Other | 18% | 17% |

***Note:*** **Percentages add to more than 100% because several engaged in more than one activity.**

**Table 8**

***Use, Importance, Satisfaction, Ease, and Changes Made to Mobile Devices by Participants from the United States (US) and South Africa (SA)***

| *Type of experiences with mobile technology* | *% US participants (N=28)* | *% SA participants (N=30)* |
|---|---|---|
| Was frustrated – mobile device took too long to use | 29% | 30% |
| Had difficulty entering a lot of text | 43% | 30% |
| Had difficulty reading – screen or the text was too small, screen reader couldn't read it out loud | 39% | 17% |
| Used my mobile device for entertainment or when I was bored | 61% | 63% |
| Pretended to use my mobile device to avoid interacting with people around me | 11% | 10% |
| Was in an emergency situation where having my mobile device really helped | 21% | 27% |
| Used my mobile device to get information that I needed right away | 68% | 47%% |
| Used my mobile device to get directions while outside of my home or office | 50% | 23% |
| Used my mobile device to make plans with others | 79% | 67% |
| Turned off for a period of time to get a break from using it | 11% | 13% |
| Was in a situation where I had trouble doing something because I didn't have my mobile device with me | 18% | 37% |

***Note:* Percentages add to more than 100% because several participants had more than one recent experience with mobile technology.**

## Discussion

Before summarizing the major findings related to outcomes and benefits, it is important to highlight that conducting a bi-national study is not without its inherent difficulties. Despite economic (e.g., high income vs. middle or low income), geographic (e.g., North America vs. sub-Saharan Africa), and demographic differences between the two countries (e.g., United States' population of more than 320 million as opposed to a South African population of less than 54 million in 2015; majority of United States' population is white versus the majority of South Africa's population is Black in 2015), the two samples of adults with complex communication needs were similar in several important ways. The majority of the study participants from both countries were white, male, had household incomes below the median income for their country, lived in urban or suburban settings, were either unemployed or worked part time, lived with other people, and experienced multiple disabilities associated with complex communication needs. Participants from both countries used a variety of specialized technologies to address their disabilities with a large majority using speech generating devices and text to speech devices to address their complex communication needs, as well as using wheelchairs to address their physical disabilities.

Some relevant differences between the participants from the two countries were, however, noted. They included age, where the participants from South Africa were younger. Employment status and education level also differed, where more participants from the United States were employed full-time and achieved higher education levels compared to participants from South Africa.

**Outcomes and Benefits**

The large majority of participants from both countries owned or used some form of mainstream mobile technology. This finding compares favorably with 2014 data about cell phone ownership by the general population in United States (89%), Africa (89%), and South Africa (90%) (Pew Center, 2015). In contrast to working landlines, which continue to be common in the United States (60%), working landlines are almost non-existent in South Africa (2%). Low- or middle-income countries, such as South Africa, have entered the digital and cellular ages, bypassing the need for landline phones and desktop computers. This may be a key reason that one of the major findings of this study showed that smartphones were used more frequently than cell phones not just in the high-income country but also in a low- or middle-income country.

Among the participants, texting was the most common activity in both countries. This compares quite favorably with data from the study of cell phone use in the general population of Africa (Pew Research Center, 2015). Although mobile technology has different uses for different people, it is clear that communication and social interaction is important whether or not you live in the United States or in South Africa and whether you have a disability or not. Texting uniquely serves the communication needs of those who rely on AAC, since it bypasses the need for speech. Due to the fact that sending and receiving text messages is asynchronous, it compensates for the fact that using speech-generating devices is much slower than speech. Furthermore, it is hypothesized that texting may be especially attractive to individuals with complex communication needs because abbreviated spelling has become so typical to all of us when texting. (e.g., less fatiguing and less time-consuming).

A majority of respondents from both countries also use their mobile devices to keep a directory of contacts and to participate in social networks. Once again, this finding demonstrates the importance of socially connecting with others and supports the findings of Caron and Light (2015). Browsing the web for entertainment or for obtaining information was a popular activity for more than 50% of mobile technology owners in this study. Other activities, such as getting health information and shopping, were engaged in by fewer participants, but done more frequently by participants from the United States than those from South Africa. This may be attributed to the lower availability of these services in South Africa. That video calling was used infrequently by the South African participants (3%) is possibly related to the high cost of data use or, alternatively, because WIFI is not yet freely available throughout the country.

Outcomes from this study demonstrated that most respondents noted the importance of using their mobile devices. This finding supports recognition that mobile technology holds great promise to revolutionize lives as it provides all individuals, including those with complex communication needs, the opportunity to connect with others, and also to access education, commerce, employment, and entertainment from anywhere and mostly at any time. (Caron & Light, 2015; Foley & Ferri, 2012).

Despite the promise that mobile technology holds to enhance the lives of individuals with complex communication needs, data from this study also found that its use was difficult for approximately one-third of the participants from both countries. In addition, for those who could use this technology, a variety of device changes or modifications were needed. As such, an additional burden is likely to be placed on this population to retrofit the device so that it is accessible and easily used. This finding underscores the United Nations call to promote the design, development, production, and distribution of accessible information and communications technologies and systems at an early stage, so that these technologies and systems become accessible at minimum cost (United Nations, 2006), and the need for using principles of universal design when developing and manufacturing mobile technology.

### Limitations

Designing and conducting a bi-national study is a complex process, especially when trying to ensure that each sample is representative of the demographics of each country while also trying to ensure that the sample from each country is comparable. The complexity is more so when the target population, adults with complex communication needs who use AAC, is relatively small in size, heterogeneous, and not easily accessible due to multiple disabilities affecting speech, language, and mobility. As a result, there were within sample limitations in addition to between sample limitations.

Within countries, each sample of people who use AAC was not representative of the overall population. They were more literate and more highly educated. They mostly lived in urban/suburban areas with very few from each country living in rural areas. They were also mostly white. In addition, although household incomes of each country represented the currencies for their country and reported as their respective median income (Refer back to Table 1), the income threshold of the two countries is not the same. The purchasing power of the South African Rand versus the United States dollar differs. For example, in the 2015 UBS Prices and Earnings Review, the amount of time an average worker in different cities across the globe must work to earn enough to purchase staple consumer items (e.g. a smartphone), was calculated. The working time required to buy one such smartphone in New York City is approximately 24 hr. compared to Johannesburg, which is 86.9 hr. Considering an average 40-hr. work week, this would imply that in the United States one half-week's work will buy this smartphone, while just more than two weeks will be required in South Africa to buy the same phone (UBS, 2015).

Because complex communication needs resulting in the need for AAC is a relatively low incidence disability, it was also difficult to obtain a larger and more representative sample. With a relatively small sample size, we could not do some basic comparative statistical procedures, nor could we explore the relationship between key demographics, such as gender, age, and education and mobile device ownership and use in each country. As such, the results of this study should be viewed with some caution. However, this study on the use of mobile technology is the first of its kind in each country and in two very different countries. It can be used as a credible baseline for further replication.

### Recommendations

**Recommendations for researchers.** First, there is a need to replicate this study, striving wherever possible, to get a larger and more representative sample from each country. Of importance is the need to secure better representation from marginalized ethnic and racial minorities who have complex communication needs and who use AAC. This may be quite difficult since programs providing AAC services that serve as sources from which to recruit research participants may also underserve members of minority groups.

Special effort should also be made to recruit participants from rural populations. Odendaal, Duminy, and Saunders (2008) suggest that in South Africa there may be a digital and cellular divide between rural and urban populations. This recommendation also applies to future research in the United States since participants from rural areas were underrepresented in both the countries in this study. However, given that mobile technology has the potential to reach rural areas, it is important to learn if they are, indeed, reaching people who have complex communication needs living in rural areas.

There is also a need to replicate this study given the more recent advances in mobile technology and the activities for which they can serve. For example, within the past two years, manufacturers of smartphones have recognized the need to build in features to accommodate the access needs of people with visual disabilities, those with hearing disabilities, those with motor disabilities, and those with learning disabilities. This is especially true of iPhones, Androids, and a variety of tablets. Furthermore, there is rapid expansion of activities that can be done using cell phones and smartphones. For example, more and more commerce and banking are being conducted using these mobile devices.

**Recommendations for the mobile technology industry.** Cell and smartphone designers and manufacturers are encouraged to expand their built-in accessibility features to address the needs of people with complex communication needs who frequently have multiple disabilities. Vision is already being addressed via voice over, zoom, speak selection, larger text, contrast, and more. Hearing and learning disabilities are also being addressed. Most relevant to individuals with complex communication needs is physical and motor accessibility features, including switch control and assistive touch. As shown by the data from this study, most people with complex communication needs have motor disabilities in addition to their speech difficulties. Some also have learning, visual, and hearing disabilities in addition to their motor and speech disabilities. Not only must these access features be available on new mobile devices, but also they must be widely marketed so family members or professionals who serve and support this population know they exist. This is especially critical because results from this study indicate that family members and professionals in each country are the ones who most frequently recommend mobile devices to adults with complex communication needs.

**Recommendations for the assistive technology industry.** Manufacturers of specialized AAC devices should consider expanding their designs of software or apps that can easily be downloaded onto the platforms and operating systems that are used in mainstream mobile devices. Mainstream mobile devices are more powerful and certainly more image-enhancing than current specialized speech generating devices. Specialized assistive communication technologies, such as speech-generating devices, have rates of abandonment as high as 30% (Foley & Ferri, 2012). Research on the rate of abandonment of mainstream mobile devices by this population could yield important policy and clinical implications.

**Recommendations for individuals with complex communication needs who use AAC.** Individuals with complex communication needs who rely on AAC would benefit from learning more about the benefits of having access to and use of mobile technology such as cell phones, smartphones, and tablets. Without them, they will have fewer opportunities for social interactions, communication with a wide variety of individuals with and without disabilities, fewer opportunities for employment and commerce, less access to information and commerce, and more. They should also become more aware of the accessibility features that are already built into existing mobile devices, as well as needed accessibility features that are possible but remain absent in these mainstream devices. This information will enable them to be well-informed consumers. Additionally, armed with this information they can become effective advocates in working with policy makers at the local, national, and international levels.

## Conclusions

The findings of this research suggest that most of the adults with complex communication needs in the United States and South African samples who have access to AAC also own or use mainstream mobile devices for a variety of purposes and to engage in a variety of activities. However, for some, use of these devices is not easy. Furthermore, the burden of adapting and modifying their devices for easier use is placed on the person, rather than being built into the device, using principles of universal design or design for all. This situation must change if social, informational, and economic inclusion is to occur. For countries that have ratified the CRPD, there is a means to monitor the current situation. The CRPD can also be used as an instrument for change (cf, G3ict & ITU, 2012). Hopefully this study will provide people with complex communication needs and their advocates with needed information to effectively advocate for equal access to mobile technology in our ever-growing digital world.

### Declarations

This content is solely the responsibility of the authors and does not necessarily represent the official views of ATIA. The authors disclosed a financial relationship with the National Institute on Disability Independent Living and Rehabilitation Research. No non-financial disclosures were reported by the authors of this paper.

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