

# The Efficacy of Assistive Technology on Reading Comprehension for Postsecondary Students with Learning Disabilities

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**Abstract:** Despite the large increase of students with learning disabilities (LD) entering postsecondary institutions and the legislative emphasis on providing students with disabilities equal access to education, we have yet to develop comprehensive planning of accommodations for postsecondary students with LD in regard to assistive technology (AT). The purpose of this study was to provide empirical insight related to using AT to support reading comprehension in postsecondary students with LD. Participants were six postsecondary students with LD. A multiple baseline across participants design was employed to examine the effects of AT, specifically the ClassMate Reader, on reading comprehension. The data were analyzed to discern participant performance with and without the device, social fidelity, and acceptability.

**Keywords:** Assistive technology, Learning disabilities, Postsecondary students, Reading comprehension

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Changing workforce demands have created an environment in which postsecondary education has become a necessity for students with LD (Eckes & Ochoa, 2005; Madaus & Shaw, 2006). In addition, the National Center for Educational Statistics (2000) reported that

students with disabilities graduating from college demonstrate employment rates and yearly salaries comparable to their colleagues without disabilities. Beyond the mere financial motivation, students with LD are striving for increased self-esteem and improved quality of life by demanding access to and success at the postsecondary level (National Council on Disability, 2003).

The number of students identified with LD entering higher education has increased markedly (see e.g., Stodden, Conway, & Chang, 2003), and these students constitute approximately 2% of the total undergraduate population in the U.S. (Vickers, 2010). According to Sparks and Lovett (2009), one of the possible explanations for this increase is the range and variability of services available at the postsecondary level. However, there is noted concern in the disparity of services provided at the secondary level and eligibility for those same instructional supports at the postsecondary level. In K-12 settings, the primary focus is to provide supports to learners during instruction that allows for increased access to learning materials, increased engagement, and the demonstration of knowledge. Conversely, at postsecondary settings, the focus often is only to provide reasonable accommodations during assessment situations.

Recent legislation addresses these continuous and challenging issues. The reauthorization of

the Higher Education and Opportunity Act of 2008 (HEOA; P.L.110-315) supports access, participation, and successful learner outcomes at the postsecondary level. HEOA seeks to provide strategies and innovation to improve transition of students from K-12 to postsecondary settings, as well as bolstering instructional support services to postsecondary students with disabilities within their postsecondary environment. More specifically, the provision requires the development and implementation of effective transition practices, improved distance learning opportunities for students with disabilities through course design and strategy instruction, overall increased accessibility, and opportunities for persons with disabilities in postsecondary educational settings.

One variable which influences students' ability to succeed in postsecondary environments is reading comprehension. Students with LD face many challenges during their elementary and secondary educational careers, and these challenges persist into adulthood, thus influencing performance in postsecondary settings (Gerber et al., 1990; Heiman & Kariv, 2004; Vickers, 2010). Therefore, poor reading comprehension at the postsecondary level is likely to impede the performance and persistence of students with LD in their new learning environment.

Based on data presented in the National Assessment of Educational Progress (U.S. Department of Education, 2011), 64% of grade 8 students with disabilities scored in the below basic range in the area of reading. Further, in the National Longitudinal Survey – 2 (Wagner, Newman, Cameto, Garza, & Levine, 2005), it was found that more than 50% of secondary students with LD performed below the 16th percentile on reading comprehension measures. It is these same secondary students who enter postsecondary settings already at a disadvantage. Even though all students

transitioning from secondary to postsecondary settings experience the same increased rigors and expectations, there is a greater risk of failure for students with LD given their inherent learning challenges (Lerner & Johns, 2012). With research supporting that LD persists throughout the life of the individual (Gerber et al., 1990; Roberts, 2008), the challenges and struggles that learners face with reading and reading comprehension at the secondary level are the same challenges and struggles they will face at the postsecondary level. With reading comprehension being a vital and integrated aspect of college coursework, students with LD are at a significant disadvantage than their typically developing peers in comprehending college-level textbooks (Warde, 2005). Therefore, students with LD will need support in postsecondary environments to improve their reading comprehension skills, and thus assist in success at the postsecondary level (Allsopp, Minskoff, & Bolt, 2005; Mull, Sitlington, & Alper, 2001; Trainin & Swanson, 2005). One promising accommodation for students with LD is assistive technology (AT) devices such as screen readers or alternative media.

#### *AT and Postsecondary Education*

Screen readers were originally designed for students who were blind or had low vision (Anderson-Inman & Horney, 2007). Since then, researchers have examined the technology as supports for students with other print-related disabilities (Elkind, 1998; Hecker et al., 2002; Olson & Wise, 1992). The use of screen readers or other text-to-speech software has led to increased reading comprehension performance for students with the weakest reading skills (Elkind, Black, & Murray, 1996). There is swelling support for the use of screen readers and other forms of electronic text to assist students performing below grade level in reading (Castellani &

Jeffs, 2001; Edyburn, 2000; Raskind, 1994; Welch, 2010).

Several studies have examined the use of alternative media for improving reading comprehension for students with LD at the postsecondary level. Raskin and Higgins (1995) examined the effectiveness of speech synthesis on the proofreading aptitude of postsecondary students with LD. Students improved their proofreading skills by demonstrating an increase in identification of errors when using this alternative media versus relying on a human reader or proofreading with no assistance provided. This study was followed by Elkind et al. (1996) who examined the effectiveness of using speech synthesis during reading tasks on reading performance for postsecondary students with dyslexia. Their results showed participants not only demonstrated improved reading rates and comprehension, but also increased their ability to sustain attention while reading.

A multi-year study on AT for postsecondary students with LD was conducted at the Center on Disability (Higgins & Raskind, 1998). Higgins and Raskind examined the use of optical character recognition and speech synthesis and their compensatory value in addressing reading comprehension difficulties for 37 postsecondary students with LD. The findings demonstrated an increase in performance for the students with the lowest silent reading scores. That is, the students with the lowest silent reading scores improved most with the use of the technology support.

In 1998, Elkind investigated the effectiveness of a supported speech software program, *Kurzweil 3000*, on the reading performance of postsecondary students with LD. Twenty-six students completed reading comprehension tests, one with the use of the *Kurzweil 3000* and one without the software. The findings revealed that students who had lower reading

comprehension scores had greater benefit from the use of the technology than those students who had higher reading comprehension scores.

Furthermore, Hecker, Burns, Elkind, Elkind, and Katz (2002) examined how the use of *Kurzweil 3000* influenced the reading performance of 20 postsecondary students with the primary diagnosis of attention disorder. Of the 20 students, five were also identified as having reading disabilities. Although there were several variables measured, of importance to this study is the influence on reading comprehension. Although gains were noted among individuals, there was not a statistically significant improvement in reading comprehension for all participants in the study. However, students with the lowest comprehension test scores had noticeable improvements from use of the *Kurzweil 3000* software.

Due to the unique reading challenges of postsecondary students with LD, it is imperative that the most versatile and portable AT be available to these learners. Designing the most effective and innovative accommodations are critical so that students with LD are not denied full benefit from their postsecondary program of study. As instructional technology, AT, and alternative media options in our society continue to advance, so should the breadth and appropriateness of accommodations that are afforded to students with LD. Although the use of AT to support reading at the postsecondary level an area of key importance in supporting students with learning disabilities ability to persist to graduation, there have been few empirical studies to investigate this phenomenon at that the postsecondary level.

### *Purpose*

Although researchers and educators alike have witnessed the increase in students with LD entering postsecondary settings, support for the reading and comprehension of printed material is widely unsupported at the postsecondary level. The primary purpose of this study was to examine the efficacy of AT, specifically *ClassMate Reader* (HumanWare Group, 2005-2012), on the reading comprehension performance of postsecondary students with LD. The secondary purpose was to examine whether *ClassMate Reader* is perceived as socially acceptable by participants and if participants would use *ClassMate Reader*, if made available in the future.

### **Method**

#### *Participants*

All participants were served in the Supporting Transition and Education through Planning and Partnerships Program (STEPP) at a public university in the southeastern region of the U.S. The program offers comprehensive academic, social, and life-skills support to students with identified Specific Learning Disabilities who have shown the potential to succeed in college, but would have difficulty doing so without significant educational supports.

Six participants, four males and two females, were selected for participation in this study after an initial screening by the STEPP Director. To be eligible for the study, students within the STEPP Program had to be (a) already identified as having a learning disability via the screening process acceptance into the STEPP Program, and (b) demonstrated challenges in the area of reading comprehension. From the initial screening, eight students were identified.

The researcher met with each individual interested in participating and presented perceived risks and benefits of the study. Further, the researcher discussed the time commitment needed to complete the study. From these meetings, six students volunteered to participate and were asked to sign Informed Consent. Each participant provided specific learning disability documentation from their school system as well as confirmation of his or her present reading level at the onset of the study. The reading comprehension scores of the participants ranged from 5th grade to 8th grade, as measured by *The Basic Reading Inventory* conducted by Project STEPP Director prior to the onset of the study. The participants ranged in age from 19–22 yrs of age and had class ranks from freshman to junior level.

*Annie.* Annie is a 20-yr-old Caucasian female diagnosed with dyslexia. Although she has three accommodations available to her, she reportedly does not use the accommodations. She was first identified at age seven as having both a learning disability and attention deficit hyperactivity disorder (ADHD). To assist with the attention and concentration challenges, Annie takes medication daily. Her current full-scale IQ score, as determined by the *Wechsler Adult Intelligence Scale – III*, was 90. Her instructional reading level was determined to be at the 5th grade level based on her performance on *The Basic Reading Inventory* prior to the beginning of his study.

*Colin.* Colin is an 18-yr-old Caucasian male diagnosed with a learning disability. His current full-scale IQ score, as determined by the *Wechsler Intelligence Scale for Children – III*, was 121. His instructional reading level was determined to be at the 7th grade level based on his performance on *The Basic Reading Inventory* prior to the beginning of this study. Of the three accommodations available to him, Colin only uses extended time for taking his tests.

*Jeff.* Jeff is a 19-yr-old Caucasian male diagnosed with a learning disability. His current full scale IQ score as determined by the *Wechsler Intelligence Scale for Children – III* was 109. His instructional reading level was determined to be at the 8th grade level based on his performance on *The Basic Reading Inventory* prior to the beginning of this study. Jeff's accommodations include extended time, note taker, and a low distraction-testing environment.

*Hugh.* Hugh is a 19-yr-old Caucasian diagnosed with a learning disability, anxiety disorder, and ADHD for which is he currently taking medication. He has been assigned extended time, note taker, low distraction testing environment, and a word processor for essay exam by disability support services. As determined by the *Wechsler Intelligence Scale for Children – IV*, his current full-scale IQ score was 98. As measured by the *Woodcock-Johnson III*, his grade equivalent for reading fluency, word attack, and reading comprehension were 14.1, 11.6, and 13.0 respectively. His instructional reading level was determined to be at the 8th grade level based on his performance on *The Basic Reading Inventory* prior to the beginning of this study.

*Sabron.* Sabron is a 19-yr-old Caucasian freshman diagnosed with a learning disability and ADHD for which he is taking medication. Disability Support Services has assigned Sabron extended time, note taker, and a low distraction environment for testing as his accommodations for the current school year. His full-scale IQ score, as determined by the *Wechsler Intelligence Scale for Children – IV*, was 117. His instructional reading level was determined to be at the 5th grade level based on his performance on *The Basic Reading Inventory* prior to the beginning of this study.

*Joanna.* Joanna is a 22-year-old Caucasian junior diagnosed with a learning disability and dyslexia. Her current full-scale IQ score, as

determined by the *Wechsler Intelligence Scale for Children – III*, was 99. Her instructional reading level was determined to be at the 5th grade level based on her performance on *The Basic Reading Inventory* prior to the beginning of this study. Disability Support Services has assigned extended time, low distraction environment, word processor for essay exams, and a reader for exams as Joanna's accommodations.

### *Setting*

The research venue was the AT Lab located at the participating university where the participants were currently enrolled. Within the AT Lab, there are five pods housing 27 computers. A conference table, as well as a reception area, is located near the entrance of the lab. A separate study room is located directly across from the reception area. Collection of data for this study occurred in the separate study room that was visible to the researcher, but provided a barrier to assist with noise reduction. All materials and collected data were stored in a locked cabinet within the AT Lab.

### *Instructional Materials*

*ClassMate Reader.* The specific AT device used in the study was the *ClassMate Reader* developed by HumanWare, Inc. (2009). The *ClassMate Reader* is a portable text reader designed to promote reading and learning independence. Students can listen to the audio version of text or other materials while following the highlighted text on screen. More specifically, the touch screen or navigation buttons can be configured to a participant's preference (e.g., color, font type and size, line spacing, text speed). The *ClassMate Reader* files can be stored on a removable Secured Digital (SD) memory card. It is compatible with National Instructional Material Accessible Standard (NIMAS) format, Digital Accessible

Information System (DAISY), Bookshare.org, and .txt files.

The *ClassMate Reader* allows students to modify/adjust the rate at which the text is read the volume of the reading, and the highlighting features to meet their needs. The color of the text, font style, and highlighting colors can be changed to address the students' preferences. Further, there is an on-screen dictionary that allows for immediate retrieval of word meaning and pronunciation. Setting preferences can be changed during text reading with a simple touch of the screen. The hardware features of the device include a net weight of 10.7 ounces and dimensions of 3.54" x 6.1" x 0.98." The device uses Nuance Vocalizer human-sounding voice for the built-in text-to-speech (TTS). The full color-reading screen is 2" x 3." The only aspect of the device that was utilized was by one participant in which she changed the color of the text. Participants reported that they did not use the on-screen dictionary.

*Reading passages.* A pool of 15 standardized reading passages at the 11th grade reading level was utilized given that the textbooks used by participants in the college coursework had readability scores at the 11th grade reading level. The SAT Critical reading passages published by Major Tests at [www.majortests.com](http://www.majortests.com) (Mathur, 2010) served as a resource for reading passage selection. All passages used during baseline were produced in printed form and then these same passages were converted to a .txt file for use during intervention. Each reading passage was expository text, approximately 400 - 600 words in length, and described a unique topic. The length of the passages did not vary across phases.

### *Measures*

*Reading comprehension.* Tests were administered to each participant to obtain repeated

measures for each condition. A pool of 15 reading passages at the 11th grade level was utilized for all comprehension measures. Each reading passage contained a reading comprehension measure consisting of six to eight questions that addressed factual, main idea, prediction, purpose, or clarifying questions. A percentage score was calculated for the number of correct answers to the six to eight questions on each test. The number of correct answers divided by the total number of questions and multiplied by 100 was the formula used for the percentage score.

*Social validity measure.* A Student Exit Interview consisting of five questions each formatted with a five-point Likert-type scale, ranging from '1' (*strongly disagree*) to '5' (*strongly agree*) and three open-ended questions were used to assess the social validity of the intervention. The survey items required the participants to rate their attitudes about reading, the use of the *ClassMate Reader*, and the potential for further utilizing *ClassMate Reader* in their coursework, if made available. In addition, the three open-ended questions were conducted individually with each participant and the researcher. Open-ended responses were analyzed qualitatively using the constant comparative methods described by Glaser and Strauss (1967). This survey was administered at the completion of the study and lasted no longer than 30 min.

### *Research Design*

The design for this study was a multiple baseline across participants design. In a multiple baseline across participant design, each participant begins baseline at the same time and the independent variable is systematically presented to each participant in a sequential order (Kennedy, 2005).

The order of reading passages was counterbalanced across participants between

baseline and intervention phases. This design allowed for within-individual comparisons and provided an opportunity for each participant to have access to the *ClassMate Reader*, a potentially beneficial source of support.

#### *Dependent Variable*

The dependent variable was the percentage correct on reading comprehension measures. Upon completion of the comprehension measure, each participant's score was converted into a percentage.

#### *Independent Variable*

The presentation of the comprehension quiz varied from baseline to intervention. This research study examined the variation in comprehension scores when the participants (a) read and completed the comprehension quiz without any supports other than the traditional paper/pencil format (baseline); and (b) utilized *ClassMate Reader* for both the reading and completion of the comprehension quiz (intervention). Therefore, the independent variable for this study was the implementation of the *ClassMate Reader* to assist with the reading of the passages and the comprehension measures.

#### *Procedure*

*General procedures.* All sessions occurred in the AT lab. Each participant participated independently, and provided his or her participant ID to the research assistant who then supplied the student with the randomly assigned reading passage and reading comprehension measure. The participant sat in the separate study area in the lab. Each session required the participant to independently read a passage and complete a reading comprehension measure in paper format during baseline or with the aid of the *ClassMate Reader* device during the

intervention phase. Each session required approximately 30 min of student participation.

Regardless of the condition, the scoring sheets were the same. After completing the measure on the scoring sheet, participants were prompted to provide their perceived score on the present measure as well as indicate any changes made to the device during the reading of the passage or test completion during the intervention condition. The time of day for the sessions varied across participants. Although the times varied across participants, each participant's session time of day remained constant throughout the study. Verbal reinforcement was given at the end of each session, but only with regard to the participants' commitment and participation. Participant performance on comprehension measures was not scored in view of a participant. Comparisons of their perceived performance noted on the participant's scoring sheet and their actual performance were recorded for all tests.

*Baseline.* The participants were given a reading passage at the 11th grade instructional level in a paper format. Each participant independently read the passage in text format and was provided as much time as necessary to read the passage. He or she was instructed to read the passage in their preferred manner (e.g., silently or aloud). After reading the passage, the participant returned the reading passage to the research assistant and was given a paper test and answer sheet. No additional instructional prompts or feedback were provided. The participant was not given access to the reading passage during the completion of the reading test. Upon completion of the test, the participant returned the test to the research assistant who confirmed the next appointment day and time and thanked the participant for participation. Out of view of any participants, the researcher scored and recorded the percentage correct

on the test. Then a research assistant conducted a reliability check.

*Intervention.* When the participant's baseline data became stable, group training on the use of the *ClassMate Reader* was conducted. The director of the AT Lab at the participating university gave the group training. The *ClassMate Reader* training session lasted 55 min in length. Participants were shown how to open and play reading passages saved to their device. The researcher observed the training and completed a Procedural Checklist to ensure all key elements of the *ClassMate Reader* were addressed.

The training was an interactive demonstration of the features of the device. Participants were provided a handout of the *PowerPoint*<sup>TM</sup> presentation utilized during the training. Each participant was assigned a device during the training so that the device could be set during the training based on his or her preferences. Participants were shown basic features of the device (e.g., power, accessing materials, and dictionary use) as well as elements that would allow for individualization (e.g., highlighting features, rate of reading, font size). The format of the training was to demonstrate a particular feature or function of the device, then requesting the participant to replicate the demonstration immediately with assistance as needed. At the completion of the training, each participant was asked to demonstrate his or her ability to independently navigate the device. All participants successfully completed all items on the Competency Checklist at which point the training ended.

In subsequent intervention sessions, the participants were provided with an 11th grade reading passage on the *ClassMate Reader*. The participant asked the researcher or research assistant to locate his or her assigned *ClassMate Reader* device. The researcher or research assistant verified that the device was working properly and inserted the appropriate

SD Card for the participant. After verifying the correct reading passage, the researcher or research assistant then left the study room. After reading the passage with the use of the *ClassMate Reader* device, the participant requested the reading comprehension test from the researcher or research assistant. The test was presented on the *ClassMate Reader*. The *ClassMate Reader* read the questions to the participant who completed the scoring sheet with paper and pencil. The participant was not given access to the reading passage during the completion of the reading test. The participant completed one reading passage comprehension test per session. Participants remained in the intervention phase until a percentage of 80% or greater had been achieved on two reading comprehension tests.

When participants met intervention exit criteria (i.e., 80% on two comprehension tests), they were scheduled for an exit interview with the researcher. During this interview, the researcher provided an overview of their performance (e.g., scores with and without the device, comparison of perceived and actual scores). Following this overview, the participant provided responses to the Student Exit Interview questionnaire via a speech recognition software program, *Dragon Speak*<sup>TM</sup> (Nuance Communications, Inc., 2009). After the interview, the participants were presented with a collection of gift certificates to local businesses in appreciation of their participation.

#### *Inter-observer Agreement*

Inter-observer agreement data was collected for each participant by a trained second observer during a minimum of 40% of the sessions for each participant across phases. Two scorers independently scored each reading comprehension measure. An agreement was tallied if both scorers recorded the same score. The percentage of agreement was calculated by dividing the number of

agreements by the number of disagreements plus disagreements and then multiplying by 100. A minimum percentage score of agreement must meet 90%. A total of 50% of all reading comprehension tests were selected and checked for accuracy of scoring. There was 100% agreement on the scores given on comprehension tests.

### *Procedural Fidelity*

The research assistant observed and recorded independently and simultaneously on the researcher's implementation of intervention procedures using a prepared intervention protocol data sheet. Procedural fidelity was assessed for each participant in 100% of the sessions across phases. Procedural reliability was calculated by dividing the number of agreements by the number of agreements and disagreements and multiplying by 100%. Across all phases and all participants, procedural fidelity was followed in 99% of the sessions. Interrater agreement of procedural fidelity was calculated for 50% of sessions. Results indicate a 100% agreement of treatment fidelity for the study.

## **Results**

### *Effectiveness*

Figure 1 presents the percentage of reading comprehension questions correct across all participants as well as individual participant's data graphs with trend lines. A visual analysis of data showed an accelerating trend for the six participants in their performance only when the intervention was introduced.

Annie showed both low and declining test performance during baseline ( $M = 54.00\%$ ,  $n = 3$ ), with a great measure of variability during the intervention phase. Colin's baseline phase  $M$  was  $44.75\%$ , with a downward trend being noted ( $n = 4$ ). Three of his highest scores occurred in the intervention phase ( $n = 4$ ),

even with some variability being noted. Hugh's mean score during baseline was  $54.2\%$  with a downward trend noted ( $n = 5$ ). Once in intervention, Hugh demonstrated a clear upward trend after the initial session with the device ( $M = 78.13\%$ ,  $n = 4$ ). His final three data scores indicated a mean of  $83.3\%$ . During baseline, Joanne showed variability, but ultimately presented a downward trend in performance ( $M = 37.50\%$ ,  $n = 4$ ). Once in intervention, she scored her five highest test scores, even with variability again being noted. Jeff's baseline demonstrated a downward trend with an average comprehension test score of  $36.7\%$  ( $n = 4$ ). An immediate effect of intervention was noted, with a 42-point improvement in his first intervention comprehension test. Further, his three highest test scores occurred during intervention. During baseline, Sabron demonstrated variability in his test performance, but once the intervention was introduced, he steadily increased his test scores on all but one concurrent session during the intervention phase. Only a slight increase in his trend line was noted from baseline to intervention phase.

Further analysis consisted of calculating a percentage of non-overlapping data points (PND). Given that the intervention for this study was designed to increase target behavior (i.e., reading comprehension test scores), the PND procedure was used to determine the percentage of all data points during intervention which fell above the highest baseline data point. When evaluating the effectiveness of an intervention, PND scores above  $85\%$  suggest a highly effective intervention; scores between  $65\%$  and  $85\%$  suggest a moderate intervention, and scores below  $65\%$  may indicate marginally effective intervention. Therefore, Colin, Joanna, Annie, and Jeff's percentages suggest a moderate intervention effect. Hugh's percentage would suggest this intervention was only marginally

effective for him, while Sabron showed no benefit from the use of the device.

Improvement rate difference (IRD) was calculated for each participant and were reported as percentages. An IRD score of 100% would indicate that all data points during the intervention phase exceeded all baseline data points. Therefore, the closer the IRD value is to 100%, the more effective the intervention (Parker, Vannest, & Brown, 2009). Under this measure of effect, Colin and Jeff demonstrated improvement rates of 50% that suggest a moderate effect of the intervention. Joanna and Annie demonstrated slight improvement rates with scores of 19% and 17% respectively, with Hugh and Sabron showing limited difference in the improvement rate across phases with a score of 10% and 7%, respectively. Thus based on these results, the intervention achieved mixed benefits with some students performing better with the use of Classmate Reader whereas others demonstrating slight improvements.

#### *Social Acceptability and Validity*

After the study concluded, most students reported that the use of *ClassMate Reader* aided their performance on the comprehension quizzes and they would use the device to assist with their coursework if the device were available to them. Conversely, only 16.7% felt their performance was aided most in the traditional format of paper/pencil alone. In addressing the participants perceptions of their comfort with the device, five out of the six participants agreed with the statement that they would feel comfortable using *ClassMate Reader* around their peers.

Five concerns emerged from the anecdotal comments by participants related to the social acceptability and validity of the device: portability, time benefit, ability to proofread, increased memory, and technology as a benefit. The most prevalent concern centered

on the portability of the device. For example, participants discussed the benefit of having a device that can “just be thrown in my book bag.” As one participant stated, “This thing is so little. I can throw it in my purse and have it available when I have a few minutes. I cannot do that with my laptop.” Another noted, “I can still get done what I need, but it is easier for me to carry the Classmate around versus an entire computer.”

A second concern reflected the time benefit of using the device. For example, five of the six participants discussed how time intensive reading material for class was for them. Each of the five discussed having to “read material over and over” to retain the information. One participant stated that, “My reading is so slow that I know I miss stuff, so I go back and read and read. When I listen, I still get it, but it don’t take as long.” Another participant noted that the device would assist in both time for reading as well as time management when stating, “The fact I read slow – I get it. This device takes that pressure off and so I feel like the time I save struggling with the reading or procrastinating to not read will help with my overall time management.”

A third concern that was expressed by four of the six participants was the additional benefit of the device to have the ability to proofread their work before submitting an assignment. For example, one participant stated,

I am a slow writer too and so by the time I finish, I don’t wanna mess with reading it over, so I just turn it in. This thing will let me listen to my assignment and I can check for errors without looking at the paper.

A fourth concern related to the helpfulness of both seeing and hearing the information was to their ability to recall information. One participant stated, “When I hear it, I can remember it – so I know that helps. I mean it

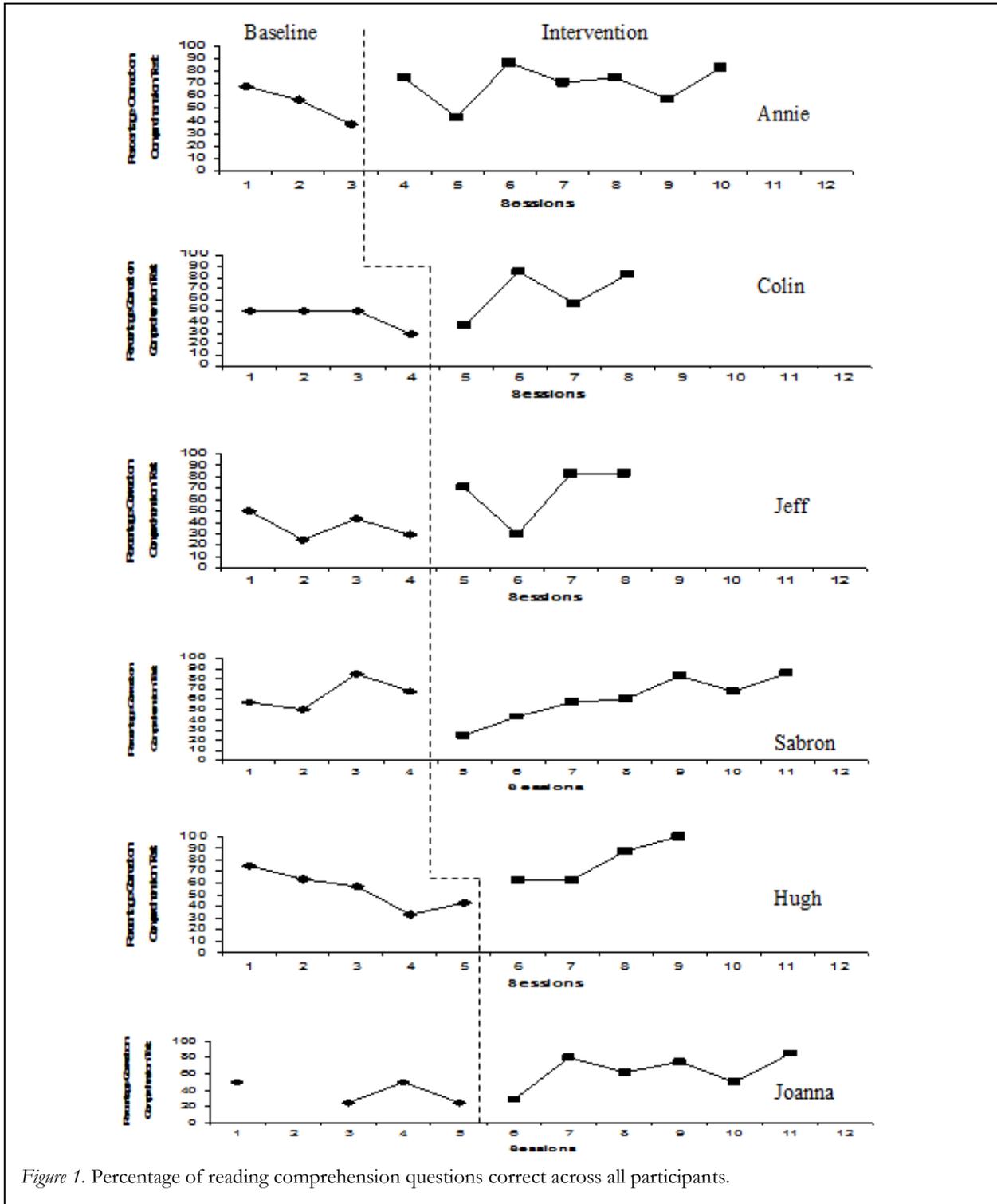


Figure 1. Percentage of reading comprehension questions correct across all participants.

has to give me some help, you know.” Another participant is keenly aware of the challenge of his disability and notes the challenge that reading fluency may play in his ability to remember information by stating: “I

am fighting to decode and sound out, so I lose the mental image. When I hear it, I can also see it and that helps me remember what I have just read.”

A final concern reflected technology as being a benefit to these participants. Three of the six participants felt that technology aided their learning in ways that are separate and unique from the assistance of people as evidenced in one participant's thought that "I would much rather rely on technology than people. My laptop and this thing have not shown up or given me wrong information." Additionally, another participant noted, "I have found that technology has been a life saver for me. I need to have technology to support and combat, I guess, my struggles that come from my dyslexia."

## Discussion

Although this study specifically sought to ascertain the effectiveness of *ClassMate Reader*, outcomes illustrate that AT can be a viable support at the postsecondary level. The relevance of such information parallels the fact that most frequent accommodations for postsecondary students with LD is testing accommodations (e.g., extended time, read aloud, separate setting). There is much research needed to effectively meet the educational needs of postsecondary students with LD as it relates to the reading and comprehension of printed material.

### *Effects of ClassMate Reader*

Carson, Chase, Gibson, and Hargrove (1992) found a postsecondary student's ability to read is of vital importance for academic success as reported by both faculty and students. In this current study, it was hypothesized that the use of the device would aid in reading comprehension performance, given that the device would read aloud text to the participant, thus removing the barrier of participant's independent reading ability. Removal of this barrier allowed for the demonstration of their knowledge, which is the essence of an effective accommodation (McKevitt & Elliot, 2000).

The results of this study mirror the findings that AT is a viable support for postsecondary students with LD in completion of reading comprehension tasks (e.g., Elkind et al., 1996; Hecker et al., 2002; Higgins & Raskind, 1998). In the previous studies, benefit was noted when reading performance with the use of Kurzweil was compared to similar reading performance without the aid of the text-to-speech software. One noted difference from these studies is that not all participants demonstrated improvement. This was not the case for the current study, given that all participants, regardless of their reading ability, performed at a higher skill level with the support of the device. For example, only one of the participants was able to score above an 80% on the reading comprehension test without the aid of the device. Conversely, all participants achieved two scores of 80% within a maximum of seven trials when utilizing the device. Clearly, these participants were better able to demonstrate their comprehension abilities with the device than without it. These observations are further supported by the fact that several different metrics demonstrated positive intervention for most participants.

It was of interest that none of the participants demonstrated apprehension of using new technology. Perhaps the participants, being natives of the technology generation, could explain this. Further, prior to the onset of this study, only one participant took advantage of text-to-speech capabilities, yet all participants were aware of computerized speech and quickly grew accustomed to the didactic presentation of text. Commonly, AT is often viewed as being primarily for students with more significant disabilities; therefore, this study further extends the literature as to the feasibility of providing AT for students with mild disabilities such as LD. With a clear trend reversal noted in all participants during the intervention phase, the findings of this study support the conclusion that the use of

*ClassMate Reader* does benefit some postsecondary students with LD.

### *Social Validity*

Measuring the student's perceptions of their performance with and without the device, as well as the acceptability of using the device around their peers, were other measured outcomes of the study. Without knowing reading performance outcomes on the reading comprehension tests, five of the six participants felt the device aided their performance on the reading tests. This clearly demonstrates their confidence in the effectiveness of using such a device. Likewise, five of the six participants answered that they would feel comfortable using the device around their peers. With some research suggesting that one of the strongest indicators of AT abandonment is peer acceptance (Dickey & Bowman, 2004; Parette & Scherer, 2004), this high social acceptability is very encouraging for the likelihood of continued use.

Of further significance was that all but one participant would be willing to use the device for future coursework, if made available. Three participants have already placed requests with the AT Lab director for use of the device in their courses. Participants felt that having both the visual and oral presentation of the material would assist them in both the reading of material, but also a proofreading aid to their own work. Additionally, participants discussed how seeing and hearing the text would help with long-term memory. Without the device, the participants mentioned that they would struggle with simply reading the words and that the text was often quickly forgotten. This device would provide them with the support they need to have material presented in such a way that they can glean meaning and interact cognitively with the material more easily.

Beyond the realization by participants that this technology was beneficial, was the belief in technology as a tool to academic success. Each participant had a minimum of three accommodations afforded to him or her through disability services. Only two actually took advantage of those accommodations. However, all participants use various forms of technology to support their coursework (e.g., *DragonSpeak™*, *Pulse Smartpen™*, and *Natural Reader™*) which were not provided through disability support services.

All participants shared that they recognized the importance of reading at the postsecondary level. This realization ties to the expectation of increased literary competence at the postsecondary level held by both faculty and students. In support of this realization, five of the six participants indicated that having assistance with reading comprehension was vital to their success in college. Further stated, their perception was that ongoing reading support was a necessity, not a luxury.

### *Limitations and Future Research*

There are several limitations to this study that should be noted. One limitation is the small sample size. Although a small sample size is appropriate for single subject research designs, only six students were involved. Further, the specific deficits and learner characteristics of the participants within the study may limit the ability to generalize the findings to a larger disability set. Replication with more participants and participants with different skill levels will be beneficial in understanding the use of *Classmate Reader* to improve reading comprehension performance.

To address external validity, experimental conditions were replicated across participants and materials. Lack of ethnic diversity of the participants may also limit the ability to

generalize the findings to a larger population. Further, this study was comprised of a convenience sample of students who volunteered for the study. These students were a subgroup of the STEPP Program that represents a very unique group of learners that limits the external validity as well.

To address internal validity, possible maturation effects were compensated for by each participant completing the study within the same time frame. Given that each comprehension measure was unique, there was limited influence of testing effects. Yet, there may be a risk of variability in the results across the reading samples due to inherent differences in the samples. To mitigate this possibility, however, samples were randomly assigned across participants. Instrumentation effects were addressed by requiring the researcher or research assistant to perform a maintenance check on each *ClassMate Reader* prior to its use by participants.

To address the potential for interaction among participants, the use of a text passage and test bank was utilized. The duration of the study was a limitation in that the study lasted for only six weeks. Although extending the study in this instance was not feasible due to program requirements of STEPP in which participants were involved, a lengthier study would provide evidence of sustainability of the participant performance. Current findings need to be viewed in light of the above limitations, thus caution is advised in generalizing these findings to populations involving LD.

The need for further examination of avenues in which to increase the carryover of successful accommodations and AT from secondary schools to postsecondary institutions is needed. Careful and systematic review of documented accommodations and AT that aligns with the student's skill deficits should provide a clear description of needed

supports in settings beyond high school. Future research should include the investigation of other products available such as smartphone apps, *Pulse Smartpen™*, and *Natural Reader™* to see if similar results are achieved. Future research should also include examination of students' participation in IEP meetings at the secondary level to determine if their participation better prepares them to effectively self-advocate once they enter postsecondary settings. By providing a succinct and direct process, the student will gain skills needed to navigate the challenges of self-advocacy in a straightforward and consistent framework.

More information is needed on the influence exerted by postsecondary faculty on the educational success of students with LD at the postsecondary level. The empirical body of research needs to be expanded in order to provide such directives to postsecondary faculty. Once strategies, accommodations, and technology are established, faculty must be trained and supported as they work toward including effective practices into their classroom environments. Just as faculty are encouraged to learn the elements of effective instruction in distance learning environments, the same effort must be placed into providing classroom instruction focused on research-based instructional strategies and technologies that benefit postsecondary students with LD.

## Conclusions and Implications

The results of this study provide support for the use of the *ClassMate Reader* to improve the reading comprehension performance of postsecondary students with LD. This is an initial step in addressing the academic challenges students with LD face at the postsecondary level.

Recognizing the current state of support for students with LD at the postsecondary level, there is a need for mandated examination of

effective intervention practices for this population. Therefore, with the current passage of the HEOA, the timeliness of this research is without question. From the findings of this study, it is evident that AT provides a viable option for these students.

Postsecondary institutions have the luxury of being exempt from Copyright Act by the Chaffee Amendment (1996). This exemption is afforded to nonprofit organizations or governmental entities for the purpose of training or education (Wolfe & Lee, 2007). Postsecondary institutions can capitalize upon this opportunity to convert print materials into alternative media formats as well as encourage publishers to provide textbooks and other instructional materials in alternative media formats. As more alternative media materials become available through government initiatives (e.g., NIMAS; NIMAC), research agendas must be developed to ascertain the most effective format for assisting students with LD across skill areas.

Postsecondary disability support personnel must be kept abreast on the use and benefits of AT for students with LD. By doing so, appropriate supports and services can be made available to students upon entering the postsecondary environment. By providing appropriate AT to assist with the completion of coursework, in conjunction with supports during testing situations, this dual effort may combat the high attrition rate experienced by students with LD at the postsecondary level.

## References

Allsopp, D., Minskoff, E., & Bolt, L. (2005). Individualized course-specific strategy instruction for college students with learning disabilities and ADHD: Lessons learned from a model demonstration project. *Learning Disabilities Research & Practice, 20*, 103-118.

- Anderson-Inman, L., & Horney, M. A. (2007). Supported e-text: Assistive technology through text transformations. *Reading Research Quarterly, 2*, 153-160.
- Carson, J. O., Chase, N. D., Gibson, S. U., & Hargrove, M. F. (1992). Literacy demands of the undergraduate curriculum. *Reading Research and Instruction, 31*(4), 25-50.
- Castellani, J., & Jeffs, T. (2001). Emerging reading and writing strategies using technology. *Teaching Exceptional Children, 33*(5), 60-67.
- Classmate Reader (Version 1.0) [Hardware]. (2009). Retrieved from <http://www.humanware.com/en-usa/search?keywords=ClassMate+Reader+audio+book+player&go=yes>
- Dickey, A., & Bowman, C. (2004). Special education and assistive technology to the rescue for literacy teaching and learning. In C. Crawford et al. (Eds.), *Proceedings of society for information technology and teacher education international conference 2004* (pp. 4899-4901). Chesapeake, VA: AACE.
- Dragon Speak (Version 9.5) [Software]. (2009). Burlington, MA: Nuance.
- Eckes, S., & Ochoa, T. (2005). Students with disabilities: Transitioning from high school to higher education. *American Secondary Education, 33*(3), 6-20.
- Edyburn, D. L. (2000). Assistive technology and students with mild disabilities. *Focus on Exceptional Children, 32*(9), 1-24.
- Elkind, J. (1998). Computer reading machines for poor reader. *Perspectives, 24*, 9-13.
- Elkind, J., Black, M. S., & Murray, C. (1996). Computer-based compensation of adult reading disabilities. *Annals of Dyslexia, 46*, 159-186.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory* (11th Printing, 1980). Hawthorne, NY: Aldine.
- Gerber, P. J., Schnieders, C. A., Paradise, L. V., Reiff, H. B., Ginsberg, R., & Popp, P. A. (1990). Persisting problems of adults with learning disabilities: Self-reported comparisons from their school-age and adult years. *Journal of Learning Disabilities,*

- 23, 570-573.
- Hecker, L., Burns, L., Elkind, J., Elkind, K., & Katz, K. (2002). Benefits of assistive ready software for students with attention deficit disorders. *Annals of Dyslexia*, 52, 243-272.
- Heiman, T., & Kariv, D. (2004). Coping experience among students in higher education, *Educational Studies*, 30, 441-455.
- Higgins, E. L., & Raskind, M. H. (1998). The compensatory effectiveness of optical character recognition/speech synthesis on reading comprehension of postsecondary students with learning disabilities. *Learning Disabilities*, 8, 75-87.
- Higher Education Opportunity Act, 20 U.S.C. 1001 § 403 (2008)
- Humanware Group. (2005-2012). *Humanware. See things differently*. Retrieved from <http://www.humanware.com/en-usa/search?keywords=ClassMate+Reader+audio+book+player&go=yes>
- Kazdin, A. E. (1982). *Single-case research designs: Methods for clinical and applied settings*. New York: Oxford Press.
- Kennedy, C. H. (2005). *Single-case designs for educational research*. Boston: Pearson.
- Lerner, J., & Johns, B. (2012). *Learning disabilities and related mild disabilities: Characteristics, teaching strategies, and new directions* (12th ed.). Independence, KY: Cengage Learning.
- Madaus, J., & Shaw, S. (2006). Disability services in postsecondary education: Impact on IDEA 2004. *Journal of Developmental Education*, 30(1), 12-21.
- Mathur, H. (2010). *Practice tests and resources for high school, college and graduate tests*. Retrieved from <http://www.majortests.com/>
- McKevitt, B. C., & Elliot, S. N. (2003). Effects and perceived consequences of using read-aloud and teacher-recommended testing accommodations on a reading achievement test. *School Psychology Review*, 32, 583-600.
- Mull, C., Sitlington, P. L., & Alper, S. (2001). Postsecondary education for students with learning disabilities: A synthesis of the literature. *Exceptional Children*, 68, 97- 118.
- National Center for Educational Statistics. (2000). *Postsecondary students with disabilities: Enrollment, services, and persistence*. Washington, DC: U.S. Department of Education. Retrieved from <http://nces.ed.gov/surveys/peqis/publications/2000092/>
- National Council on Disability. (2003, September). *People with disabilities and postsecondary education. Position Paper*. Retrieved from <http://www.ncd.gov/publications/2003/Sept152003>
- U.S. Department of Education. (2011). *National assessment of educational progress*. Retrieved from: <http://nces.ed.gov/nationsreportcard/about/naeptools.asp>
- Olson, R. K., & Wise, B. W. (1992). Reading on the computer with orthographic and speech feedback. *Reading and Writing: An Interdisciplinary Journal*, 4, 107-144.
- Parker, R., Vannest, K., & Brown, L. (2009). The improvement rate difference for single-case research. *Exceptional Children*, 75, 135-150.
- Parette, P., & Scherer, M. (2004). Assistive technology use and stigma. *Education and Training in Developmental Disabilities*, 39, 217-226.
- Raskind, M. H. (1994). Assistive technology for adults with learning disabilities: A rationale for use. In P. J. Gerber & H. B. Reiff (Eds.), *Learning disabilities in adulthood: Persisting problems and evolving issues* (pp. 152-162). Stoneham, MA: Andover Medical.
- Raskind, M. H., & Higgins, E. L. (1999). Speaking to read: The effects of speech recognition technology on the reading and spelling performance of children with learning disabilities. *Annals of Dyslexia*, 49, 251-281.
- Roberts, T. B. (2008). Evidence-based strategies for reading instruction of older students with learning disabilities. *Learning Disabilities Research and Practice*, 23(2), 63-69.
- Sparks, R. L., & Lovett, B. J. (2009). *College Assistive Technology Outcomes and Benefits*

- students with learning disability diagnosis: Who are they and how do they perform? *Journal of Learning Disabilities*, 42, 494-510.
- Stodden, R., Conway, M., & Chang, K. (2003). Findings from the study of transition, technology, and postsecondary supports for youth with disabilities: Implications for secondary school educators. *Journal of Special Education Technology*, 18(4), 29-44.
- Trainin, G., & Swanson, H. L. (2005). Cognition, metacognition, and achievement of college students with learning disabilities. *Learning Disability Quarterly*, 28, 261-272.
- Vickers, M. Z. (2010). *Accommodating college students with learning disabilities: ADD, ADHD, and dyslexia*. Raleigh, NC: John W. Pope Center for Higher Education Policy. Retrieved from <http://www.popecenter.org/acrobat/vickers-mar2010.pdf>
- Vaughn, S., Levy, S., & Coleman, M. (2002). Reading instruction for students with LD and EBD: A synthesis of observation studies. *Journal of Special Education*, 26, 2-13.
- Wagner, M., Newman, L., Cameto, R., Garza, N., & Levine, P. (2005). After high school: A first look at the postschool experiences of youth with disabilities. *A report from the national longitudinal transition study – 2 (NLTS2)*. Menlo Park, CA: SRI International.
- Warde, B. (2005). Reading miscues of college students with and without learning disabilities. *Journal of College Reading & Learning*, 36(1), 21-36.
- Welch, M. (2010). Instructional technological factors that impede and impel struggling adolescent students' reading comprehension. *The International Journal of Technology*, 6, 137-150.
- Wolfe, G., & Lee, C. (2007). Promising practices for providing alternative media to postsecondary students with print disabilities. *Learning Disabilities Research & Practice*, 22, 256-263.