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The Effects of a Speech-to-Text Software Application on Written Expression for Students with Various Disabilities

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Abstract

The purpose of the study was to determine the efficacy of speech-to-text software across diagnoses and to determine if training cognitive load could be minimized. Participants represented three categorical disabilities affecting the areas of reading and written expression. Researchers analyzed the samples of students' writing with and without the supports of speech-to-text software.

The individuals who make-up today's society function in an era of talking to the varied electronic devices in their daily lives. They think nothing of talking to their computers, video games, phones, cars and receiving verbal responses in return. Hearing a computer-generated voice ask questions requiring a response is now the norm and hearing a human voice asking the questions has become unique. Knight (2012) summarized this phenomenon with the statement, "Our culture is rapidly moving into a more extensive voice interface arena and the individuals making up our younger generations are unfamiliar with any other world. Consequently, today's students are not engaged nor are they motivated by other approaches.

In the age of public school accountability, educators need to grasp and utilize instruction and learning strategies that appeal and engage students. The 1997 Reauthorization of the Individuals with Disabilities Education Act (IDEA) made the charge of school accountability even more challenging. IDEA 1997 (1998) held schools accountable for the achievement of all

students including those receiving special education services. From that point forward, it is required that students with disabilities be included in general state and district wide assessment programs assessing student learning.

Within the population of students with disabilities, the acquisition of written expression skills is a difficult and enduring problem. The inability to put thoughts to words and then to paper is a common obstacle encountered by children with disabilities. If technology, specifically speech-to-text software, can provide students with disabilities reasonable and appropriate accommodations to increase educational learning and performance on assessments, educators should be diligent in taking advantage of these opportunities.

Word processors as a means of transferring thoughts into text for manipulation and revisions have been used for decades; however, speech-to-text programs that converts spoken word to written language is relatively new. Speech-to-text programs are a type of software that effectively takes audio content and transcribes it into written words in a word processor or other display destination. Originally developed as an assistive technology for the hearing impaired, today its applications are virtually limitless. Older versions of speech-to-text programs required training to recognize a specific person's speech before attaining an acceptable level of accuracy. Newer programs can decipher the average person's speech without much training required, opening up possibilities for new applications of the technology. As a result, speech-to-text programs have a promising outlook as a means to aide students with disabilities in their written expression endeavors in the classroom (MacArthur, 2009).

Speech-to-text program can be used to help student's compensate for the individual challenges with transcription, spelling, handwriting and conventions such as punctuation and capitalization. Students who have these needs could potentially benefit from using these types of programs beyond the classroom such as test accommodations and life situations past the school setting (McArthur & Cavalier, 2004). Many types of speech-to-text software exist today. Google's *Google Voice*; Nuance's *Jott* and/or *Dragon Dictation*; Crescendo Systems' *Crescendo Speech Processing*; Nuance's *Dragon Naturally Speaking*; me2me's *Frisbee*; Spantel's *TSP*; and *MacSpeech Dictate* are current examples of this type of technology (Williams, 2010). This creates a teacher responsibility to research the software that best serves the needs of the students using it.

Exponentially important when choosing a speech-to-text program for students with disabilities is the critical issue of ease of training and use. While many programs have proven to be helpful for most students, there are at times the challenges posed by software training and use that creates what can be referred to as cognitive overload for students with disabilities. The programs tended to recognize most adults' voices, but unfortunately did not always recognize children’s voices. Some children showed low accuracy when using the software while others were not recognized at all (Higgins & Ranskind, 2004). In addition, lengthy training modules with extensive reading also proved to be difficult for many students with disabilities that did not having adequate reading skills.

The Purpose

The purpose of this study was to examine the potential of speech-to-text software dictation as a means of composing a written piece for students with disabilities. After careful analyses of different speech-to-text programs and the best design to meet the students' in the

study's needs, this researcher chose Nuance's *Dragon Naturally Speaking*. Three research questions guided this study. First, does the use of speech-to-text software affect the total words written per writing sample, number of multisyllabic words per writing sample and number of Correct Writing Sequences per writing sample of students? The next query asked, does the use of speech-to-text software make a positive impact on the writing samples of students with various disabilities. The final question asked, can the cognitive demands of speech-to-text software training and use be effectively reduced for students with various disabilities.

Participants

The participants included three school-age students. The first participant was a third grade male student with specific learning disabilities in the areas of reading and written language; the second participant was a second grade male student with emotional disturbance and the final student was an eleventh grade female student with an intellectual disability. Because of the heterogeneity of the identified population, students met the following criteria to be eligible for participation in the proposed study: a) trained professionals in the public schools district identified each participant, through diagnostic assessments, as a student with a categorical disability as designated by IDEA, 2004; b) academic performance for each student was at least one or more standard deviations below the mean on a standardized test of written language and reading; and c) the students received special education services in either a resource or self-contained setting. In addition, the study was limited to students who primary language was English. Participants were not balanced by race, gender or socio-economic status.

Each student participating in the study was administered a series of training to use the tools for *Dragon Naturally Speaking* (DNS).Training included a) quick voice formatting; b) dictating documents; c) editing documents and d) correcting errors. Participants were also administered an Informal Attitude Inventory activity involving a questionnaire and thought bubble drawing exercise. This informal technique provided insight into the students' emotional status toward academic skills and activities. Johnson (2005) proposed using questionnaires in conjunction with the thought bubble assessment as a method that can be used to uncover students' beliefs about themselves. In addition, Le Count (2000), suggested drawings allow researchers to understand their study members from the inside out because drawing frees students to express emotions and ideas they might not say or be able to say in words.

Method

This study involved three phases. The first phase involved completing the software training. Student training took place one hour per day for five days. Training addressed how to use the speech-to-text software which was the latest version DNS. Modifications were made to lessen the cognitive requirements for the training process. The prescribed training process required the user to read words on the screen as a yellow arrow highlighted them. The lowest level reading content for the instructional training sessions was at a third grade level, so, because 2 of the three students read below this level, modifications were made. The trainer first read the

sentences presented and then the students were allowed to practice the passage. This prevented readability from being a training issue that would prohibit student use of the software.
The second phase involved data collection using repeated-measures design (pretest-posttest). All research participants received all treatment conditions. This design had the advantage of requiring fewer participants than other designs because the same participants participated in all experimental conditions. This design also had the advantage of the participants in the various experimental groups being equated because they are the same participants in all of the treatment conditions.

During the pretest, each student was given a choice of three picture prompts about which to write. Each student was then given a piece of paper and asked to hand write a response. During this pretest, students were not provided any assistance in spelling, grammar or punctuation. Students then independently completed their writing sample. Each of the writing samples were then analyzed to determine the total words written per writing sample, number of multisyllabic words per writing sample and number of Correct Writing Sequences (CWS) per writing sample. With only a short passage of time, students were administered a posttest using the same format at the pretest with the exception of being allowed to use speech-to-text software to transfer thoughts to paper.

The procedures for measuring writing content in both the pre and post assessments involved untimed writings. For total words written, all words that made sense were counted, excluding garbles that are incomplete words, conversational asides, false starts, redundancies or words that did not make sense in context. Misspelled words were not counted as errors as long as the word could be deciphered. Final scores were reported as number of words per writing sample. The number of multisyllabic words per writing sample was measured by counting all multisyllabic words that made sense, excluding garbles that are incomplete words, conversational asides, false starts, redundancies or words that did not make sense in context. Misspelled words were counted as long as the word could be deciphered. Correct Writing Sequence tabulations involved the measure of correct 'writing sequences' written during the assessment. One Correct Writing Sequence was scored whenever two adjacent units of writing (e.g., two words appearing next to each other) were found to be correct in their punctuation, capitalization, spelling, and syntactical and semantic usage (Wright, 2013).

Phase three involved administering an informal attitude and dispositions survey designed to uncover participants' feelings toward writing and themselves as writers. The informal attitude assessment involved three open-ended survey questions and thought bubbles response exercises. Zambo (2006) suggested combining drawing and writing more effectively gauged student internal feelings about writing. The students were asked to provide responses for the three following questions:

1. What are your feelings about writing?
2. How well do you feel that you write?
3. Describe what it means to be a good writer?

The responses were then recorded on the sheet to be included with each student's writing files. The students were also given a thought bubble exercise. The thought bubble exercise was modeled after Zambo's (2006) thought bubble exercise design. Each sheet contained a male or female character, research participants were allow to choose one of the characters, which is

pictured writing on a piece of paper with thought bubbles above their head. The student was asked to draw the character's face as they are writing. Then each student was told to write in the thought bubble what the character was thinking while writing.

The drawing and the writing were then analyzed and scored based on a table provided for the instrument (Zambo, 2006). Three observers were used to eliminate probability of bias. The scores between -2 and +2 were given for both face and dialogue analyses. Therefore, the total could be as positive as +4 (+2 face and +2 dialogue) or as negative as -4 (-2 face and -2 dialogue). Again, this was not a scientifically, research based practice; this informal assessment did give some insight into the participating student's feelings of writing. As shown above, this informal assessment was also originally designed for reading, but was redesigned to include writing.

Results

The first phase of data collection involved repeated-measures (pretest-posttest) designed to reveal changes in the students total words written per writing sample, number of multisyllabic words used per writing sample and number of Correct Writing Sequences per untimed writing sample of students with various disabilities. Pretest scores represent student writing samples produced manually and posttest scores represent student writing samples produced with the assistance of voice-to-test software. To obtain inter-rater reliability, three examiners scored the student writing samples in all three categories. Comparison of the pretest and posttest results revealed changes in student performances.

Total Words Written

Total words written score for this research was characterized as a count of the number of words written. The word count was defined as all words that made sense, excluding garbles that were incomplete words, conversational asides, false starts, redundancies or words that did not make sense in context. Misspelled words were not counted as errors as long as the word could be deciphered. The pre/posttest comparisons revealed the following results for each student.

Analysis of pretest results for Student A revealed a total words written score of 18 words per writing sample and a posttest score of 113 words per writing sample. This represented a gain of 95 words per writing sample. Analysis of pretest results for Student B revealed a total words written score of 15 words per writing sample and a posttest score of 47 words per writing sample. This represented a gain of 35 words per writing sample. Analysis of pretest results for Student C revealed a total words written score of 22 words per writing sample and a posttest score of 101 words per writing sample. This represented a gain of 79 words per writing sample. The results can be found in Figure 1.

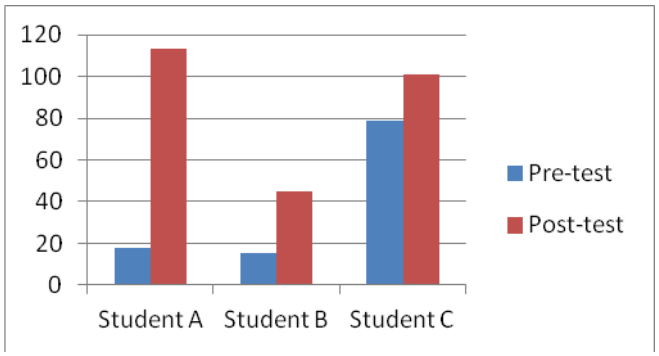

Figure 1. Total words written.

Multisyllabic Words Used

Total number of multisyllabic words per writing sample for this research was characterized as a count of the number of all multisyllabic words used per writing sample. A multisyllabic word was defined as all words containing more than one syllable that made sense, excluding garbles that are incomplete words, conversational asides, false starts, redundancies or words that did not make sense in context. Misspelled words were counted as long as the word could be deciphered. The pre/posttest comparisons revealed the following results for each student.

Analysis of pretest results for Student A revealed a total of 2 multisyllabic words used per writing sample and a posttest score of 20 multisyllabic words per writing sample. This represented a gain of 18 multisyllabic words per writing sample. Examination of pretest results for Student B revealed a total of 7 multisyllabic words used per writing sample and a posttest score of 9 multisyllabic words per writing sample. This represented a gain of 2 multisyllabic words per writing sample. The breakdown of pretest results for Student C revealed a total of 2 multisyllabic words used per writing sample and a posttest score of 8 multisyllabic words per writing sample. This represented a gain of 6 multisyllabic words per writing sample. Figure 2 contains the results.

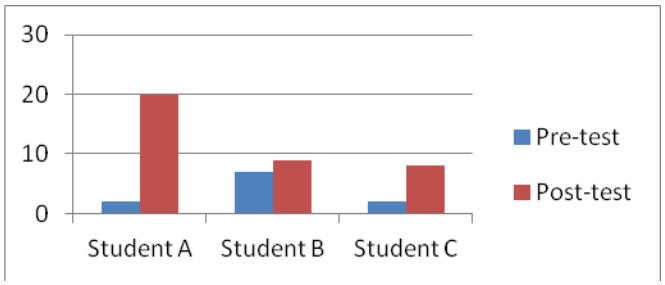

Figure 2. Multisyllabic words used.

Correct Writing Sequences

The final investigation required the examination of Correct Writing Sequence (CWS). CWS tabulations involved the measure of correct writing sequences written during the assessment. One CWS is scored whenever two adjacent units of writing (e.g., two words

appearing next to each other) are found to be correct in their punctuation, capitalization, spelling, and syntactical and semantic usage (Wright, 2013). Pre/posttest comparison revealed the following for each student.

Analysis of pretest results for Student A revealed a total of 4 CWSs. Examination of Student A's posttest revealed a CWS score of 106. This represented a gain of 102 CWS points per writing sample. Examination of pretest results for Student B revealed a total CWS score of 1 and a posttest CWS score of 44 per writing sample. This represented a gain of 43 CWS points per writing sample. The breakdown of pretest results for Student C revealed a CWS score of 4 and a posttest CWS score of 93 per writing sample. This represented an increase of 89 CWS points per writing sample. Figure 3 includes the correct writing sequences.

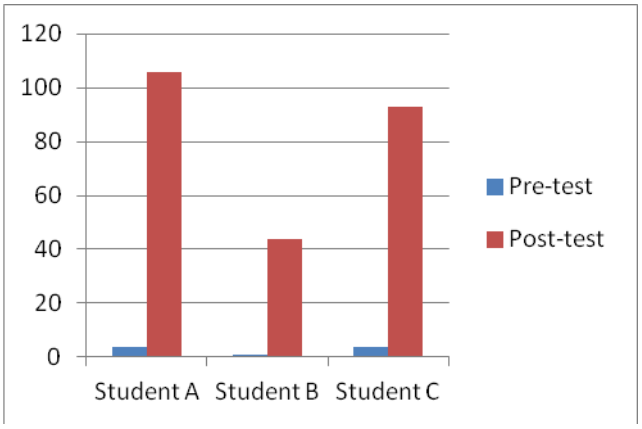

Figure 3. Correct writing sequences.

Informal Attitude Survey

The informal attitude assessment of writing involved three open-ended survey questions and thought bubbles response exercises, modeled after Zambo (2006) reading attitude assessment. The survey was given to identify participants' general attitudes toward writing; their own writing skills and writing experience using speech-to-text software. Analysis of student drawings involved using a code system that scored the physical features of the face, emotional cues and the information written in the thought bubble. Each item was ranked from +1 positive, 0 for neutral and -1 for negative feelings. Overall scores can range from +4 to -4. The informal attitude assessment was administered to determine the results of the effect of the speech-to-text technology for the writing abilities. Three different recorders scored the face drawing and thought bubble words. To ensure inter-rater reliability all three discussed the expectations and scoring of assessment items prior to final individual scoring. This assessment was given after students were trained and allowed to use speech-to-text software when writing. The following scores were reported for each student. The Student A and student B earned an overall score of +1 attitude toward wring. Student C has a neutral score of 0.

Discussion

K-12 educational curriculum scope and sequence outline expectations for the writing processes and procedures. Within that scope and sequence, student writing skills proficiencies clearly delineated. The Common Core State Standards expands the importance of writing skills and processes for all learners as reflected in Writing - Standard 10 stating students should routinely be able to write for a range of tasks, purposes, and audiences. Graham and Perin (2007a & 2007b) called further attention to the importance by suggesting writing allows for communication with of what one knows or thinks about a particular topic. Learning to write is a remarkable achievement as writing utilizes multiple cognitive skills when the writers generates ideas, organizes them, and execute the physical acts of writing (Kulikowich, Mason, & Brown, 2008). Proficient writers draw upon a wide collection of fundamental abilities. To be effective writers, students must be fluent in word and vocabulary use, as well as a working knowledge of syntax (Nelson & Van Meter, 2007; Kuder, 2013). The National Assessment of Educational Progress (NAEP) further supports the importance of writing and the need to improve student-writing skills. According to the NAEP research results, the majority of students do not write well enough to meet the expectations of higher academics and the workforce with as few as one-third of the nation's students score at or above the proficient level indicating a strong academic performance (Persky, Daane, & Jin, 2003). With writing being the primary means of assessing content knowledge, Graham and Perin (2007a & 2007b) point out those students who are struggling writers are at a particular disadvantage in academic settings.

Research Questions

This research addressed the use of speech-to-text software as an accommodation for students with special needs to improve their attitude toward and skill with writing. The results of the study addressed the following research questions with some interesting and positive results.

1. Does the use of speech-to-text software affect the total words written per writing sample, number of multisyllabic words per writing sample and number of Correct Writing Sequences per writing sample of students?

Total words written. The writing fluency is one measure that can assist in assessing students' writing achievement and monitoring progress. The information gathered from the students' performance on the writing fluency and other writing measures often focuses on the count of the number of words written (Venn, 2004). This knowledge leads to the development of this study's first research question. Analysis of the pre/post test results discovered the following.

Analysis of pre/posttest results for all three students did reveal an increase in the total number of words written with Student A demonstrating a gain of 95; Student B showing a gain of 35 words per writing sample; and Student C exhibited a gain of 79 words per writing sample. When using speech-to-text software, students demonstrated an average increase of 70 words per writing sample.

Multisyllabic words used. Encoding and decoding are the most basic of literary skills. Decoding is simply reading, processing the words and understanding their meaning. Encoding is

spelling, or writing out words to encode ideas (DeVries, 2011). To decode and encode multi-syllable words the student needs to apply more advanced strategies. Some students automatically develop the proper strategies for decoding and encoding words but many do not and struggle with these longer words. Because the majority of English words are multisyllabic, continued academic success is dependent on students' ability to effectively decode and encode multisyllabic words.

Examination of pre/posttest results for all three students did reveal an increase in the number of multisyllabic words used per writing sample. Student A revealed gain of 18 multisyllabic words per writing sample; Student B exhibited a gain of 2 multisyllabic words; and Student C displayed a gain of 6 multisyllabic words per writing sample. When using speech-to-text software, students demonstrated average increase 9 multisyllabic words per writing sample.

Correct writing sequences. The act of writing is complex. Translating thought into written expression requires that the student master a multitude of skills, including the physical production of text; and mastery of rules of capitalization, spelling, punctuation, and syntax (Robinson & Howell, 2008). Correct Writing Sequence measures the student's ability to apply the interrelated skills of basic mechanics and conventions of writing (Wright, 2013). Investigation of pre/posttest results for all three students did reveal an increase in the CWS score per writing sample. Student A posted a gain of 102 points in CWS per writing sample. While Student B revealed a gain of 43 CWS points per writing sample and Student C demonstrated a CWS score an increase of 79 points per writing sample. When using speech-to-text software, students demonstrated average increase in CWS scores of 75 points.

2. Does the use of speech-to-text software make a positive impact on the writing samples of students with various disabilities?

A short synopsis of research participants is critical to analysis of results and probable implications of those results. Student A is in the third grade and is a male who has an educationally diagnosed Specific Learning Disability affecting the content areas of reading, written expression, and mathematics. Student B is in the eleventh grade and is a female who has an educational diagnosis of intellectually disabled. Student C is in the second grade and is a male who has been identified as emotionally disturbed.

Total words written. Student A's earned a pretest score of 18 for totally words written and a posttest score of 113 words. This resulted in an increase of 95 total words written. Student B's pretest score was15 words and her posttest score was 47 words written. This is an increase of 35 total words written. Student C's pretest score was 22 words written and his post test score was101 words used. This represented an increase of 70 total words written. Overall all students demonstrated an increase in total words written when using speech-to-text software. This would support the concept that speech-to-text software can increase the total number of words included in the writing of students with various disabilities. It should be noted that the participant who had been diagnosed with a specific learning disability realized larger gains.

Multisyllabic word used. The pretest-writing sample of Student A included a total of 2 multisyllabic words. Student A's posttest sample contained 20 multisyllabic words. This

represents an increase of 18 multisyllabic words. Student B's pre-assessment writing contained7 multisyllabic words and her post-assessment writing included 9 multisyllabic words. Student C pre-assessment writing sample included 2 multisyllabic words while his post-assessment included 8 multisyllabic words. This represents an increase of 6 words multisyllabic words per writing sample. This would support the concept that speech-to-text software can increase the total number of multisyllabic words included in the writing of students with various disabilities. It should be noted only minimal increase were noted by the students diagnosed as Emotionally Disturbed and Intellectually Disabled. The participant who had been diagnosed with a specific learning disability realized larger gains.

Correct writing sequences. The pretest-writing sample of Student A earned a CWS score of 4. Student A's posttest writing sample earned of score of 106. This represents an increase of 102 points earned on CWS evaluations. Student B's pre-assessment writing earned a CWS score of 1 and her post-assessment writing earned a CWS score of 44. This represented a 43-point increase in her CWS score. Student C pre-assessment writing sample earned a CES score while his post-assessment writing earned a CWS score of 93. This represents an 89-point increase of Student C's CWS score.

All three components of the assessment does support the theory speech-to-text software makes a positive impact on the writing of students with various disabilities. However, it should be noted a greater impact was made on the writing of students diagnosed with specific learning disabilities.

3. Can the cognitive demands of speech-to-text software training and use be effectively reduced for students with various disabilities?

The readability of training presented the key challenge for research participants' use of speech-to-text software. A 3.0 reading passage level was the lowest level of training while participant reading levels of ranged from <1.0 to 4.0. To lessen the cognitive load of training for two participants whose reading level was 1.0 or lower, the participants were allowed to practice the passage prior to training. This accommodation to the training process appeared to be effective and was supported by positive gain in assessment scores.

The results from the informal writing attitude survey also supported the concept that the cognitive load of speech-to-text software can be effectively reduced for students with disabilities. After training had been completed and students were allowed to use the speech-to-text software for writing, student dispositions and attitudes toward writing was assessed with an informal survey. The Student A and student B earned an overall score of +1 and Student C earned a score of 0. Scores indicated the students held a positive to neutral self-efficacy beliefs toward writing. Current research supports the theory there is a significant correlation between self-efficacy beliefs, domain-specific focusing on specific abilities, and academic achievement (D'Amico & Cardaci, 2003).

Conclusions

The technology is ever improving. Teachers are held to very high standards for student educational growth. Students are technologically astute and their interests lie in the fast paced

world of the computer. Speech-to-text technology is one form of technology that can diminish the all too common issue of repeated failure for the student with educational challenges (McArthur & Cavalier, 2004). Whether it be a classroom aid or a test accommodation for a student with any educational challenge, speech-to-text technology can be a strong influence on students' skills in connecting writing to reading and generating thoughts to paper. With this tool as an accommodation to aid the success of these struggling students', expression previously denied for them due to educational challenges or physical impairments now become accessible and useful. With the proper selection of software and the training and use of the speech recognition programs, students with educational challenges can make great gains in their writing ability, motivation, and confidence as found in the three research subjects of this study. These three students made improvements in the areas of word count usage, vocabulary, and Correct Writing Sequences when allowed to use this speech-to-text technology. They also learned they could write and effectively express their thoughts. With today's society growing rapidly in technology and educational requirements for student growth ever increasing, why not use assistive technology that has been correctly chosen for and provides students with this ability and confidence?

Implications and Further Research

Educators need to continue their efforts to provide individuals with disabilities a Free and Appropriate Public Education (FAPE) and accommodations such as voice-to-text software could potentially offer students with a disability this opportunity. Accommodations as described in the literature are alterations of environment, curriculum format, or equipment that allows an individual with a disability to gain access to content and/or complete assigned tasks. Since accommodations do not alter what is being taught students with disabilities are able to pursue a regular course of study like students without disabilities. Not only will the use of voice-to-text software allow students to demonstrate their true knowledge but composing orally may help motivate students with disabilities to learn more about written language conventions as the technology frees them from perception and motor demands of handwriting. This study did not conclusively verify voice-to-text technology as a means to provide FAPE but does warrant a more in-depth longitudinal research investigation of how the potential voice-to-text technology could provide a more equitable education for individuals with various disabilities.

School accountability, the process of evaluating school performance on the basis of student academic acquisition, is increasingly prevalent around the nation. Consequently, accountability measures have become a centerpiece of district administrations' education policies. Centralized reporting of district and school-wide examination scores has been a concern for decades. Accommodations, such as voice-to-text technology, can make students' academic scores a truer reflection of student knowledge and competencies. So the time for placing greater emphasis on the use of student dictation and other oral modes of student production has now arrived. As the one-to-one initiatives are sweeping through schools, this technology offers a more viable option not only for students with disabilities but all students. It is important now to start considering how we can best use such tools and what teachers and students need to do to make them as effective as possible. In an age where electronic products rapidly become smaller

and more sophisticated, we may all soon prefer to talk to our computers instead of struggling with keyboards or handwritten forms of composing.

Many pose the theory there is a significant positive correlation between the constructs of positive self-efficacy and attitudes and academic growth (Bandura, 1997; Roskam & Nils, 2007; Schunk, 2003). While this research was not successful in improving the link between self-efficacy, attitudes and writing performance; the study did expose several valuable areas of future research. Writing proficiency in the individuals with disabilities are an important skill, and writing self-efficacy and attitudes does potentially play a role in writing performance. However, little research has been conducted concerning these areas. Few interventions designed to improve self-efficacy or attitudes have been conducted. It is imperative that this concept be explored further, to see if interventions can improve the efficacy and attitudes of individuals with disabilities. Additionally, it is important to investigate how factors such as technology can be used as an accommodation that will impact the effectiveness of student writing competencies and strengthen student attitudes toward writing. Regardless, the area of self-efficacy and attitudes and its impact on student effort and success with writing have nonetheless not been thoroughly investigated up to the present time, and so, should be a focal point for future research.

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