Using Technology to Support Students with Autism Spectrum Disorders in the Writing Process: A Pilot Study

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Writing is an important content area that pervades all subject areas and is required for post-school success, yet many students with autism spectrum disorders (ASD) often struggle in written expression. In this article we discuss the characteristics of students with ASD that make writing difficult, and the strengths, such as the use of technology, that can help support writing development. We then report findings of a pilot study that utilized First Author® software to improve the writing of secondary students with ASD. Research questions explored whether students would improve the quality and quantity of their writing products after receiving instruction in writing using the First Author® software, and whether the intervention would have social validity with the classroom teacher. Preliminary findings were mixed, indicating that students showed some improvements in writing quality and quantity when being taught using First Author®. Implications for teachers and practitioners discussed.

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People write for various reasons, from communication with others through emails or text messages, to personal expression, and when attempting to persuade others. For school-aged children in the United States, the recent implementation of the Common Core standards, with an added focus on writing instruction, requires students to become proficient writers, and to use writing across content areas (Common Core State Standards Initiative, 2014). Furthermore, colleges and universities require an extensive amount of writing in all major areas; for these reasons, those who cannot write fluently may face considerable challenges in higher education (Graham & Perin, 2007). Beyond the classroom, a recent graduate will find that many jobs require basic written language ability; a survey of business professionals found that effective communication in writing often is the difference between being hired and receiving promotions (National Commission on Writing, 2004). It is imperative, therefore, that students acquire this important life skill.

Written expression requires students to produce text in a way that requires coordination of a range of processes, including the physical aspect of forming letters, the cognitive and linguistic act of organizing the message in a way that best represents their ideas, and an awareness of the social components of writing (Boucher & Oehler, 2013; Dray, Selman, & Schultz, 2009). As a result, many students struggle with the writing process. In fact, results from the most recent National Assessment of Educational Progress writing assessment indicate that only 27% of students performed at or above a proficient level in writing (National Center for Educational Statistics, 2012). Among those who struggle with writing are students with Autism Spectrum Disorder (ASD).

Students with ASD

ASD is a disability characterized by deficits in socialization and restricted, repetitive patterns of behavior or activities (American Psychiatric Association, 2013). People with ASD are a highly heterogeneous group that vary in terms of language development, intellectual ability, and adaptive functioning. Severity levels in individuals with ASD may range from needing minor support to needing very substantial support (APA, 2013). While many often receive some special education services, an increasing number of students with ASD are being educated in general education classrooms (Callahan, Henson, & Cowan, 2008), including inclusive writing classrooms. It is therefore important that all teachers understand the areas of difficulty and general strengths for students with ASD, and how these areas might impact writing.

Children with ASD exhibit a wide variety of characteristics, some of which may inhibit their ability to write effectively. First, people with ASD often have difficulty with fine motor skills and visual-motor speed, which can impact handwriting or word processing (Broun, 2009). In fact, the handwriting of children with ASD has been found to be lower quality, specifically in terms of letter formation, than typically developing peers (Fuentes, Mostofsky, & Bastian, 2009). This deficit may be problematic for two reasons; first, students who have difficulty with handwriting tend to produce briefer pieces so that they do not have to endure the physical struggle of writing (Asaro-Saddler & Bak, 2014); and second, neatness of a written product tends to impact a teacher's rating of a writing sample. Specifically, illegible papers tend to score lower than those of equal quality that are written neatly (Graham, Harris, & Hebert, 2011).

Aside from the physical component, the cognitive aspect of writing also can be a challenge for students with ASD. Effective writers must manage a range of processes, including the cognitive act of organizing their thoughts and presenting the message in a way that best represents their ideas (Graham & Harris, 2005). Children who struggle to navigate this process, like those with ASD, may have difficulty producing written texts. Deficits in three primary cognitive processes - weak central coherence, theory of mind, and executive functioning - may

contribute to writing struggles for students with ASD (Carnahan, Williamson, & Christman, 2011).

Weak central coherence, characterized by a focus on minor details rather than a larger concept, may also contribute to poor writing in some children with ASD (Carnahan, Williamson, & Christman, 2011). Several studies have shown that students perform better on local processing than global processing of stimuli (Fleury et al., 2014). For example, researchers found that while reading, participants with ASD read much better at the word level than at the sentence level (Norbury & Nation, 2011), and it is possible that they process sentence writing in the same way. Even at the word level, people with ASD may tend to focus on the individual letters rather than the word as a whole. Daniel Tammet (2006), a self-described "autistic savant", wrote in his memoir:

> I was... unable to write words with the letters all together. If single letters were difficult enough, combinations such as gh... were impossible for me to write in a single stroke. Even today I write most of the letters in a word individually one after the other (p. 50).

Potential deficits in theory of mind (ToM), or the ability to understand that other people have thoughts or feelings that are different than our own, may make it difficult for children with ASD to write for an absent audience, as they may not understand that their writing will be read by someone who may think differently than they do (Brown & Klein, 2011). ToM deficits may also pose challenges when writing about characters' thoughts, feelings, and motivation for actions (Siller, Swanson, Serlin, & Teachworth, 2014).

Executive functions (EF), or higher order processes that relate to regulating one's behavior (Reid, Mason, & Asaro-Saddler, 2013), include organizing, planning, and self-monitoring, and are crucial to writing well. EF deficits may impair the carrying out and monitoring of the essential cognitive processes writers need to effectively manage during the writing process (Saddler, Moran, Graham, & Harris, 2004). Specifically, deficits in EF can lead to problems for students with ASD in terms of regulating attention and integrating new information (Carnahan et al., 2011), taking one's ideas and transferring them to a final written product (Asaro-Saddler & Bak, 2012), and self-monitoring their progress (Reid et al., 2013).

Inflexible thinking patters and rigidity are often associated with students with ASD (Sansoti, Powell-Smith, & Cowan, 2010). Their tendency to be "perfectionists" can impede written expression. As Daniel Tammet said:

> Whenever I wrote, I poured over every letter and word and period. If I noticed a smudge or error I would erase everything and start over. This streak of perfectionism meant that I sometimes worked at a snail's pace, finishing a lesson in a state of near exhaustion, yet with little effort to show for it. (2006, p. 50).

Despite these difficulties, there are many unique strengths of individuals with ASD. The next section will discuss these strengths and how they may be utilized to help students be successful in the writing process.

Of all the strengths students with ASD possess, perhaps the most often cited is that they respond well when information is presented visually (Sansoti et al., 2010). Temple Grandin, a world renowned professor of animal science, author, and individual with ASD, has indicated that visualization is so important to people with ASD that she, and many other individuals with ASD, thinks in pictures (Grandin, 2006). Therefore, individuals with ASD may benefit from the use of visual information and supports, such as graphic organizers, while writing.

Students with ASD may also have deep interest or fascination with one or more topic (Kluth & Chandler-Olcott, 2006). Students with ASD may research these topics at length, thus developing background information in the area. These interests, also called special interest areas (SIAs), can contribute positively to the development of writing skills for students with ASD. In one study, participants increased their intelligibility, vocabulary, word order, and syntax when talking about their SIAs (Winter-Messiers, 2007). They also were more enthusiastic and used more emotion when speaking about their SIA. Therefore, SIAs may similarly improve the motivation and quality of written texts of individuals with ASD.

Some of the areas that cause difficulty for students with ASD in writing may also serve as strengths. For example, while limited central coherence may not allow some individuals with ASD to see the "big picture" of a writing assignment, the details of their work may be richer (Carnahan, Williamson, & Christman, 2011). As Daniel Tammet said, "The stories I wrote… were descriptively dense – a whole page might be taken up in describing the various details of a single place or location, its colors, shapes and textures" (2006, p. 44).

Another strength of students with ASD is their interest and fluency with technology (Ramdoss et al., 2011). In fact, technology-aided instruction and intervention (TAII) has been identified as an evidence-based practice for people with ASD (Wong et al., 2015), and it has been found to improve the writing of students with ASD (Pennington & Delano, 2012). TAII can include the use of computers, software programs, or speech generating devices. A recent review of the literature identified a range of domains in which technology has been implemented with adolescents with ASD, including social, communication, vocational and academic skills (Odom et al., 2014). Researchers in support of technology have asserted that using technology such as computers and software programs can allow students to focus on the content of their written products, rather than using cognitive and physical energy to correctly form letters or spell words (Carnahan, Williamson, & Christman, 2011). Technology

programs can also provide concrete, visual supports, which are especially helpful for students with ASD who often prefer visual stimuli (Caron & Shane, 2014), and can allow students to work more independently without the need for additional personnel support (Kagohara, Sigafoos, Achmadi, O'Reilly, & Lancioni, 2012). Finally, and perhaps most importantly, according to John Elder Robison, an author and adult with ASD, "technologies may help erase disabilities that might otherwise be visible and humiliating" (Robison, 2008, p. xxiv).

In terms of written expression, researchers have explored various forms of technology on writing skills such as spelling (e.g. Kagohara, Sigafoos, Achmadi, O'Reilly, & Lancioni, 2012), word construction (Sugasawara & Yamamoto, 2007), sentence construction (Basil & Reyes, 2003), story and narrative writing (e.g. Pennington, Stenhoff, Collins, Turner, & Gunselman, 2014; Schneider, Codding, & Tryon, 2013) and crafting emails and blogs (Wollak & Koppenhaver, 2011). Ashburner, Ziviani, and Pennington (2012) also found that students with ASD who used keyboarding instead of paper and pencil were more motivated to write.

Some researchers have explored the use of specific software programs to teach writing to children with ASD. One of these software programs is First Author®, developed by Dr. Janet Sturm and distributed by Don Johnston Incorporated. First Author® is a curriculum and software program that guides students through the writing process by prompting them to choose a topic, select a picture prompt, and then write with the support of accommodations such as word banks, word prediction and auditory feedback. Preliminary analyses found that students with ASD and developmental disabilities who used First Author® increased writing quality, topic diversity, and new and unique words when compared to students who wrote with paper and pencil (Sturm & Knack, 2011).

TECHNOLOGY IN ACTION: A PILOT STUDY

The current study sought to extend the findings of Sturm and Knack (2011). The authors examined the use of First Author® software to improve the quality and quantity of the writing of secondary students with ASD in a brief summer program, and explored whether the intervention would have social validity with the classroom teacher.

Participants and Materials

The study occurred as part of a larger research project conducted during an extended school year (summer) program at a suburban high school in New York State. The six-week program was offered for students with disabilities who require 12-month special education programming. The participants included 10 students composed of six males and four females, including five students with autism, three students with multiple disabilities including autism, and two students with intellectual disability (as indicated on the students' Individual-

ized Education Programs, or IEPs), with a mean group age of 16 years. These students were considered good candidates for First Author® software due to their limited writing abilities. Academic achievement scores in the area of writing were available for only half of the participants, as many were considered non-writers and were unable to complete standardized tests of writing. The data that were available indicated that students who completed standardized tests of writing (Written Expression subtest from the Woodcock-Johnson® III Tests of Achievement, Wechsler Individual Achievement Test®-Third Edition, and Kaufman Test of Educational Achievement, Second Edition) performed mostly in the below average range, with scores ranging from 43 to 91, with a mean score of 59 (M=100, SD = 15).

Lessons developed and designed as part of the First Author Writing curriculum® were used in the study. These lessons, aimed at guiding developing writers toward greater writing ability, each began with a short mini-lesson, followed by independent writing time, and ended with Author's Chair, which was an opportunity for students to share their writing with the group. The lessons also included a tip sheet for students to use as a reminder of the main points of the lesson, as well as picture or alphabet boards to support their writing (if needed). Instruction was provided by a doctoral student in Educational Psychology who had six years of experience as a special education teacher at the school.

Independent writing time occurred using First Author® software, which provides students who are beginning writers with access to assistive features during the writing process (planning, composing, sharing and publishing). The planning screen supports topic selection by providing students with individualized photo images across three categories (My Life, My School, and My World). Students navigate among images, make a photo choice, and are then taken to the composing screen. The composing screen offers students vocabulary support through word banks that offer both function words (high frequency, high utility, and frequently misspelled vocabulary needed for beginning text types) and topic-specific words (e.g., cheetahs). This screen also offers students a read aloud feature for word bank vocabulary (reads upon rollover) and text composed (reads aloud letters, words, sentences, or all text) by the student, and provides self-regulatory prompts (when idle, provides a set of individual verbal cues to continue writing). On screen keyboards are also available on the composing screen as an alternative access option. The "publish and share" screen creates a published format (e.g., book cover and photo with text on book pages) that can be read aloud and printed. First Author® software also provides a separate set of tools in Teacher Central that allows educators to customize the features and measure outcomes using a set of writing quantity and quality and attitude measures.

PROCEDURE

The researchers gathered pre-test data in which participants wrote one writing sample per day for two days about a topic of their choice using pencil and paper. Participants were given as much time as necessary to complete the writing task. Once these samples were collected they began the intervention lessons. These lessons began by introducing the students to the First Author® software and teaching them how to use it. On the first day of training, the students watched a demonstration of the software on a projection screen in the front of the room, during which the teacher showed students how to find and open the software in the folder on the desktop of the computer and how to use the various features of the program. Students were then allowed to log onto the computers, create their individual folders, and use the program. During the second training lesson, students were asked to do some writing and show the teacher how much they remembered about using the program, with the teacher answering any questions and demonstrating on the screen as needed. On the third day of training, the teacher encouraged the students to log on, locate the program, and begin a new piece of writing without any assistance. By the end of the third lesson, the teacher was confident that the students could use the program with a high level of independence and were ready to start the lessons.

On the fourth day, students began the First Author Writing Curriculum® lessons. Students used the planning screen in the First Author® software to assist in selecting their writing topics and writing their samples. All writing samples composed by students were self-selected writing topics. Participants were given as much time as they wanted to complete the writing samples, and they were able to go back to an entry they began previously, if desired. Mini lessons and independent writing utilizing First Author® occurred five days per week for approximately 30-40 minutes per session for four weeks. When the intervention was completed, the researchers collected post-test data in which the students wrote two samples about a topic of their choice using paper and pencil under the exact same conditions as pre-test. They did this to assess potential generalization effects of the technology back to paper and pencil conditions.

Measures

To measure writing quality, researchers used the Developmental Writing Scale for Beginning Writers (DWS; Sturm, Cali, Nelson, & Staskowski, 2012), a scale developed to identify qualitative progression of student's writing skills that includes 14 levels from the lowest (scribbles) to highest (well-organized with one coherent idea) quality of writing. To measure writing quantity, they assessed the total number of intelligible words (TIW), defined as the number of correctly or phonetically spelled words that could be identified by two independent raters, and the total number of unique words (TUW), defined as the number of dif-

ferent words a student used in a sample spelled correctly or phonetically. These measures were selected because they were used in previous research exploring the use of First Author® (Sturm & Knack, 2011).

Two graduate students in Educational and Counseling Psychology were trained by Janet Sturm, the developer of First Author®, to score the writing samples for these three measures. The students scored several samples together until reliability of 90% was reached, then raters scored the writing samples independently. For the samples collected during the study, interrater reliability was calculated first and then scores for each rater were averaged to arrive at the final reported scores for quality and quantity. One point differences in scores were averaged, and scores that varied by more than one point were discussed until agreement was reached.

To assess social validity of the intervention, the teacher answered a series of questions related to the intervention, including: How did the students respond to the use of First Author®? What positive or negative impacts did you see? What was the response/feedback of your colleagues, administrators, or school community in regard to the use of these interventions? What aspects of the interventions were most effective? What types of students benefitted most from the interventions? What were the limitations you faced in conducting this study? and What suggestions do you have for future research? This measure is reported qualitatively through teacher responses.

Results

Writing Quality and Quantity

Descriptive statistics are reported to show results for quantity and quality measures for each participant. Inferential statistics were not reported due to the small sample size. The pre-test and post-test scores were an average of the two writing samples collected in each phase. The intervention score is an average of the final two samples collected during the intervention phase, since those were collected at the end of the intervention period.

Quantitative results were mixed. For the DWS, students made minimal progress, with an increase in overall group mean from 9.5 at pre-test to 10.2 after intervention and 9.95 at post-test (See Table 1). Six of the students improved from pre-test to intervention, with another student staying at the same level as pre-test. At post-test, six of the students increased from baseline, with another two scoring the same as pre-test. Interrater reliability for the DWS score was 89%.

Means for the TIW indicated an increase from pretest (41.4) to intervention (69.2), with the post-test mean of 65.1 indicating a slight drop from intervention (See Table 2). During the intervention stage, five students increased their number of intelligible words, with one writing the same number of words. At post-test, eight students increased their number of words, with one writing

the same number as pre-test. Interrater reliability for the total number of intelligible words was 80%.

For TUW, the group showed an increase from an average of 27.3 at pre-test to 31.0 after the intervention, with an additional increase to 32.6 at post-test (See Table 2). Five students increased their TUW from pre-test to intervention, and seven increased their number from pre-test to post-test. One student wrote the same number of words across conditions. Interrater reliability for the total number of unique words was 78%.

Table 1. *Means for writing quality from pre-test to intervention to post-test*

	DWS score		
	Pre-test	Intervention	Post-test
Student 1	12	13	12
Student 2	13	12	11.5
Student 3	9.5	12	11.5
Student 4	10	11	10.5
Student 5	12.5	12	12.5
Student 6	11.5	12	12
Student 7	11.5	11	12
Student 8	2	2	2
Student 9	5	8	7
Student 10	7.5	9	8.5
Group mean	9.45	10.2	9.95

Table 2. *Means for writing quantity from pre-test to intervention to post-test*

		TIW			TUW	
	Pre-test	Intervention	Post-test	Pre-test	Intervention	Post-test
Student 1	36	245	67.5	37.5	109	36.5
Student 2	106	47	101.5	67.5	36	71
Student 3	20.5	38	31	19.5	28	18
Student 4	58.5	70	132	27.5	32	44.5
Student 5	112	44	113.5	65	33	69.5
Student 6	28.5	28	49	21	20	29.5
Student 7	41.5	21	89	24	13	41.5
Student 8	0	0	0	0	0	0
Student 9	4.5	82	18	4.5	22	7.5
Student 10	6.5	117	49.5	6.5	17	8
Group mean	41.4	69.2	65.1	27.3	31	32.6

To more fully illustrate the potential outcomes of the intervention, a case study is presented:

Case study: Samantha. Samantha, a 21-year-old female with autism, graduated from high school with an IEP diploma, but continues to attend school to receive additional training in vocational skills. At the start of the intervention Samantha's writing skills were very limited; she generally needed prompts to write, and was able to independently generate a few simple sentences. When writing she often struggled to stay on one topic, and if prompted to write more, would stray from the assigned topic in order to think of more sentences. She also struggled to include details in her writing and to think of a writing topic without prompting. Although she complied when asked to engage in writing tasks, she often complained and verbally expressed her dislike before beginning the task.

Samantha's inability to stay on topic or to even choose a topic to write about is illustrated by the following writing sample, taken before the study began:

> *I like London with my mom.*
> *I like to play Basketball.*
> *I like to go to The Denny's.*
> *I love to go to vermont with my mom.*
> *I like to go to The mall with my dad.*
> *I love my Papa.*
> *I like to go to Myrtle Beach.*
> *I love to go to great escape with my dad.*

I like to go to disney land with my mom.
I like my brother Mike.
I like to go see the movies.
I'm going to Disney world with my aunt.
I'm going to Hang with my big brother.
I love to see farm Animals.
I'm going to the Animal fair.
I'm to go to Rhode Island with my Papa.
I like to see grandma.
I love to see my dad.

During the First Author® sessions, Samantha enjoyed using the technology to produce her written work, as indicated in the comments she made to the teacher about how much she liked writing with First Author®. She told the teacher that she especially liked using the pictures. Unlike previous writing sessions, she no longer complained when it was time to write, but was eager to get started and did not vocalize any dislike toward the task. She was able to access the technology independently with ease and required no additional support once trained in how to use the software. The technology and use of a picture also enabled her to generate multiple ideas and details related to a single topic. This is illustrated in the two writing samples below, taken during the study while using the First Author® software:

White rabbit
I love white rabbit in the cage. They are cute. They are going to the woods. They were eating carrots. I have a pet rabbit at pet store name hocus pocus. I like to play with rabbit. I love to sleep with Rabbit. They Hops into the forest. The rabbits feel soft. I love to pet it rabbit.

London
I Love to go to london with my mom. I can see the big ben. I like to see olympics. i love To drink a tea. I Love To dance. I Love to go to the airport. I Love To see a queen And King. The Baby named prince george. I like to see the princess. I like to see the grand duke. I Love To see The King.

Samantha's writing improved in several ways as a result of using the First Author® technology. First, it enabled her to write about the same topic for several sentences without switching to something new, and encouraged her to include details about a single topic without prompting. It also greatly increased her topic variety, causing her to write about various subjects she had not written about before, according to her teacher. Her sentences were also more varied in their structure and she used a greater variety of vocabulary. Although

the samples above are somewhat shorter than her pre-intervention sample, they illustrate a higher level of writing and thinking about a specific topic, and are not just a list of thoughts.

Social Validity

The teacher responded favorably to the questions regarding First Author®. She reported an increased motivation to write and a positive response by a group of students that she called "reluctant to write." She noted less behavioral outbursts during writing time, and improved quality of writing as well. When asked about the feedback of the school community in regard to the use of these interventions, she cited the content and structure of the lessons being well-received by supervisors. The librarian, who was often present when the lessons occurred, shared that she had never seen this particular group of students so attentive and engaged during academic time. The teacher stated: "An English teacher (at the school) actually pulled us aside and asked how we got that group of students to do that kind of writing and sharing."

The teacher thought the short, consistent structure of the sessions and providing a choice of a topic about which to write were the most effective components of the lessons. In addition, she cited sharing with the Author's Chair to be highly motivating for the students. She found it especially helpful that the students who were non-verbal could share by using the voice technology supported by First Author®, and was surprised by how attentive the students were to one another during the sharing time.

When asked what types of students benefitted most from the intervention, the teacher indicated that all of the students who participated in the study benefitted in some way, citing the only obvious barriers being behavioral issues and severe motor skill issues. She felt that the students with ASD may have benefitted because the lessons provided a structure and concrete examples that decreased the anxiety and increased the understanding of the students with ASD. The teacher reported the limitations of the study to be the short time frame of the summer program and related inability to take full advantage of the technology features of First Author® (e.g. the Teacher Management tools to personalize and track student progress) and suggested that future research conduct the study over a longer period of time "in order to benefit the students more and really allow them to grow their writing skills."

DISCUSSION

Preliminary findings indicated that several of the participants showed some improvements in writing quality and quantity when being taught using First Author®, even when implemented over a short summer program. As results indicated, some students made more progress than others, with many showing noteworthy gains and others showing minimal or none at all. Students

who began the study already writing at the sentence level appeared to make greater gains than those with lower writing ability. Student 8, for example, who wrote only scribbles at pre-test and post-test, was unable to work independently during the intervention (though he was able to select a picture and write one unintelligible word with prompting), thus resulting in scores of 2 (scribble level) on the DWS and 0 for both TIW and TUW.

Overall, few differences were noted in terms of writing quality when measured using the DWS. One possible explanation may be that the intervention period was quite short, and although the lessons seemed to benefit the students, interaction with the interventions for a longer period of time may have results in greater improvements in quality. This finding would support previous research that even with writing instruction, proficiency develops over time and with sustained practice (Graham & Perin, 2007).

In terms of quantity, overall mean for TIW increased noticeably from pre-test to the intervention for the group, which was expected given the supports that First Author® provides (e.g. word prediction, spell check), and previous literature indicating that technology can decrease the number of misspelled words and increase writing fluency (Schneider, Codding, & Tryon, 2013). What was not expected, however, was to see gains to almost the same level at post-test. Given that the students went back to paper and pencil at post-test, we did not anticipate such gains from pre-test, given the need to generalize the task from the computer to paper. It is possible that the supports of the technology transferred back to the paper and pencil condition for the students, as observed in previous research (Purrazzella & Mechling, 2013). More modest gains (M=5 words) were made in TUW, consistent with previous literature (Sturm & Knack, 2011), which found that students had greater increases in intelligible words than unique words. Some students actually decreased the number of words written from pre-test to intervention conditions. Interestingly, two of the three participants (Students 2 and 7) who decreased their TIW and TUW written were the students with intellectual disability (ID) as their primary diagnosis. This finding was not consistent with previous literature (Sturm & Knack, 2011), which found that students with ID made gains utilizing First Author®. This contradiction might suggest that participants with ASD who also have intellectual disability may benefit less from the intervention when it is conducted over a brief period of time.

The teacher indicated that the use of First Author® was beneficial for students with ASD. In line with previous research (Asaro-Saddler & Bak, 2012), which found that students with ASD reported visual supports (e.g. graphic organizers) to be the most helpful aspects of a writing intervention, the teacher in this study cited the visuals as an effective component of the intervention. She named the consistent structure of the lessons as being beneficial as well, given

that many students with ASD desire structure and routine (Sansoti et al., 2010). Finally, the teacher particularly liked that the program could be individualized, so she could cater it to the specific unique interests of their students with ASD, as students with ASD often perform better when their special interest areas are incorporated (Winter-Messiers, 2007). The teacher also reported that the students were more motivated to engage in writing, perhaps because many students with ASD enjoy the use of technology and visual media (Caron & Shane, 2014). This increased motivation was a positive outcome, as students who are motivated to write often view writing more positively, and ultimately may have better products (Boscolo & Gelati, 2013).

The use of First Author® allowed students with significant communication difficulties to effectively participate in the sharing of their writing, which is one possible benefit of using technology to support writing. When students were unable to verbally share, the text to speech function could be utilized to where the students turned their screen toward the class and the computer read their story. This function can allow students with disabilities in inclusive settings to more fully participate both academically and socially in their classroom (Wollak & Koppenhaver, 2011). Another benefit of the technology was that, as in other studies, it increased students' independence and decreased their dependence on the teacher and paraprofessionals (Kagohara et al., 2012). For example, students with word prediction software did not need to wait for an adult to help them spell words.

Limitations and Future Research

There were several limitations that may have affected the results of this study. First, and perhaps most importantly, the limited number of participants in this study did not permit the use of more advanced statistical analyses such as repeated measures analysis of variance. More stringent group design studies, or single-case design studies such as multiple baselines, should be conducted to add to the empirical research base. Second, as indicated, since the intervention occurred during a summer program, the intervention period was brief. Students may not have been able to make significant gains during that time, and if they did, measures may not have been sensitive enough to detect changes. Future researchers should implement First Author® over a longer period of time to see if results can be significantly improved. In addition, though teacher social validity was explored, researchers did not have the opportunity to interview the students with ASD to determine their perceptions, likes and dislikes when utilizing the technology. Future research should assess participant social validity to determine whether the students perceive the intervention as useful. Researchers also should assess whether utilizing the First Author® software increases students' perceptions of themselves as writers, an important contribution to improved writing outcomes.

CONCLUSION

Students with ASD can become fluent writers when appropriate supports, such as technology, are put in place. Teachers should be sure to have high expectations of their students and provide the appropriate adaptations necessary for success. Utilizing the strengths of students with ASD in conjunction with evidence-based practices can help them become confident and successful writers.

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