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Intellectual Disability, Literacy, and Assistive Technology in the Community College Setting

Kimberly Maich
Memorial University

Jennifer Jahnke
Mohawk College

Camille Rutherford
Brock University

kmaich@mun.ca, jennifer.jahnke@mohawkcollege.ca, camille.rutherford@brocku.ca

Abstract

This pilot project utilized a mixed-methodology approach to investigating assistive technology (AT) with students enrolled in a college program for students with intellectual disabilities. Its purpose was the provision of AT-based software, training, and support to examine changes related to academic learning and independence. Twelve college student participants were assessed using pre- and post-intervention assessment tools. Six student participants and five front-line Learning Facilitators also participated in focus groups. Focus group data were analyzed inductively resulting in seven emergent themes; assessment data were analyzed statistically and showed an increased trend in scores over time.

Keywords

Assistive technology, college, post-secondary, intellectual disability

Introduction

The Community Integration through Cooperative Education (CICE) college program began in Ontario, Canada in 2012 to provide post-secondary learning support in an inclusive environment primarily for students with intellectual disabilities (ID). Ontario Colleges (2017) advertises CICE as:

> The opportunity to experience college life and pursue postsecondary education, with courses tailored to meet your individual needs. You will learn the skills you need to be independent in your community and find employment in your chosen field. (para. 1)

CICE is also described as: "the opportunity to pursue a postsecondary education, develop skills to help prepare for employment, and experience college life" (Mohawk College, n.d.). Students are supported by Learning Facilitators (LF), part-time paraprofessionals. The LF role focuses on individual academic potentials (Mohawk College, 2014). The use of assistive technology (AT) in this role, however, was not a widely used or an inherent part of related programming. The purpose of this project was to provide AT software, training, and support to examine changes related to academic learning outcomes and levels of independence.

Literature Review

Post-secondary programs are seeing an increase in enrollment of students with intellectual disabilities (ID); however, such students need effective strategies to access course information and complete course requirements (Chezan, Drasgow, & Marshall, 2012) such as accommodations (including AT), explicit instruction, strategy instruction, and systematic evaluation (Cannella-Malone, Konrad, & Pennington, 2015). Accommodations can include note takers, extra time, lighter course loads, quiet places for exams, or copies of visual aids. One accommodation area that is gaining ground is the use of AT: "any piece of equipment, software

program or product system that increases, maintains or improves academic capabilities" (Malcolm & Roll, 2017). Three broad groups of AT exist: general use (e.g. word processing), assistive computer technologies (e.g. Braille printers), and adaptable technologies (e.g. dictation software) (Fichten, Asuncion, & Scapin, 2014). Additionally, AT falls under multiple functional domains, including communication, education, inclusion, employment, and leisure (Wehmeyer, Smith, Palmer, & Davies, 2004). Malcolm and Roll (2017) students used available AT frequently, in multiple settings, enjoyed its use, and found that it supported their studies.

Technology can improve quality of life for students with an ID (Palmer et al., 2012) and promote independence. Additionally, technology can contribute to learning and increasing skills through effective and efficient strategy use (Chezan et al., 2012). For students with ID, AT can improve home and community functioning, transitioning, time management, and organization skills—amongst others (Mechling, 2011; Wehmeyer, Tassé, Davies, & Stock, 2012). Research has shown that AT is helpful in secondary school for students with ID; however, less research has been completed on post-secondary programs (Bouck & Flanagan, 2015).

Students are dynamic in their needs, and a key aspect of helping them with their studies is to assess their specific needs and match them with appropriate AT. Students who are supported and can participate in school and community based activities benefit from their use of AT. AT should have a universal design, to help eliminate barriers, gain independence and environmental control for individuals with ID (Wehmeyer, Tassé, Davies, & Stock, 2012). With proper training in demonstration of the AT, combined with strategies, students with ID can greatly improve their educational experience and outcomes.

Despite the fact that AT is predominant in schools, studies suggest that individuals with ID have limited access to technology and use computers much less than their peers (Palmer et al.,

2012; Wehmeyer et al., 2004). Barriers to fully utilizing AT are problematic, and include cost, knowledge, and beliefs, as well as areas of impairment (Ayres, Mechling, & Sansosti, 2013; Carroll, 1993 as cited in Wehmeyer, Smith, Palmer, & Davies, 2004; Copley & Ziviani, 2004; Derer, Polsgrove, & Rieth, 1996; Mechling, 2011). Computers, for example, can be costly (e.g., purchase, upgrading, maintenance, repair) (Mechling, 2011). Thought Palmer et al. (2012) found 49.7% of families with at least one member using computers, 12.7% noted a lack of access to this potential benefit. AT use requires training and strategies so that students get the most out of their technology—such as what AT is, which devices meet individual needs, and full utilization of AT potential (e.g., fairness during assessment) (Ayres et al., 2013; Copley & Ziviani, 2004; Cohen and Spenciner, 2015; Wehmeyer, Smith, Palmer, & Davies, 2004).

Most research on AT to date has focused on students with learning disabilities rather than an intellectual disability; most AT research has focused on reading assistance, and less research has been completed on AT for improving writing skills. To date, the most supported and researched method appears to be *strategy instruction* for writing skills; most commonly, "self-regulated strategy development" (SSRD) (Joseph & Konrad, 2009). SSRD focuses on learning strategies and teaches knowledge for planning and composing writing, using a gradual release of responsibility mode where students have more efficacy as they proceed through development, discussion, modelling, memorization, support, and independence. Students who learned SSRD produced longer, more complete, qualitatively better pieces (Graham, Harris, & Mason, 2005). Most research into writing strategies has focused on writing quality and accuracy, and less on planning and other prewriting tasks (Asaro-Saddler, Knox, Meredith, & Akhmedjanova, 2015; Joseph & Konrad, 2009).

Methodology

This project is an example of a mixed-methodology pilot study, utilizing techniques from qualitative and quantitative traditions to provide a fuller understanding of a research purpose; in this case, from the point of view of the disabled student participants themselves as well as their front-line LFs (Mertens & Hesse-Biber, 2013). The quantitative component (measuring academic learning outcomes) and the qualitative components (exploring levels of independence) provide complementarity, where "the intent is to measure overlapping but different facets of a phenomenon" (Frels & Onwuegbuzie, 2013, p. 185).

Participants & Resources

Following ethics clearance (June-July 2015), CICE students were recruited primarily through a group presentation including a question and answer period with researchers. Interested students completed written consent forms distributed and collected by a research assistant (Sept.-Dec. 2015). From three cohorts of 20 students each, 12 students initially agreed to take part. Ten students fully completed both pre- and post-intervention assessments (six female, four male; aged 19-23), and six students took part in at least one focus group. Five LFs (two male, three female) took part in at least one focus group. Three researchers, two research assistants, two WordQ-specific trainers, seven LFs, and nine student LFs supported this applied research; the latter provided intermittent, rotating support in this short-term student LF role. Technology programs and training for students included WordQ (ST4 Learning, 2015), Dragon NaturallySpeaking (speech-to-text) (Nuance, 2014), Livescribe Smartpens ™ (audio recorders) (XYZ, Inc., 2015), NaturalReader (screen reader) (NaturalSoft Ltd., 2014) as well as individual training on built-in smart device preference settings (e.g., text-to-speech, word prediction, font size) (see Table 1).

Table 1. Student AT Training. (*Brackets indicate approximate training time)

Student	Word Prediction (WordQ)	Speech-to-Text (Varied) S= Siri™ D= Dragon Naturally Speaking	Text-to-Speech (Natural Reader)	Audio Recording (Livescribe Smartpen)	Word Prediction (Smart Devices —Varied)	Preference Settings (Smart Devices Varied)
1	Y		Y (15)	Y (20)	Y (10)	
2	Y		Y (15)		Y (10)	
3	Y	Y (20)* S			Y (10)	
4	Y	Y (20) S	Y (15)		Y (10)	
5	Y				Y (10)	
6	Y	Y (120) D	Y (30)		Y (15)	Y (30)
7	Y	Y (20 x 2) S	Y (30)	Y (40)	Y (15)	Y (30)
8	Y				Y (10)	
9	Y		Y (40)	Y (40)	Y (15)	Y (30)
10	Y					
11	Y	Y (120) D	Y (40)		Y (15)	Y (30)
12	Y					

Training Processes

Each student participant individually completed approximately 30-minute needs assessments, recording responses to open-ended questions around goals and needs. Responses guided the selection of individual AT (see Table 1), and training was provided to students and LFs to ensure its ongoing support and use. All participants initially attended a 30-minute workshop-style group training with follow-up individualized support provided by LFs throughout the duration of the research project. Students were trained along with researchers, representing Patton's (2015) categorization as *learning with* participants. LFs were further trained in three-hour group workshops by the LF supervisor, researchers, and a technology developer (e.g., WordQ, AT options) and were provided with ongoing independent training

opportunities (e.g., videos) delivered through an online learning management software system.

Data Collection

The below data collection techniques would be categorized as *learning about* participants (Patton, 2015).

Quantitative Assessments

Student participants were assessed using two pre- and post-intervention assessment tools to examine reading and writing skills. Initial writing samples were taken for *Readability* analysis; post-AT training writing samples were also taken. Readability, a built-in mechanism of Word, provides one-click information about written text, such as number of words per sentence (see Table 2 for a full listing of subtests). The *Diagnostic Online Reading Assessment* (DORA) was also completed pre- and post-intervention. DORA was designed as a K-12 measure that provides assessment data across eight sub-skills of reading (see Table 2) allowing for AT utilization. During post-intervention assessments, students were permitted to utilize assistive technology tools. Assessments were scored, scores were compiled on Excel spreadsheets, and analyzed for quantitative change (see Results).

Table 2. DORA & Readability Subtests. (Passive sentences is the only measurement that is a percent rather than a whole number)

DORA Measurement	**Readability**	**Type & Measurement**
High frequency words	Counts	Words
Word recognition	Counts	Characters
Phonics	Counts	Paragraphs
Spelling	Counts	Sentences
Oral vocabulary	Averages	Sentences per paragraph
Reading comprehension	Readability	Words per sentence
Reading comprehension	Readability	Characters per word
Reading comprehension	Readability	Flesch Reading Ease
Reading comprehension	Readability	Flesch-Kincaid Grade Level
Reading comprehension	Readability	Passive sentences (%)

Qualitative Focus Groups

Independent focus groups were carried out with both LFs and student participants mid- and post-intervention to examine shifts in independence as well as social validity. Focus group interviews were facilitated using a semi-structured interview (see Table 3), audiotaped, and transcribed. See Table 4 for further details.

Table 3. Focus Group Questions.

CICE Students	**Learning Facilitators**
How do you feel about using AT to complete your homework?	How do you think the AT study for the CICE students are going?
What do you like best about using AT?	Is there any additional AT training you would like to receive in order to support the students' Individualized Assistive Technology plan?
What do you like least about using AT?	How are you doing with tracking the hours you're working with the students?
Can you share any ideas where AT could help you more?	How are the students using the AT?
How do you feel about using AT for social communication (such as Facebook, email, texting, etc.)?	Do you think the students are becoming more independent with their studies? Why or why not?
Before being introduced to assistive technology you may have needed to wait for help from a LF to do your homework. How has AT changed this, or not?	
Do you feel using AT for homework or social communication has increased your independence? If so how?	

Table 4. Focus Group Participants.

Type of Intervention	**Learning Facilitator Participants (Facilitated by researcher)**	**College Student Participants (Facilitated by RA with presence of researcher)**
Midway Intervention	$n = 5$	$n = 4$
Post-Intervention	$n = 2$ (completed as individual interviews)	$n = 3$

Results

Paired t-tests were completed for pre-post DORA and Readability assessments. This small sample size impeded the detection of a significant change; however, the average percent change for each student was also calculated and showed an increasing trend for most participants (6/10; 60%); all male participants showed improved Readability scores (4/4; 100%). Figures 1 and 2 are presented in order of descending percent change for each assessment tool. Figures 3 and 4 are sorted by identified gender.

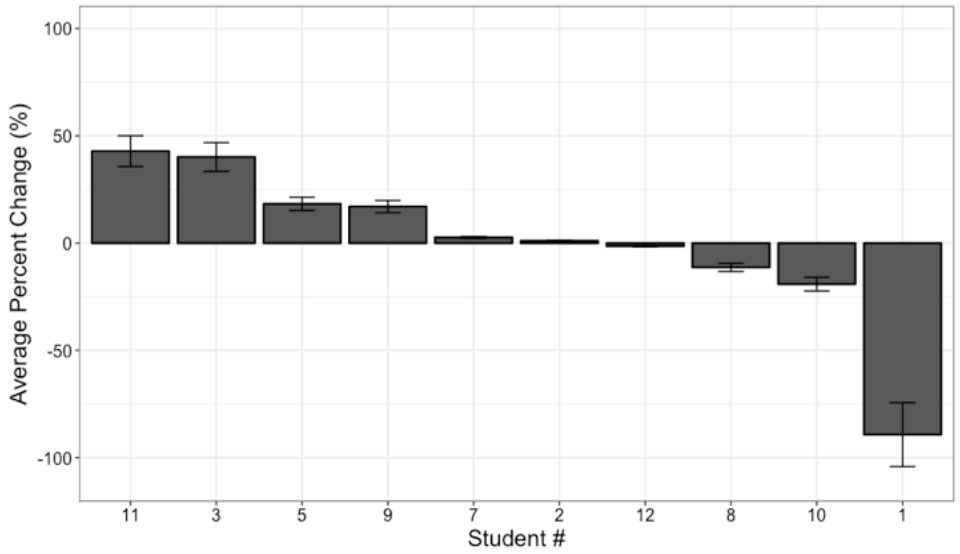

Fig. 1. Paired t-tests pre-post DORA presented in order of descending percent change.

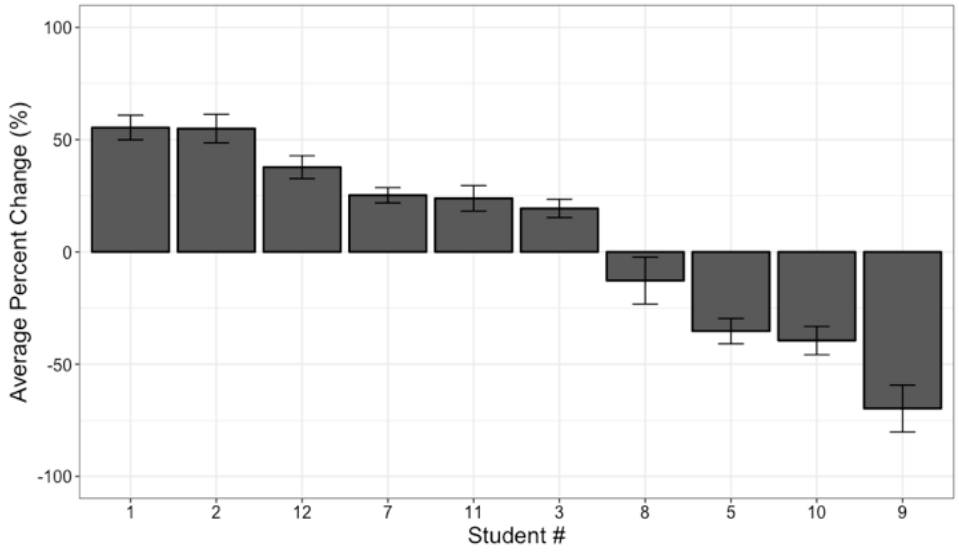

Fig. 2. Paired t-tests pre-post Readability presented in order of descending percent change.

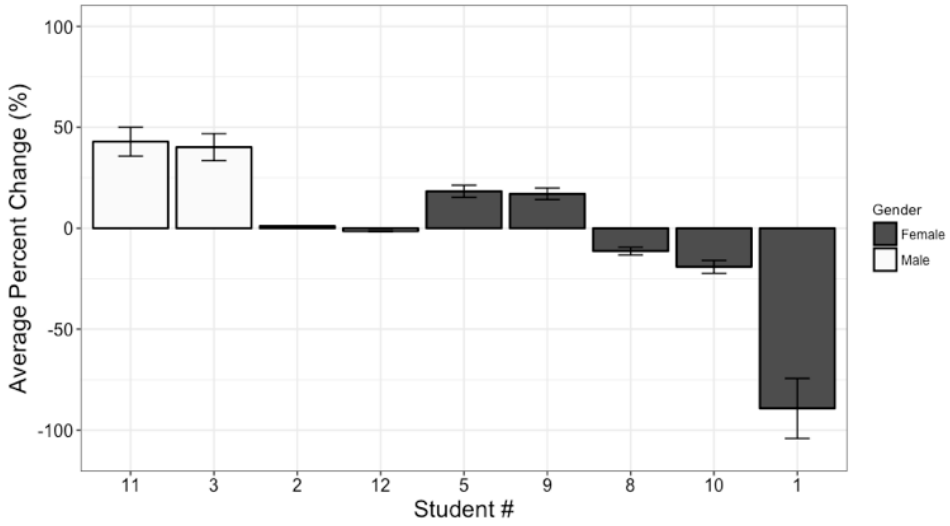

Fig. 3. Paired t-tests pre-post DORA are sorted by identified gender.

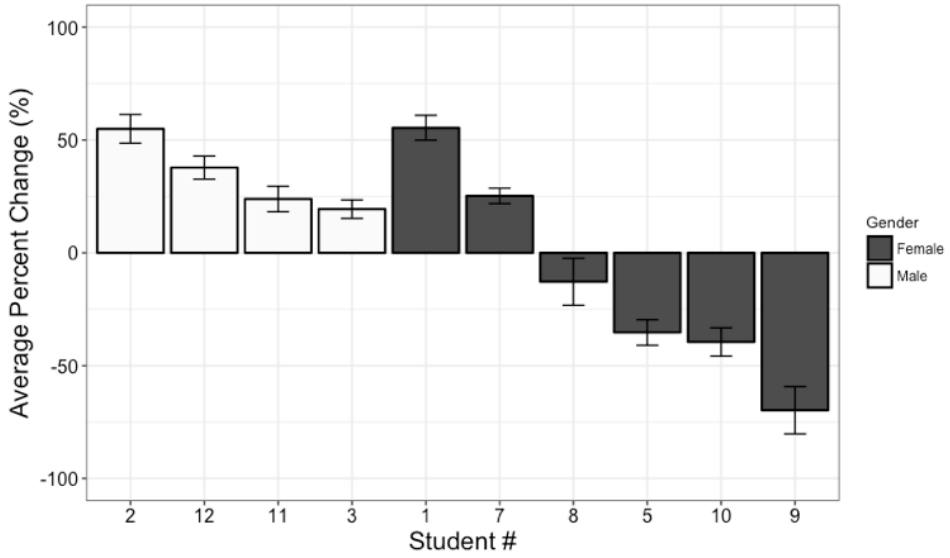

Fig. 4. Paired t-tests pre-post Readability are sorted by identified gender.

Focus group transcripts were duplicated in *Dedoose* (SocioCultural Research Consultants, 2016), coded, and thematized (Braun & Clarke, 2006; Creswell, 2018). Quantitizing these data (Frels & Onwuegbuzie, 2013) for student participants, seven codes emerged with 59 excerpts of text; most commonly, 39 segments focused on positive outcomes and 23 focused on WordQ. For LFs, six codes emerged with 44 excerpts; 22 were focused on next steps and 10 on skills for life. Examining only quantitatively robust coding patterns, it appears that students are looking back with positivity on their experiences, and LFs are looking ahead for future improvements. Five overall themes also emerged.

Efficiency, Effectiveness, and Productivity Develop

CICE students found positive outcomes of their AT related to efficiency, effectiveness, and productivity. One student expressed that: “It has changed [homework time] greatly. Before it used to take me an hour and it [AT] cut it down into 30 minutes” and “It cuts the time down in half ... why struggle” (Student 3)? A second student described his increased productivity in everyday tasks:

> What I like best about using assistive technology, [is] it works great for emails and that now it takes half the time it used to take me to make emails; it makes me more productive … so that way I can get my work done faster. And I can [make] time for other things that I really enjoy in life. (Student 5)

Student 3 also pointed out that we should use available tools for beyond homework—like social media:

> Making a post on Facebook, the last thing I want is misspelled words; it doesn't look good on your Facebook profile to have everything misspelled, right? That hard word that you're just trying to think [of] and then ... maybe it'll come later … you don't want to post and then that one word in that sentence is wrong and then you'll be the talk of the town on that.

The LFs, however, were not sure that the students' perceived positive outcomes translated to classroom success. For example, one reported that it was too early to tell:

> Confidence in their academic abilities has allowed [students] to expand when doing written essays in everything so in that sense the academic has improved. I think it would take a little bit longer for grades, and I don't know for sure if grades would improve [from AT use]. (LF 1)

These student participants, then, appeared to see the potential and possibility in developing positive outcomes like efficiency, effectiveness, and productivity with the use of AT. It appears unclear, though, whether this translates to higher evaluations in the post-secondary environment.

Skills for Life Emerge

Beyond its immediate applications to their college program, some student participants saw or envisioned generalization of their new skills to other environments such as home [“so you don't have to rely on your parents to help you.” (Student 5)] and school work task without additional supports [“the LFs won’t always be there.” (Student 5)]. One participant specified vocabulary [“I've learned words that now that I didn't know before.” (Student 3)]; another, spelling as positive outcomes:

> I've learned words from it that I have never learned before how I could spell, so it's also a bit of a teaching tool. ‘Cause now ... you can hear [the AT] say the word and then I can remember that [word] and now I'm learning to spell words. So it's actually more than just a word prediction or word correction software; it also teaches the person on how to improve for the future so the next time they make fewer errors and that is good for the future for jobs and anything like that. (Student 4)

As well, knowing that AT exists will be an area to attend to for the future: “as technology evolves and newer technology comes out, maybe they'll have something [else] in the future” (Student 3).

Participants also expressed that AT provided an increased level of independence: “It's more easier if we have the assistive technology to help … so [we] don't have to rely on [an LF]” (Student 5) —or parents, as above-noted. One participant shared that, “I find it's kind of embarrassing that I have to ask someone [at] my type of age [that] I don't know how to spell one word or two" (Student 3). He found that AT is, “Basically a second set of eyes; you can basically say to proof your stuff … which makes you feel more professional and independent and [it] makes you look more smarter … it's boosted your self-esteem, right?” (Student 3). One LF agreed: “Independence is the main factor that I have seen … they are able to do it on their own

and ask for less support. I think their overall confidence has improved" (LF 1). However, not all LFs concurred. Other LFs noted that, to get there, willingness and capability must converge for a movement towards independence to happen.

Willingness and Capability are Intertwined

One LF reflected that, "It's [AT] definitely limited the amount of effort I need to put in one-to-one … it's given me much more time to work with other students." She further reflected that there is potential for a level of independence, but that independence depends on willingness: "I think if we encourage the use of it here as much as possible, and also translate it [to] everyday life, then they are most likely going to do it." She feels that the capability is there, but that, "Some of them just don't like some things and then they won't follow through" (LF 1). Another LF provided an example with Livescribe Smartpens:

> If they use it properly--I know that one of my students is actually using it right now, and she goes back and puts it into her computer, it comes right on there so she's actually getting what's supposed to get out of it … where[as] I know another student; she just refuses to use it. (LF 3)

Not surprisingly, it seems that students are more likely to utilize tools that they enjoy.

Ease of Use Impacts Use at All

One LF mentioned that the student participants often needed prompting and convincing to get over some moments of resistance that came up around the use of AT. She noted that students did see the benefits of its use and did become more independent. For example, "WordQ I've noticed is now a staple for whenever they are doing homework … as soon as they log on, WordQ's up" (LF 1). Another LF said that, in their role, she tends to *push* the software that appears to provide ease of use with fewer steps: "I push (WordQ) the most ... only because it's

easy for them to be more independent with that one … it has to be really simple for our students" (LF 3). A further LF added: “Yeah. Turn it on and go” (LF 4). This seems to be true for LFs, too, with more training and refreshers desired to better support its use.

Too Little Too Late

In a contradictory theme, some LFs noted that they did not necessarily feel that CICE students were indeed becoming more independent; rather that the use of assistive technology is too little and too late—they have already learned *dependence*. They feel that AT gives students *some* skills for more independence, but not all skills. One LF articulated that: “Assistive technology to help them get the words out, and they don't have the assistive technology to help them get the support that we give them” but that they also “need *our* support in staying on task and staying focused and pulling information that's kind of at the back of their heads to the front of their heads” (LF 2).

At times, they found that students needed step-by-step verbal prompting to utilize the AT: “They forget to use it so we need to remind them … some of them will say ‘I don't know how to read that,’ and [we respond], ‘It's on the computer, turn on this program and then use [it]" (LF 4). But they also expressed hope: “I think there's potential for there if we started right from the beginning of day one … and [set] that expectation” (LF 6). Another LF imagined what it could potentially be like for CICE students to use AT through their program—from the beginning:

> They ... will probably have a better chance of succeeding in their electives with less support. So right now, a lot of their assignments are modified because they are just getting used to assistive technology. So, as they progress through the semester and as they're finished, they'll need a lot less support, so they're most likely to do it as is, instead of a heavily modified assignment. (LF 1)

Discussion

Results for each student were aggregated to obtain a clearer image for both DORA and Readability; however, because the scales for subtests varied widely, variables with a larger scale become more important. For example, the average number of characters was 385.1 pre-intervention and 962.5 post-intervention. These results are similar to the results of previous research that indicated that the use of speech-to-text assistive technologies can enhance writing productivity (Evmenova, Graff, Jerome, & Behrmann, 2010; Garay-Vitoria & Abascal, 2010; Palmer et al., 2012; Stoop & van den Bosch, 2014; Tam & Wells, 2009). As indicated by the research participants that noted how the use of AT reduced homework completion time, "It has changed [homework time] greatly. Before it used to take me an hour and it [AT] cut it down into 30 minutes," speech-to-text and word prediction software enabled students with ID to write faster, with greater spelling accuracy and more complex word usage (Evmenova et al., 2010; Stoop & van den Bosch, 2014). Consequently, using a device equipped with word prediction technology, people with intellectual disabilities can increase their communication rate considerably as it reduces the number of keystrokes, thus saving time and preventing mistakes.

In contrast to the significant improvement in the number of characters written by student participants, the average number of paragraphs pre-intervention was 2.4 and post-intervention was 1.2. What appears to be an anomaly in the quantitative results indicating a decrease in the number of paragraphs written is not an unusual outcome when using assistive technology. Providing learners with speech-to-text software that reduces cognitive load can result in the students becoming more focused on the structure and complexity of word usage rather than lower-order writing tasks (e.g., spelling, grammar) (Arcon, 2015; Stoop & van den Bosch, 2014). Therefore, percent change was also individually graphed for overall DORA and Readability

(refer again to Figures 1 and 2). It should be noted that student one had a pre-post difference from 6.5 to 1.83 on one subtest, creating a -255% change and affecting the overall average for that student. Percent change, therefore, is not a perfect solution to such analyses, but does give an alternate, more informative way of viewing these data. In any case, conclusions from this initial pilot research project with a small group of participants at a single college site should be regarded with cautious enthusiasm. A future solution beyond this initial pilot would be to include more students in a follow-up study, multiple sites, multiple data points (e.g., standardized assessments midway) as well as a control group.

As noted earlier, students are more likely to utilize tools that they enjoy and find useful. Thus, individual perception about the usefulness of technology is the most important consideration in determining the behaviour of adopting or accepting new technology (Venkatesh, Morris, & Ackerman, 2000). This highlights the importance of ensuring that the selection of specific assistive technology resources is carefully matched individual needs and abilities. Galla (2010) insists that effective technology implementation begins with ongoing assessment of student's progress and assurance ensuring that the technology meets the particular needs of the students.

Conclusions

This mixed-methodology pilot study provides useful information both for developing further studies, refining related methodology, and for teaching and learning using assistive technology in community-college based programs for students with IDs or other impactful learning challenges. It is important, however, to keep in mind that this is a small-scale pilot study and its results are not meant to generalize beyond the context of this particular research project. Methodological recommendations emerging from this pilot project include: (1) the addition of a

control group at the same or different provincial college CICE program; (2) the inclusion of a more formal or standardized AT assessment or decision-making tool prior to implementing AT supports; (3) the collection of duration data to see if direct support time and/or type of supports (e.g., verbal prompting versus full physical prompting) from LFs changes as a result of interventions; and, (4) the provision of an opportunity for LFs and CICE students to rate the ease of use of various AT tools used.

Related programming suggestions for teaching and learning with AT in the college CICE context continue: (5) scaffolding AT use at the beginning of the program and implementing it into all courses post-intervention; (6) systematically building rapport between faculty, LFs, and students and their peers; (7) providing clear task analyses for students with visuals to create further independence; (8) including any built-in AT tools, such as screen readers built into online learning management systems; (9) continuing an individualized approach with individual supports from both faculty members and LFs, framed through Universal Design for Learning; (10) build in structured, ongoing training and face-to-face refreshers for LFs in order to maintain and improve usage skills; perhaps, formalizing this into a continuing education certificate program or including it as a job requirement; (11) Utilize low cost or no cost AT alternatives (e.g., Google tools or built-in smart device apps); and, (12) when possible, provide instructors with ongoing AT training and refreshers in a community of support so that they can offer their recommendations as to when and how the AT resources should be used to complete coursework. This should result in the course-specific benefits of using AT to be highlighted throughout the course of study.

There is much potential for the use of AT to make a difference in the teaching, learning, and independence of adult students with intellectual disabilities and other significant learning

challenges in a manner that is respectful and inclusive of similar strategies used by their peers in the college and community. Though the outcomes of this pilot study show tentatively positive conclusions, further research must be done to fully explore the potential of such resource use as an everyday part of inclusive community college-based teaching and learning programs for this student population.

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