Implications of the Use of Assistive Technologies with Persons who have a Learning Disability: Achievement, Self-Efficacy, and Acceptance Levels of Students with a Learning Disability in Northeaster Ontario

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Introduction

The purpose of this paper is to report the results of a study that examined the implications of the use of AT by students with a Learning Disability in an inclusive classroom. The results of the Cognitive Abilities Screening Instrument (CASI), routinely administered twice a year in this school district, were used to compare the levels of student achievement pre-and-post intervention. The perceptions of students, parents, and teachers were gathered and analysed to determine the perceptions of key stakeholders regarding the acceptance levels of AT with this population. The inclusion of persons with LD and the perceptions by key stakeholders of the use of AT to overcome barriers to learning is the focus of this study.

What is a Disability?

Disability is an umbrella term for impairments, activity limitations, and participation restrictions, referring to the negative aspects of the interaction between an individual and that individual's contextual factors (World Health Organization, 2011). An individual's contextual factors include all aspects of the physical and social worlds. To determine if an individual has a disability, the individual's activity limitations are assessed in relation to a particular environment with or without the assistance of aids or equipment.

Learning Disability

A commonly occurring disability found among students is a learning disability (LD). LD affects a substantial number of students in schools. Fifty percent or more of all students identified as exceptional are identified as having a learning disability; between 5 to 10 percent of Canadians have LD (Weber & Bennett, 2012). In Ontario, that represents between 64,430 and 128,520 people based on 2011 numbers (Statistics Canada, 2011). With a population in northeastern Ontario of 509,000, the estimated number of persons with an LD is between 25,450 and 50,900 people (Statistics Canada, 2011).

Learning disabilities may affect the acquisition, organization, retention, or understanding of verbal or non-verbal information, despite having average or better intelligence (Learning Disabilities Association of Ontario - LDAO). The difficulties stem from impairments in the processing of perceiving, thinking, remembering, or learning. The difficulties range in severity and may interfere with the use of language, reading, writing, mathematics, and executive function, or the processes that individuals use to control their behaviour and to get ready to respond to different situations. This creates a situation where students with LD tend to be non-strategic learners. Strategic learners plan, monitor, and evaluate their progress.

Because students with LD have difficulty with their executive function (LDAO), a barrier to strategic learning exists. This can cause students to struggle with school and not be able to demonstrate their understandings of the curriculum, which in turn, may cause others to perceive them as incapable or lazy. Frustration from this situation can lead to many persons with learning disabilities to quit trying, act out, or turn the anger inward with emotional responses such as depression or anxiety (LDAO). In comparison to typically achieving peers, written expression by students with LD is generally shorter, less organized, lower in quality, less varied in vocabulary, and contains more spelling and sentence-formation errors (Mason & Graham, 2008).

Secondary characteristics of students with a Learning Disability include low motivation, poor self-esteem, behavioural concerns, physical affects, self-criticism, and being critical of others.

The practice of educating students with learning disabilities has gone through a number of iterations over the past several decades. In Canada we have had segregated classes, mainstreamed classes, classes with pull-out support, partial and now full inclusion.

Achieving Inclusion and Full Participation

Achieving inclusion and full participation for persons with LD requires barrier-free and inclusive design (Learning for All). Preventing and removing barriers means persons with LD should be able to access information and perform duties and requirements with dignity and without obstruction. One of the most difficult of these barriers to overcome is attitude (National Collaboration on Workforce and Disability). Teachers who demonstrate negative attitudes toward inclusion create an environment in which students are unlikely to flourish and be successful. If barriers continue to exist because it is impossible to remove them at a given point in time, accommodations should be provided to enhance an inclusive environment (Ontario Ministry of Education, 2005). The policy and guidelines on disability and the duty to accommodate from the Ontario Human Rights Commission states:

> The duty to accommodate requires that the most appropriate accommodation be determined and then be undertaken, short of undue hardship. The most appropriate accommodation is one that most respects the dignity of the individual with a disability, meets individual needs, best promotes integration and full participation, and ensures confidentiality (n.d., Article 3.3).

Once the impact of a disability is ascertained, an appropriate accommodation can be identified. For example, the requirements of a course are identified and then the difficulties the student is experiencing with the requirements are determined. From this information, and when appropriate, assistive technology (AT) tools can be selected as an accommodation to meet the needs of the person with a LD to perform the essential functions of the course. Accommodations using AT range from low-tech tools (e.g., tape recorders) to high tech electronics (e.g., speech to text software on a computer).

Universal Design for Learning

Since the 1970's there has been a movement to bring all students, regardless of ability, together for the purpose of education. This inclusion movement has resulted in students of various exceptionalities being educated together in inclusive classrooms. One of the key components of the success of the inclusion movement has been the adoption of a Universal Design for Learning (UDL) approach.

UDL is an approach to educational planning that provides access to curriculum for all learners regardless of ability (Turnbull, Turnbull, Shank, Smith, & Leal, 2002). It is intended that teachers will expect that there will be a range of abilities in the classroom and that they will plan for this from the outset. Creating a class profile will inform the teacher of the abilities of the students in the classroom and provide a starting point for educational planning. Individual student profiles will further inform the teacher of a particular student's interests, learning styles, and abilities which can be used as a foundation for building student success. In addition, students are accommodated through a variety of teaching strategies and materials, including the use of AT.

Assistive Technology

For over 75 years we have been using AT to help persons with LD to overcome barriers to learning and to gain greater access to an equal education. It began in 1935 when assistive technology was mostly limited to books recorded on records (History of Assistive Technology). In 1968 AT expanded to include the first text-to-speech system. Computer technology was first used in the classroom in 1981, followed by the introduction of Dragon Systems in 1982, and the first AlphaSmart keyboard in 1991. By 1984, Universal Design for Learning systems were introduced to the classroom (History of Assistive Technology). Today, AT has expanded to include tablets and their corresponding applications (apps). To this end it is important to study the efficacy of AT practice and its effects on the people who are most directly affected by them.

Assistive technology (AT) refers to assistive, adaptive, and rehabilitative devices used to grant greater access to activities that would otherwise be difficult or unavailable for persons with disabilities (Edyburn, Higgins, & Boone, 2005). It also levels the playing field (Parette & Peterson-Karlan, 2007).

Universally designed equipment and environments create access for a wider range of people, for example, persons with a reading disability using text-to-speech software to access written information. AT is recognized by many experts in the field as holding great promise for students with disabilities (Alper, S. & Rahariniriana, S. (2006); Blackhurst, 1997; Edyburn, 2000; Marino, Marino, & Shaw, 2006; Patrone & Pettapiece, 2007). Universally accessible design of AT is good for all users including those with LD. For example, on city streets the use of curb cuts affords safer access for persons who use a wheelchair in their ease of crossing a street so that a curb does not impede their path. Others benefit from the ease of access with specific examples being persons pushing a stroller, a skateboarder, or a traveller or worker with a pull type cart or bag.

UDL is an approach to teaching, learning, assessment, and curriculum development that uses new technologies to provide equal access to all learners. A basic tenet of UDL is that new technologies should be used from the beginning to accommodate all learners. Some examples of UDL using new technologies or AT are voice recognition, text to speech software, word prediction, and picture menus. The use of AT with persons who have learning disabilities has yielded positive results, causing researchers to identify AT as holding great promise for persons with learning disabilities.

To understand why the potential is so great requires an understanding of the relationships between LD and AT. After nine years of international revision efforts coordinated by the World Health Organization (WHO), the World Health Assembly on May 22, 2001, approved the International Classification of Functioning, Disability and Health and its abbreviation of "ICF." According to the World Health Organization, ICF (World Health Organization, 2001), every person can experience a decrease in health or ability, meaning that all persons can experience some kind of disability. This in turn, broadens the need for teachers to understand the need for AT and how to effectively use it in the classroom.

Research Questions

The purpose of the study was to identify the impact of assistive technology (AT) on the achievement, self-efficacy, and acceptance levels of students with LD in an inclusive classroom. The specific research questions that were addressed in this study were:
1. How do students access AT?
2. What is the impact of AT on student achievement levels?
3. What is the impact of AT on students' perceptions of their ability?
4. What is the impact of AT on students' levels of self-efficacy?

Method

Participants

The senior administration of the school district was approached for permission to conduct the study. This resulted in an agreement to conduct the study in a school within the district that has a significant population of students, predominantly boys, in grades 7 and 8 who have learning disabilities. In addition, the school experiences a substantial amount of difficulty with misbehavior on the part of this group of students. The school is located in a small town where the level of education of the parents tends to be less than a high school diploma and unemployment levels are higher than the norm for the province.

Students. The student participants in the study were 12 grade 7 and 8 students (n=12; age: 12-16; Gender: 4 female; 8 male) from a school in northeastern Ontario. It was anticipated that the majority of the participants would be students, but it was impossible to know how many from each grade would volunteer. Given that there were approximately 15 students from grades 7 and 8 identified by the teacher as having an LD, our target number of participants was 12. All of the students were taught the AT as part of their regular curriculum, but only participants who had filed written consent were part of the research study

Parents. The parent participants were parents of the students who agreed to participate in the study (n=7; Gender: All Female), there were 15 sets of parents and 7 participated in the study. Letters of informed consent were sent to parents for signatures to be returned to the classroom teacher, in order for their child to participate in the study. It was clearly explained that the participation in the study in no way affected their student's grades or access to learning

Teachers. Teachers (n=4; Gender: 3 Female and 1 Male). The senior administration of the school board gave consent to contact principals of schools they recommended for purposes of the study. The principals offered the opportunity to teachers to participate in the study. Only those teachers who volunteered were contacted. There are 20 staff members and we anticipated 5 would participate in the study.

Tasks. Ontario Write Traits indicators (Write Traits Ontario Rubrics Revised) were used to evaluate the level of performance for each assignment completed with and without the use of AT. For example, the Write Traits indicators rubric for organization range from a low level 1, my paper is hard to follow, 2, my paper wanders off topic some of the time, 3, my paper stays on topic most of the time, and 4, my paper is logical and stays on topic. Under each level descriptors are given that indicate the qualities of writing for that level. For example, level 1, I don't see any real pattern in my paper or my ideas and sentences do not connect to each other. Level 2 states my paper follows a pattern some of the time and some of my ideas connect to the main point; others do not. Level 3, my paper follows a pattern and grabs the reader's attention and most of my ideas and sentences connect to each other. Level 4, my paper follows a pattern that makes sense for this topic and to the reader and it's easy to see how things are connected to my main point.

CASI Reading Assessment. The CASI (Comprehension... Attitudes... Strategies... Interests) Reading assessment is used throughout Ontario to evaluate the reading skills of students. Classroom teachers within this school board routinely administer the CASI three times a year. The February and May results of the CASI were used as pre-and-post intervention measures to evaluate the impact of the use of AT on student performance. Work samples were collected and analysed for content, mechanics, and overall appearance.

In addition to the questionnaires and the CASI, using a computer lab supplemented by a classroom set of MacBooks, the students were taught how to use WordQ and Kurzweil, which are text-to-speech software. The students were then taught how to apply the AT to their class assignments and assessments.

The researchers observed and interacted with students during two separate literacy classes where they read a passage and then answered comprehension questions. The readings consisted of a 100-word passage, one about the Sumerian number system and the other about rats. Specifically during the first literacy class observation, one half of the students were asked to independently read the material and answer comprehension questions without the assistance of AT. The other half of the class of students used AT to complete these tasks. During the second literacy class observation, the students who previously had not used AT were asked to do so and the other half of the students did not. With the use of the computer lab Kurzweil and WordQ read the passage aloud to the students through headphones. To answer comprehension questions students used WordQ. The students used inventive spelling such as medisin for medicine and then selected the correct spelling/word from the drop down prediction list in WordQ. Once the comprehension questions were completed the students saved and printed their assignments and submitted them to the teacher. Elements of writing that were evaluated included ideas, organization, voice, word choice, sentence fluency, and conventions.

Interviews.

Students, teachers, and parents were surveyed and/or interviewed to identify their perceptions of student achievement as a result of using AT and their perceptions of acceptance of the AT by stakeholders. Students who had parental consent to participate were interviewed individually during class time in a private setting at the end of the research study. Each interview took about 15 minutes. The interview protocol is found in Appendix A.
Parents who had provided consent to participate in the study were interviewed individually at a mutually agreeable time in a private setting at the end of the research study. Each interview took about 15 minutes. The interview protocol is found in Appendix B.

Teachers who had provided consent to participate in the study were interviewed individually at a mutually agreeable time in a private setting at the end of the research study. Each interview took about 15 minutes. The interview protocol is found in Appendix B.

Findings of the Study

Students mentioned a few drawbacks regarding the use of AT. They noted that the computers in the labs were often slow and sometimes their work was lost. They suggested that rather than using network or laptop computers, iPads, iPhones, social networking sites, and games might be preferable.

Students, teachers, and parents reported that the AT was easy to use and to learn, but there are frustrations and delays when systems are slow or fail. Classroom observations showed that the students had a relatively high tolerance for the breakdowns, but during the interviews with the students they noted it as a drawback. Students reported their desire to access other means of technology rather than just computers.

For the most part the students were happy with their access to and the ease of use of AT. Teachers suggested that their students were happier, more motivated, and shut down less frequently when using AT. Teacher-student relationships appeared to be enhanced as students became more productive and less discouraged as they felt supported by their teacher and through the use of AT.

Teacher effects on the achievement of students are significant. The grade 8 class had 37 students in it until December 1. There was a supply teacher in the interim. Students explained that they had not used AT with the supply teacher in the fall because he did not believe in it and would not let them use it.

As of December the class was no longer split and a new grade 8 teacher was in place for January 2012. At this point there were 20 students in grade 7 and 17 students in grade 8. The CASI test results for grade 8 were disappointing, but perhaps reflect the teacher-student ratio, lack of access to AT, and the teacher's attitudes toward the use of AT. The teacher has to be a believer and not only allow the students to use AT, but to support it as well in order to facilitate access to AT and not build barriers with negative attitudes.

In general, teacher satisfaction appeared to be positive and the teachers expressed their feelings of being supported as well. In general they reported that AT improved the quality of student work, particularly those students who have experience with failure and frustration and their willingness to participate in activities and assignments, reflecting an increase in motivation. Additionally, the teachers mentioned a sense of pride on the part of the students regarding their work.

In this study, parents agreed with the improved quality and completion of their child's schoolwork, their increased level of motivation, and a corresponding increase in self-esteem. The parents did not express any concerns about their child using AT since they had witnessed these effects. Parents indicated a high level of satisfaction with the school and the progress of their son or daughter.

Classroom observations

Student distractibility appeared to be low during the class assignments. A student explained, "When the computer reads it to me I can remember it. When I read it alone, I forget what the story is about. It helps my spelling, too."

Regarding the issue of spelling, a boy offered, "My mom's a writer and she can't spell well either. It is annoying when American spelling pops up because I can't correct it because I don't know how to spell it!" Further he went on to explain a source of frustration for those who were not accommodated through the use of this AT, "Our old teacher wouldn't let us use it and then he gave us heck for not being able to spell."

These students also were clear on some of the shortcomings of the software application. "The computer's not my brain."

Work Samples

Upon examination of the work samples provided in March and April, the differences between the paper and pencil samples and the samples using AT were striking. Using the CASI exemplars as a guide, in general the student work changed from a level 1 to a level 2 using AT.

The appearance of the assignments, using assistive technology, were neat and professional looking as opposed to the messy, childlike penmanship of the assignments done by the students with pen and paper. This influences the teacher's perceptions of the student's ability, regardless of the quality of the product. Upon examination, however, there is an improvement in spelling, grammar, and word usage as well as overall appearance.

<Insert Work Samples>

CASI Test Results

The CASI assessment results pre-and-post intervention, indicate a one-level increase in performance for the LD students in this study. This is significant as students with LD face many challenges to their education. About one-quarter of parents of children who have a LD reported that their children were doing well at school while 75% of other parents reported their children were doing well in school.

11.2% of children with LD missed school while 5% of non-identified children were absent from school (PACFOLD, 2007). 21% of students with LD are likely to read at a level 5 years below their peers, 14.2% drop-out of school compared to a drop-out rate of 9.7% for non-disabled students. Lower scores in literacy and lower reported marks in school were among the main factors associated with high school drop-out (Youth in Transition, 2002). Canadians with LD achieve lower levels of literacy (71.6%) compared with 36.9% of the general population (PACFOLD, 2007).

Table 1: The CASI Results: February/May Scores

Grade 7 : Non-Fiction

STUDENT	FEB			MAY		
	Q5	Q6	Q8	Q5	Q6	Q8
A	1	2	3	1	1	2
B	1	3	2	3	1	1
C	2	3	2	2	1	2
D	1	3	2	3	1	2
E	1	2	2	1	1	2
F NON LD	2	2	2	3	3	3
G NON LD	3	2	3	2	2	3
H NON LD	3	2	3	2	2	3

Table 2: The CASI Results: February/May Scores

Grade 8 : Non-Fiction

STUDENT	FEB			MAY		
	Q5	Q6	Q8	Q5	Q6	Q8
A	1	2	1	1	2	3
B	0	1	1	1	3	3
C	0	1	1	0	2	2
D	1	1	2	1	2	3

Interviews: The students

Through interviews with the students it was discovered that students have formulated opinions on the ease of use of AT. One student explained, "I can't write as fast as I can think so it is easier with the computer to help you. Handwriting hurts and AT is easier to use."

Students reported using WordQ from as early as grades 1 or 3. One student who began using WordQ last year in grade 6 stated, "It is easier to write with WordQ. It helps me with spelling. Now I can read and spell. It'll read to me so I understand."

When asked about their acceptance by other students who do not use AT one student said, "Other students can be kind of mean."

One of the most interesting outcomes of the interviews with grade 7 students was that a student who was not identified as having an LD but chose to use AT said, "My grades have improved." This indicates a strategic or active learner, someone who employs strategies such as AT and monitors their progress in order to be successful in their studies. Conversely, non-strategic learners stated matter-of- fact messages as, "I don't know if my grades have improved or not. I don't know what my grades are" It was as if they had never considered that monitoring their grades was something that they should do. In conversation with their literacy coach, however, they had spent a substantial amount of time the previous year learning and practising the monitoring of their progress by tracking their achievements in their schoolwork. This harkens back to the definition of a learning disability that states that students with LD have difficulty with executive function, or the processes that individuals use to control their behaviour and to get ready to respond to different situations. The students from grade 8 talked about how easy the AT was to use and how it assisted with work completion submitted on time. One student said that "It is easier, faster to type" than to write by hand. My writing has improved a lot. It helps you to remember. I do better in school using it."

Another agreed by saying, "It helps with writing- with spelling and grammar; it helps when it reads the question to me. Then I can understand it". Further, "It helps me with research projects. I get stuff done on time now."

On the topic of access to AT one student exclaimed, "It is unfair if only some kids get to use AT because it takes longer to write on paper." She felt that all students should have access to AT regardless of their ability. Another student talked about whether he would be able to continue to use AT in high school. "I want to continue to use it through high school to get better grades." Students from both grades 7 and 8 discussed the ease of learning AT and offered insights into the mechanics of use. "I don't like the long wait for it to load. It is slow on most of our computers. That is boring. And it sometimes loses your work." Another student commented, "Sometimes it breaks down and doesn't fix the word the way you want it." The students appear to be tech savvy as they pointed out things such as, "You have to get used to a touch screen. It is easier texting on a cell phone. Some people don't like to use a computer. Better to use iPad, iPhone, social networks, or games."

When asked about other students' behaviours toward them regarding their use of computers and AT the comments were enlightening, "Some of the other kids get mad because they don't get to use it as often – only when they get to go to the computer lab." From a different perspective, "We get called dumb or retarded but we just make fun of it. We say, it's true, we are. They don't have to use it; they're lucky. Because it looks weird, they don't know what it is so they make fun of it. They think they're better than me." One of the students showed an unexpected level of maturity when she added, "They have to take their anger out on others." It was interesting to hear that, "Over half of our class uses it."

Interviews: Parents of students in grades 7 and 8.

The parents who agreed to be interviewed talked about the effect of AT on their child's level of achievement in school. While some parents said yes their child's grades had improved, others disagreed. "It hasn't improved his grades but he can get his answers down." Another parent noted that her child had "more confidence. He can get his assignments done. No one teases him. No complaints." One parent confessed, "I was against it at first because I thought it would make him lazy but the opposite happened. Now he is reading (environmental) signs and he never would before. We tried all kinds of things before and nothing worked."

Regarding the emotional effects of the use of AT for their child, parents commented, "Less frustration. Higher self-esteem. He gets discouraged when trying to do things by himself without the program."

Interviews: Grade 7 Teachers

In general the teachers found that AT "improves the quality of student work." "We see improved grades; more writing." On another note, the appearance of assignments created with a computer is neater and more professional looking. "Teachers are keener to go through a "clean" assignment."

The teachers also commented on AT's apparent effect on the level of student motivation. "The students are more willing to try; they are more motivated. It encourages students to continue. Gives them a back up plan and helps with research." Another said, "Students are not bogged down by a lack of fine motor skills." Further, "We see better student self-esteem because they are proud of their work and they are not daily faced with failure." The grade 7 teachers noted that parents are supportive of the use of AT. "Parents see improvement in grades." From the teachers' perspective, AT is readily acceptable and accessible, "So many kids are using it and even "A" students ask to use it."

Interviews: Grade 8 teachers.

The grade 8 teachers also commented on the appearance of student work. "It looks good; everyone feels accomplished. Without it the best you get from students is 1-2 sentences. It is easier for teachers to mark, edit. Stories have a better flow and students not held up by OT (Occupational Therapy) issues."

With reference to low executive function for students with LD, the teachers explained, "Students save their work on the computer so nothing is lost – unlike assignments done on paper that students lose all of the time."

The grade 8 teachers mentioned the effect on students' level of motivation as well. "It is novel to the students to be engaged on a computer. It makes the students feel comfortable and supported."

Conclusions

Stakeholder perceptions are generally in agreement that student accomplishment, work completion, student motivation, and in some cases, academic achievement, increases when using AT. It is worth noting that non-strategic learners are not aware of their grades so do not have an awareness as to whether their grades have improved as a result of using AT. They did report that they found the work easier to complete with the use of AT, less fatigue, and that they were more able to keep up with the pace of the classroom. Strategic learners taught themselves how to use the AT and elected to use it on their own volition to enhance the accessibility of information and the quality of their work. These strategic learners were also aware of their grades and the positive effect that AT had on them.

The overall findings of this study indicate that all stakeholders perceive that students who use AT attain higher grades leading to greater feelings of efficacy, self-esteem and motivation on the part of the students. Students are better able to keep up with the rest of the class with the completion of assignments. Students suggested that they found it easier to focus on their tasks at hand while using AT but that not all teachers allowed its use. Attitudes were identified as a barrier to access not only from teachers but from other students as well. When teachers do not perceive AT as useful or meaningful the students are not given access to the devices. For example, a teacher who does not start the laptop or other device and load the software so that it is ready to use by the student during class may create a situation where the time employed for set-up takes away so much valuable class time that the student abandons the AT. When students convey negative messages about students who use AT the students in question may become resistant and abandon their use. Overall, few drawbacks for using AT were identified.

Limitations of the Study

The findings of this study are not readily applicable to all settings and situations as the sample size was small. Most of the participants in the study had been exposed to AT for a number of years, so the findings may not depict the experience of students newly introduced to such applications. In addition, the study took place in a small town in northeastern Ontario, which may not relate to larger centers or more remote locations.

Recommendations

As noted, teacher attitude has a significant impact on student use and success. For this reason, workshops and consultations regarding the use of AT in the classroom should continue to be offered on a wide spread basis. One teacher in a school using AT well can cause a positive ripple effect as other teachers see student and stakeholder responses, especially the increased productivity of their students and their resulting increased perceptions of self-efficacy.

The use of AT should be continued throughout high school and into post secondary to continue the happy results of positive teacher-student relationships and students' and teachers' perceptions of support. To support the use of AT, teachers should guide students in the recording of their rates of success before and after the introduction of AT. In this manner students can track their progress. Additionally, teachers should provide students with a means of tracking their grades in order to determine the impact of AT on their grades. In this way teachers can guide students into becoming more strategic learners and encourage them to continue to use AT throughout their school career.

School boards should continue to investigate different types of hardware rather than just the use of computers in the classroom, such as iPads, iPods, and iPhones. Research into different types of AT available for different purposes should continue and support should be offered to teachers regarding the appropriate matches of AT to student needs.

Parents should be invited to participate in workshops in order to de-mystify and learn about AT and the hardware their children are using in school. In this way, home and school relations can be built on a positive note and parent support garnered.

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