Examining the Literature on Assistive Technology

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This article examines the research on assistive technology, a term for any device or software that is used to help an individual adapt to their environment. For students with learning difficulties this may include general instructional technology as well as computer software that support the reading and writing process through text-to-speech, speech-to-text, graphic organizers, and word prediction programs. Research demonstrates the effectiveness of assistive technology for students with disabilities (Higgins & Raskind, 2004), with specific emphasis on its ability to increase academic achievement (Hetzroni & Shrieber, 2004). Others note it may improve students' reading and writing in all content areas (MacArthur, 2009).

Research demonstrates the effectiveness of assistive technology for students with disabilities.

In the article we examine the use of assistive technology in inclusive classrooms, noting that assistive technology benefits students with disabilities (White, Wepner, & Wetzel, 2003), and that it can improve access to the curriculum for all students (Silver-Pacuilla, 2006). We follow with an examination of how education is beginning to witness the convergence of "assistive" and "mainstream technology" (Ludlow, 2014), noting that the abundance and redefining of assistive technology may leave teachers feeling unprepared to effectively use the technology in their inclusive classes (Sider & Maich, 2014). We then examine teacher training and other barriers to technology implementation. We conclude by noting that much needs to be done to improve the quality of special education technology research (Edyburn, 2010). We advise that teachers need training and support in order to capitalize on available technologies and find ways to integrate them into their instruction, for the technology itself will not help students overcome their learning difficulties (Newton & Dell, 2011).

Assistive technology refers to devices and services that are used to increase, maintain, or improve the functional capabilities of a student with a disability (Dell, Newton, & Petroff, 2012). Assistive technology devices range from low-tech to high-tech. Low-tech devices are generally inexpensive, widely available, and easy to use, such as pencil grips and line guides (Parette, Wojcik, Peterson-Karlan, & Hourcade, 2005). Mid-tech devices, such as audio recorders, can be useful without the cost associated with high-tech devices (Young & MacCormack, 2014). Other examples of mid-tech devices include concept maps, portable note takers, MP3 players, calculators, and pentop computers. Mid- to high-tech tools include specialized software such as text-to-speech software,

speech-to-text software, word prediction software, and graphic organizer software. These high-tech devices are complex and multifunctional and require a computer or tablet.

Assistive technology offers compensatory and remedial approaches to facilitate learning and can be used in a variety of situations within school and classroom settings. The purpose of assistive technology is to enable students with disabilities to participate in and complete tasks they would otherwise not be able to complete (Simpson, McBride, Spencer, Lowdermilk, & Lynch, 2009). Assistive technology is used to assist students in meeting the goals outlined in their individual educational plans (Blackhurst, 2005), and it can support a student to complete tasks and enable a student to bypass an area of difficulty, such as handwriting (Young & MacCormack, 2014). In addition, assistive technology can enable students with disabilities to be more independent in completing tasks and achieving academic success (Hasselbring & Bausch, 2005).

Research on Assistive Technology

Graphic organizers, word processors, word prediction, spell checkers, speech recognition software, and text-to-speech software are common forms of computer-based tools used to support the writing of students with learning difficulties (MacArthur, 2009; Parette & Peterson-Karlan, 2007). Batorowicz, Missiuna, and Pollock (2012) conducted a review of 28 studies regarding the use of technology to support the written productivity of children with learning disabilities. While the researchers found the evidence to be moderately low, they suggest there are some positive influences from some technology on students' writing performance and behaviour. The findings from this review suggest that using technology may positively impact student's attitudes, independence, and motivation to write (p. 222).

Using technology may positively impact student's attitudes, independence, and motivation to write.

Evmenova, Graff, Jerome, and Behrmann (2010) examined three different word prediction programs and their effect on the length, spelling accuracy, and rate of students' journal writing and students' expression of their opinions. Six students, who were in Grades 3 through 6, participated in this study. These students were identified as having severe writing and/or spelling problems. All three of the programs included additional features, such as text-to-speech and the spell check feature. The researchers established a baseline level of student performance where students used Microsoft Word for their journal writing. For the treatment condition, students used the word prediction programs for a week and then alternated to one of the other programs. The students demonstrated improvements in spelling accuracy across the three different programs. All students increased the total number of words using at least one of the programs, and five of the students increased their rate of composition using at least one of the programs. The interviews indicated students and teachers enjoyed using the prediction programs and found them beneficial (Evmenova et al., 2010).

There is some evidence highlighting the positive impact of assistive technology on the reading skills of students with learning difficulties. Chiang and Jacobs (2009) investigated the effects of computer-based instruction on the academic self-perception and functional ability of 50 high school students with learning difficulties who were assigned to either the comparison group or the computer-based instruction group, who used the assistive reading software, Kurzweil 3000 (K-3000; www.kurzweiledu.com), intensively for 10 weeks. This program provides reading and auditory presentation of text and study-skills tools and provides students with reading, writing, and study strategy support. Before and after the intervention period, standardized measurements, such as the self-perception profile for learning disabled students, the self-perception profile for adolescents, and self-developed questionnaires, such as a job application form, were administered. The computer-based instruction group made more progress than the comparison group on the reading and general competence subtests and made more progress in filling out the education information and work experience sections of the job application form. The

results suggest that the assistive reading software Kurzweil 3000 improves academic self-perception and functional task performance of high school students with learning difficulties.

Text-to-speech supports the development of metacognitive strategies, student dialogue and collaboration, spontaneous reader response, and self-efficacy and self-advocacy.

Parr (2012) conducted a classroom case study where text-to-speech was integrated into daily instructional practices. Text-to-speech is typically categorized as a type of assistive technology for reading, as it transforms the text of print or digital materials into a text that is read aloud by a computer-synthesized voice. Parr (2012) employed ethnographic inquiry in an investigation that took place over a period of eight months and involved 28 student participants. Text-to-speech was not provided to individual students as an accommodation; instead, all students had access to and the option to use this technology for reading support. Findings highlight that text-to-speech supports the development of metacognitive strategies, student dialogue and collaboration, spontaneous reader response, and self-efficacy and self-advocacy. Parr (2012) proposes a re-envisioning of text-to-speech, in which it is no longer used an added-on, isolated, compensatory support for individual students. Instead, she recommends that this technology be embedded as an "integral and flexible component of inclusive reading education that incorporates the principles of universal instructional design" (2012, p. 1427). This educational framework is designed to increase accessibility for all students by considering the potential needs of all learners when designing and delivering instruction and by identifying and eliminating unnecessary barriers to teaching and learning, while maintaining academic rigor.

Inclusive education means that all students attend and are welcomed by their neighbourhood schools in age-appropriate, regular classes and are supported to learn, contribute, and participate in all aspects of the life of the school. Inclusive education occurs in common settings where students from different backgrounds and with different abilities learn together. Marino (2009) investigated technology-based tools used to support an inclusive middle-school science class in order to determine if there was a relationship between students' reading ability, use of cognitive tools, and their comprehension of scientific outcomes. The study involved 16 general education teachers who implemented a universally designed curriculum in 62 inclusive classrooms. Students were grouped based on their reading performance as opposed to disability classification. Students used Alien Rescue as a tool to learn an astronomy unit. This technology-based tool utilizes problem-based learning and tools that scaffold the learning process, such as illustrations, pictures, animations, videos, and graphic organizers to allow students to learn at their own pace. The results indicated that the low-ability readers benefitted from using these tools, even tough they did not use them as frequently as the proficient readers.

Upon examination of the use of assistive technology, it is noted that while assistive technology benefits students with disabilities (White, Wepner, & Wetzel, 2003), it can improve access to the curriculum for all students (Silver-Pacuilla, 2006). As assistive technology features are becoming embedded in commonly used devices that are being used to support teaching learning, we follow with an examination of the use of assistive technology in inclusive environments, with specific emphasis on the need for teacher training and ongoing professional development.

Using Assistive Technology in Inclusive Classes

According to Ludlow (2014), education is beginning to witness the "convergence of assistive and mainstream technology" (2014, p. 1). Many "built-in" assistive technology features are advantageous for a broad range of individuals, not just those with special needs. King-Sears and Evmenova (2007) encourage teachers to find opportunities to implement innovative technologies with all of the students in the class. However, the abundance

and redefining of assistive technology may leave teachers feeling unprepared to effectively use the technology in their inclusive classes (Sider & Maich, 2014).

Education is beginning to witness the "convergence of assistive and mainstream technology".

Okolo and Deidrich (2014) surveyed educators to provide a snapshot of their knowledge, skills, and perceptions of technology use for students with disabilities, along with common obstacles that are faced by educators in implementing technology. The 1,143 participants encompassed kindergarten to Grade 12 general and special education teachers, related service personnel, administrators, and technology coordinators. Respondents were asked, "In your school or district, what are the top three ways technology could be used to have an impact on the learning and success of students with disabilities?" Sixty-seven percent of educators indicated improved access to curriculum, which included increased access to text, ways to respond, access to aural information, captioning and described video, and universal design for learning. Other frequent responses for technology's impact on teaching and learning included positive impact on academic outcomes; improved teaching practices (differentiation, individual feedback, pacing, more interactive or relevant instruction and support for individual learners); and better-quality functional outcomes, such as improved opportunities to communicate with peers (Okolo & Deidrich, 2014). Educators were also asked to identify three of the biggest barriers to using technology to support the education of students with disabilities. Seventy percent of educators named staff knowledge as a barrier to technology use. Respondents pointed to the need for more training to improve the knowledge and skills of educators. The second most common barrier to technology use was related to lack of student access to adequate technology. Sixty-one percent of respondents were not satisfied with the quantity, quality, and type of technology available for use by students and teachers. Educators mentioned a general dissatisfaction with the technology, as well as specific problems, such as how the technology was distributed, broadband speed, lack of technology-related resources, and out-dated technology. Funding was cited as the third most common barrier, followed by issues with implementation, including factors relating to infrastructure, support for technology, lack of time for teachers to learn about how to implement technology, and staff allocation of technology support personnel.

Seventy percent of educators named staff knowledge as a barrier to technology use.

Flanagan, Bouck, and Richardson (2013) conducted a survey to explore the use, effectiveness, and factors impacting the use of assistive technology for literacy teaching and learning. The findings revealed that while teachers believed assistive technology supported student literacy skill development, its use was very minimal and often limited to low-tech assistive technology options, which are less costly. The results suggest providing effective training to teachers during pre-service education or professional development sessions may support teachers' use and understanding of assistive technology.

While technology holds great promise, teacher training and teacher efficacy, accompanied by ease of access to quality technology, remain barriers to implementation. The text that follows encourages the reader to consider how common technology can serve as assistive technology to meet the diverse learning needs found in inclusive classrooms.

Assistive Technology and Instructional Technology

Inclusive classrooms utilize instructional and assistive technology (King-Sears & Evmenova, 2007). Instructional technology is more general in nature. Unlike assistive technology, which is geared toward a single child's strengths and needs, instructional technology supports teaching the curriculum and facilitating learning (Parette & Peterson-Karlan, 2007). In the current era of

accessible technological devices, the lines that distinguish instructional from assistive technology are beginning to blur. Some technologies, such as digital textbooks, may be considered both instructional and assistive (King-Sears & Evmenova, 2007). High-tech assistive technology tools are becoming more common as specialized technology becomes increasingly available to classrooms and all students. A vast array of instructional technology contains the same attributes as assistive technology. For example, speech recognition software is highly beneficial for students with difficulties in reading and writing and is routinely acknowledged as assistive technology for students with disabilities. However, this same technology is ubiquitous on current smartphones and other mobile devices that people without disabilities use on a daily basis. Therefore, Marino, Sameshima, and Beecher (2009) argue that the majority of assistive technology and information technology products are symbiotic in nature.

Rethinking Assistive Technology

iDevices, Android devices, and word processing software come embedded with numerous assistive technology features, such as voice recognition, word prediction, spell check, and autocorrect. Schools are moving towards allowing all students to access assistive technology through more universally accessible devices and programs. With personal digital devices being popular, less costly, and widely available to students, they can provide an inclusive way to integrate assistive technology into the classroom.

Bouck, Flanagan, Miller, and Bassette (2012) argue that because today's students are increasing their use of technology in and out of school, teachers need to capitalize on available technologies and find ways to integrate them into their instruction. These authors propose "rethinking assistive technology" as a way of taking advantage of widely available devices to support student learning, even though these devices were not intended as assistive technology. Rethinking common technology as assistive technology provides opportunities for schools to reduce challenges commonly associated with their use. Earlier research demonstrated that nearly one-third of assistive technology devices are abandoned (Todis, 1996). Students may abandon their technology for fear of looking different from their peers and of stigmatization associated with the device (Todis, 1996; Parette & Scherer, 2004). Student abandonment of assistive technology can be reduced if the technologies are desired and used by their peers (Parette & Scherer, 2004). Therefore, commercially available technologies, such as smartphones, tablets, MP3 players, and educational toys that are attractive, familiar, and already equipped with built-in accessibility features, may lead to a decrease in assistive technology abandonment and an increased learning benefit for all students. These devices are lower in cost because they are mass-produced, and can help overcome the high cost associated with specialized assistive technology.

The technology itself is not going to help students with disabilities to overcome their learning obstacles.

Students and teachers can avail themselves of free tools on standard devices, such as a graphic organizer, math support, and voice recognition applications. In addition, students have free access to utility tools such as a dictionary, calculator, and calendar on their devices. Assistive technology does not have to be an accommodation for a particular student as added-on, retrofitted support. Instead, teachers can make use of more natural technological supports, such as mobile devices, by designing the instruction, materials, methods, and assessments to be flexible and supportive of a full range of learning styles and abilities. Newton and Dell (2011) caution students and teachers against being blinded by exciting new mobile touch-screen devices. They assert that the technology itself is not going to help students with disabilities to overcome their learning obstacles. Students, along with a parent, must receive adequate training on how to use the technology, and a detailed plan on how to implement, support, and assess whether the assistive technology is having a positive impact on student learning is required (Newton & Dell, 2011).

Limitations to the Research

Much needs to be done to improve the quality of special education technology research (Edyburn, 2010). Little research has been conducted on the use of assistive technology in inclusive schools (Watson, Ito, Smith, & Andersen, 2010), and few researchers are conducting systematic, well-designed research that can lead to confident conclusions on how the use of assistive technology affects learning (Gersten & Edyburn, 2007; Wanzek, Vaughn, Wexler, Swanson, Edmonds, & Kim, 2006). In addition, research cannot be produced quickly enough to match the rate of technological innovations, and as a result, educators tend to rely on the claims of the producers of the technologies rather than evidence-based research (Blackhurst, 2005).

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Quinn, Behrmann, Mastropieri, Chung, Bausch, & Ault (2009) found the use of assistive technology in schools to be low, but especially low for students with high-incidence disabilities in general education environments. There is a need for more research on how teachers are using assistive technology to provide learning environments that are accessible to all learners (Basham, Israel, Graden, Poth, & Winston, 2010). A review of the current literature on assistive technology use shows sparse results, and the studies are limited as they focus on specific disabilities and investigate a narrow range of assistive technology devices (Quinn et al., 2009). It is important to rethink how universally accessible devices and programs can serve as assistive and instructional technology and be used to support inclusive learning environments.

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