Supporting Content Learning Through Technology for K-12 Students With Disabilities

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Table of Contents

Innovation Configuration for Supporting Content Learning Through Technology for K-12 Students With Disabilities

This paper features an innovation configuration (IC) matrix that can guide teacher preparation professionals in supporting content learning through technology for K-12 students with disabilities. This matrix appears in the Appendix A.

An IC is a tool that identifies and describes the major components of a practice or innovation. With the implementation of any innovation comes a continuum of configurations of implementation from non-use to the ideal. ICs are organized around two dimensions: essential components and degree of implementation (Hall & Hord, 1987; Roy & Hord, 2004). Essential components of the IC—along with descriptors and examples to guide application of the criteria to course work, standards, and classroom practices—are listed in the rows of the far left column of the matrix. Several levels of implementation are defined in the top row of the matrix. For example, no mention of the essential component is the lowest level of implementation and would receive a score of zero. Increasing levels of implementation receive progressively higher scores.

ICs have been used in the development and implementation of educational innovations for at least 30 years (Hall & Hord, 2001; Hall, Loucks, Rutherford, & Newton, 1975; Hord, Rutherford, Huling-Austin, & Hall, 1987; Roy & Hord, 2004). Experts studying educational change in a national research center originally developed these tools, which are used for professional development (PD) in the Concerns-Based Adoption Model (CBAM). The tools have also been used for program evaluation (Hall & Hord, 2001; Roy & Hord, 2004).

Use of this tool to evaluate course syllabi can help teacher preparation leaders ensure that they emphasize proactive, preventative approaches instead of exclusive reliance on behavior reduction strategies. The IC included in Appendix A of this paper is designed for teacher preparation programs, although it can be modified as an observation tool for PD purposes.

The Collaboration for Effective Educator, Development, Accountability, and Reform (CEEDAR) Center ICs are extensions of the seven ICs originally created by the National Comprehensive Center for Teacher Quality (NCCTQ). NCCTQ professionals wrote the above description.

Incorporating technology into instruction in a manner that supports students with disabilities can take many forms, can have multiple purposes, and can frequently change as technology evolves. Both policy and research contribute to this technology integration across teaching practices for students with a variety of academic and social/behavioral strengths and challenges. The purpose of this IC was to present the literature related to the use of technology for supporting the academic learning and engagement of students with disabilities and other diverse learning needs so that teacher educators can apply the literature to their teacher preparation programs. Because technology is constantly changing, we focused on broad themes that transcend individual technologies rather than identifying applications (apps) or software that may become outdated in the near future. We based our recommendations on the analysis of both policy and current educational research.

The Importance of Instructional Technology Integration for Students With Disabilities

Peterson-Karlan and Parette (2005) noted that technology provides a much-needed medium to develop socialization and communication skills that are often lacking in millennial students (i.e., those who entered school after the year 2000) with disabilities. Today's students have the abilities and, in many cases, the resources to use mobile technologies in the classroom. Grunwald Associates LLC (2013) conducted online surveys of technology use with a nationally representative study of 925 parents of children aged 3 through 18 as well as interviews with 54 families of children aged 3 through 5 not enrolled in preschools to ascertain the level of mobile device use among children. The authors noted that 60% of high school students and 43% of all pre-K-12 students used a smartphone, most on a daily basis. The authors also noted that 51% of the high school students brought smartphones to school on a daily basis. These devices can provide assistive technology (AT) and instructional technology (IT) tools such as advanced planners, voice recognition software, reminders, virtual dictionaries, and an ever-increasing supply of instructional apps. However, 72% of parents in the Grunwald survey reported that their children's schools had policies preventing the use of family-owned mobile devices at school. This is unfortunate because research indicates that students with disabilities benefit more than their peers without disabilities from technology-based tools (Marino, 2009). A recent study by Marino, Israel, Beecher, and Basham (2013) examining the perceptions of middle school students across 14 states revealed that an overwhelming majority of students preferred virtual learning environments above traditional instructional methods such as class discussions, reading, and labs. The authors indicated that traditional learning methods rely on reading and writing, so difficulties with these skills often hinder content instruction. Although research in the content areas examining the efficacy of using mobile devices and apps is only emerging (Nordness, Haverkost, & Volberding, 2011), it does provide evidence that these technologies can help students with disabilities and other learners who are at risk of learning failure in the content areas (Rappolt-Schlichtman et al., 2013; Twyman & Tindal, 2006).

Since the Obama administration released the Elementary and Secondary Education Reauthorization Blueprint for Reform in 2010 (U.S. Department of Education, 2010a), calls for the increased use of technology to enhance the accessibility of academic content specific to instruction and assessment have been included in nearly every federal education policy initiative. For example, The National Education Technology Plan (NETP; U.S. Department of Education, 2010b) states, "the challenge for our educational system is to leverage the learning sciences and modern technology to create engaging, relevant, and personalized learning experiences for all learners that mirror students' daily lives and the reality of their futures" (p. x). In the past decade, two types of overlapping technologies have been most prevalent in supporting students with disabilities and other struggling learners: AT and IT.

Assistive Technology

There is a wide array of AT devices ranging from low-tech devices (e.g., pencil grips) to high-tech software (e.g., speech recognition software). The Individuals with Disabilities Education Act (IDEA, 2004) defines an AT device as "any item, piece of equipment, or product system, whether commercially acquired off the shelf, modified, or customized, that is used to increase, maintain or improve the functional capabilities of a child with a disability" (34 C.F.R. § 300.6). This definition has remained virtually unchanged over the past 20 years with advocates for the definition arguing that the ambiguity allows flexibility for individual education program (IEP) teams in determining the types of AT that best meet the needs of students with disabilities. Edyburn (2004) noted that this ambiguous definition has led to varied policy interpretations that undermine the continuity of AT services for many students.

A vast array of IT contains the same attributes as AT. For example, speech recognition software, which is highly beneficial for students with dysgraphia or dyslexia, is routinely acknowledged as AT 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) argued that the majority of AT and IT products are symbiotic in nature. As such, educators should focus on the efficacious aspects of the technology rather than defining it as AT or IT.

General and Content-Specific Instructional Technology

Technologies that support academic learning and engagement for students with diverse needs, including students with disabilities, fall into the categories of (a) general technologies that apply across instructional contexts and (b) technologies that are content specific. Although there is no consistent definition of technology integration, many scholars consider (a) how teachers use technology to facilitate students' thinking skills, (b) the ways in which teachers use technology in their general classroom instruction, and (c) the availability of technology in the learning environment (Hew & Brush, 2007). We considered technology integration to represent a combination of these areas as well as the incorporation of AT and the Universal Design for Learning (UDL) framework.

General technologies are transferable across content areas and grade levels (e.g., software for digital recording, voice recognition, creating multimedia presentations). For example, students can use multimedia software to create projects in social studies about world events and in mathematics to solve theorems. Content-specific technologies have a finite purpose. For example, scientific probeware for measuring barometric pressure and temperature may only be useful in science classes. This IC focuses on both general and content-specific technologies as these both serve distinct purposes and overlap in function.

Universal Design for Learning Framework

UDL is a broad instructional framework for teaching students with diverse instructional needs that often incorporates innovative technologies to address the needs of these learners (Meo, 2008). UDL guides the development of flexible curricula through the following three primary principles:

- Support affective learning by providing multiple, flexible methods of engagement (i.e., Why should I learn this?).
- Enhance recognition of learning using multiple, flexible methods of representation (i.e., What is this?).

- Support strategic learning using multiple, flexible methods of action and expression (i.e., How am I going to do that?) (Rose, Meyer, & Hitchcock, 2005).

Technology-enhanced, UDL-aligned curricular materials can include authentic problems that mirror students' daily experiences. For example, to enhance recognition learning, digital text can be incorporated to create readability levels that match students' ability levels (Jackson, 2004). This allows students to focus on higher order thinking instead of decoding or other low levels of knowledge acquisition associated with Bloom's Taxonomy (Krathwohl, 2002). The UDL framework helps educators transition from a one-size-fits-all model of instruction to a diverse learning community that maximizes educational benefits in diverse classrooms (Bouck, Courtad, Heutsche, Okolo, & Englert, 2009; Curry, Cohen, & Lightbody, 2006; Rappolt-Schlichtmann et al., 2013). Although UDL should not be considered synonymous with the use of technology, appropriate use of technology can enhance teaching and learning through the UDL framework. Additionally, there is a close relationship between AT, IT, and UDL because they are all designed to promote the access, participation, and progress of students with disabilities in schools (Silver-Pacuilla, 2006). See Israel, Ribuffo, and Smith (2014) for information about the UDL IC.

Integrating Technology Into Teaching and Assessment

This IC focuses on the use of technology to support learning across K-12 content areas and settings for diverse learners, including students with disabilities. We designed it for use across multiple instructional contexts, including general education, special education, instruction of English learners, gifted education, and general instruction for students from diverse cultural backgrounds. We have included two appendices in this IC. Appendix A features the IC matrix, and Appendix B features technology studies broken down by content area (i.e., science, social studies, reading, writing, and math) and grade level (i.e., elementary, middle, and high school).

Selection Criteria

We conducted a systematic review of the literature from 2003 to 2013 using combinations of the terms *disability*, *technology*, *computer*, *virtual*, *handheld*, *tablet*, *iPad*, *mobile*, *math*, *language arts*, *reading*, *writing*, *science*, *chemistry*, *physics*, *biology*, *social studies*, and *history*. We conducted redundant searches across Google Scholar, PsychInfo (1887-current), ERIC EBSCOhost (1966-current), and Education Full Text (1983-current). We limited article inclusion to peer-reviewed journals and conference proceedings, government reports, and legislation. We reviewed references from identified articles, and we added seminal studies conducted prior to 2003. We based our recommendations on empirical works—see Appendix B—and scholarly literature reviews and meta-analyses. We limited inclusion in Appendix B to research studies conducted with K-12 students in the United States that were published between 2004 and 2013. We ensured that the studies included in the tables specifically identified students with disabilities as either the primary participant group or a subgroup within the study.

1.0 Technology and the Individual Education Program

We nested our focus on AT in the technologies that support students in meaningfully accessing content learning. There is a considerable amount of research in this area mostly focusing on mathematics, reading, and writing challenges with technologies that provide supports such as

- text-to-speech support and speech-to-text support (e.g., Blankenship, Ayres, & Langone, 2005; Moorman, Boon, Keller-Bell, Stagliano, & Jeffs, 2010) and
- digital text with support and strategy features (e.g., Anderson-Inman, 2009; Izzo, Yurick, & McArrell, 2009) and other writing supports (e.g., MacArthur, 2009).

Studies investigating these technologies point toward improved outcomes for students with disabilities in areas such as

- written expression (e.g., Dalton, Winbury, & Morocco, 1990; Hetzroni & Shrieber, 2004; MacArthur, 2009);
- reading and basic literacy tasks (e.g., Anderson-Inman, Knox-Quinn, & Horney, 1996; Fasting & Lyster, 2005; Jeffs, Behrmann, & Bannan-Ritland, 2006; McKenna & Walpole, 2011);
- spelling (e.g., Schlosser & Blischak, 2004); and
- mathematics performance (e.g., Bouck, Courtad, et al., 2009; Bouck, Joshi, & Johnson, 2013; Calhoon, Fuchs, & Hamlett, 2000; Courtad & Bouck, 2013).

In all of these cases of AT integration, the key is to match the technologies to the needs and strengths of the learners and instruct learners, teachers, and parents about how to use AT in a manner consistent with efficacious use.

1.1 - Make AT determination decisions and evaluate the success of AT for meeting students' instructional needs both as general and content-specific supports. The literature related to this critical component is nested within IDEA and subsequent regulations, which state that within the IEP process, AT must be considered for every child with a disability. The research related to AT and student learning is strong and points toward the powerful effects of appropriate AT in improving student outcomes. The key is that the technology must match students' needs for it to be effective. Additionally, commercial products can be used as AT to meet the needs of students with disabilities (Belson, Hartmann, & Sherman, 2013; Bouck, Flanagan, Miller, & Bassette, 2012; Douglas, Wojcik, Thompson, 2012). For example, Belson and colleagues (2013) found that students with learning disabilities who used commercial digital pens for notetaking increased the quality of their notes due to features such as audio feedback that allowed students to compensate for difficulties with attending to details. Students also reported that they could pay closer attention to class lectures due to decreased notetaking anxiety. In the AT determination process, therefore, both traditional, specialized, and commercially available technologies should be considered to address students' needs and determine whether the technology has a stigmatizing effect (Bouck et al., 2012).

1.2 - Teach students to identify and advocate for the use of specific technologies (i.e., AT and IT) across the content areas. Students with disabilities should be involved as much as possible as self-advocates in their own educational decision making (Lee, Simpson, & Shogren, 2007; Stang, Carter, Lane, & Pierson, 2009), and technology use for learning is an area of advocacy that should be considered while preparing teachers to help students self-advocate. The process of encouraging students to be their own self-advocates for technology supports is important for life and career success (Burgstahler, 2003). According to the National Longitudinal Transition Study-2 (NLTS2), 37% of postsecondary students used technology as part of their academic accommodations, and 10% learned job-related technologies such as Braille for reading materials (Newman et al., 2011). Thus, self-advocacy goes hand in hand with technology integration in a manner that promotes active student involvement in technology decision making.

1.3 - Integrate content-specific technologies with students' career goals and transition plans. Students with disabilities are less likely than their peers without disabilities to gain employment after completing their K-12 education. For example, as of February 2012, the employment rate for young adults with disabilities ages 20 to 24 was less than half the rate of their peers without disabilities (U.S. Government Accountability Office, 2012). Technology can provide students with rich experiences related to a number of careers. For example, although not specifically developed for students with disabilities, epistemic games are simulations of professional experiences within a gaming context that can increase students' awareness of and positive attitudes toward various careers (Hatfield & Shaffer, 2006). In a study of science.net, an epistemic game related to the work of journalists, two thirds of players stated that they experienced authentic journalistic work experiences and felt like journalists as they played the game (Shaffer, 2007). In another game, Urban Science, students became urban players and used data from geographic information systems (GIS) to work in a collaborative gaming environment as urban planners making decisions about city budgets, pollution issues, housing, and other issues. Bagley and Shaffer (2009) found that not only did the participants' knowledge of urban planning improve, but the players also increased transferable skills for other professions such as solving complex problems, understanding stakeholder values, and collaborating with others. Similar work in computer programming (Maloney, Peppler, Kafai, Resnick, & Rusk, 2008; Wang & Chen, 2010); general science careers (Marino et al., 2013); and engineering (Capobianco, Diefes-Dux, Mena, & Weller, 2011), is occurring in other professional disciplines. Marino and colleagues (2013) showed that increases in science, technology, engineering, and mathematics (STEM) career preferences are equally as powerful for students with disabilities as they are for students without disabilities. These studies point to the power of technology in supporting content learning and students' career goals.

2.0 Fundamental Technology Knowledge

2.1 - Identify student-specific barriers that occur during content instruction and assessment that can be remedied through technology. Within a UDL framework, technology can be used to increase access and reduce barriers to learning. For teachers to use technology for this purpose, they must first be able to identify student-specific barriers to learning. For example, traditional instruction focuses on a core curriculum that often relies on written text to convey information. For students who are inefficient readers, it is extremely difficult to access content in this manner (Berkeley, Marshak, Mastropieri, & Scruggs, 2011; Faggella-Luby & Deshler, 2008).

The cornerstone of UDL involves understanding learner differences in order to reduce barriers to learning.

Researchers have begun to develop instruments to identify learning barriers that technology can remedy (e.g., Edyburn, 2011; Reed, Kaplan, & Bowser, 2009). Much of this research involves environmental and ecological inventories that assess the appropriateness of different learning environments, including classroom settings; social settings (e.g., playgrounds, locker areas); and community settings for students with disabilities. Recently, this literature has begun to emerge into an assessment of barriers from a UDL perspective (e.g., Messinger-Willman & Marino, 2010; Meyer, Rose, & Gordon, 2013). For example, Coy, Marino, and Serianni (2014) developed instruments to assess the degree of UDL implementation within synchronous online learning given that increasing numbers of students with disabilities learn within these environments. The researchers examined the capacity of online environments to reduce learning barriers and the degree to which teachers integrated UDL within their instructional planning and online classroom instruction. They found that multiple means of representation were seen more often than multiple means of action and expression or engagement, leading the researchers to conclude that teachers spent more time on content delivery than on active student participation.

Regardless of the instructional delivery, barriers to learning should be examined on an individual basis so that teachers can provide instruction that is accessible, engaging, and meaningful. Once teachers identify barriers, they can begin to investigate how to leverage technology to address them.

2.2 - Select and use accessibility features within common technologies found in schools. To various degrees, schools have invested many financial resources into building technology infrastructures. Because schools have done so in different ways, there is no one way for teachers to select and use school-based technologies. Therefore, they must have the ability to evaluate the accessibility features of the technologies available to them and use those to meet the needs of their students. Marino, Marino, and Shaw (2006) provided a teacher-friendly protocol for selecting, implementing, and evaluating technology in the schools. Reed and colleagues (2009) extended this work by providing training for technology trainers. Examples of common technologies available in schools include computers, mobile learning devices, and interactive whiteboards. Each of these technologies has both accessible and inaccessible features, which are important to consider while using technology during instruction. While considering accessibility features within common technologies, it is important to consider how to use them for overcoming reading difficulties, reducing cognitive load, supporting problem solving, and providing methods of understanding complex instructional content.

Several studies have examined accessible features within technologies that are available in schools. For example, Hetzroni and Shrieber (2004) examined through a single-subject design the use of word processing to support three students with writing disabilities and found that the word processing software resulted in increased organizational quality and fewer spelling and reading errors. Wehmeyer, Palmer, Smith, Davies, and Stock (2008) conducted a meta-analysis of single-subject studies that examined aspects of UDL within pre-existing technologies for students with intellectual disabilities and found significant differences between the efficacy of devices with and without UDL features. They found that 40% of the technologies had at least one identifiable universally designed feature, but only a few provided cognitive access versus physical access. The authors defined cognitive access as software that allows flexibility in how content is accessed and manipulated such as information accessed in an auditory manner rather than exclusively through text.

2.3 - Describe and apply the UDL framework related to technology use in lesson and unit planning. Often, discussions of UDL and technology concurrently occur. Technology can support teaching through the UDL framework because it can increase access to learning and reduce barriers if effectively used. Although there is debate regarding whether technology must always be used during UDL implementation, technology is a powerful tool for reducing barriers to learning and increasing meaningful access and engagement (Rappolt-Schlichtmann et al., 2013).

The research conducted on the use of technology to support teaching and learning through the UDL framework supports the power of technology for enhancing learning and engagement and includes multiple designs such as randomized pre- and post-test designs (e.g., Bottge, Rueda, Kwon, Grant, & LaRogue, 2009); quasi-experimental designs (e.g., Dalton, Proctor, Uccelli, Mo, & Snow, 2011; Marino, 2009); meta-analyses (Wehmeyer et al., 2008); and qualitative studies (e.g., Basham, Meyer, & Perry, 2010). For example, Bottge and colleagues (2009) evaluated middle school science students' use of a UDL-based computerized assessment system compared to traditional paper-and-pencil tests and found that a computerized system allowed teachers to understand the extent to which students attended to critical features. For more information about UDL, see the UDL IC (Israel et al., 2014).

A major component of UDL implementation involves the planning process. It starts with the teacher's belief that instruction should be accessible and engaging for all learners and that planning can address the needs of a broad range of learners. The literature includes lesson planning that encompasses UDL principles (Courey, Tappe, Siker, & LePage, 2012; Dymond et al., 2006; Spooner, Baker, Jarris, Ahlgrim-Delzell, & Browder, 2007) and the implementation of curricula that are based on the UDL framework (Marino, 2010). Studies examining technology within a UDL framework point toward the adaptability and individualization afforded to learning by the flexibility inherent within technologies such as gaming, digital text, text-to-speech software, media-rich experiences, and flexible technology-based assessment systems. For example, Marino (2009) investigated the outcomes of UDL-based, technology-supported curricular materials with middle school students with diverse reading abilities. He found that these UDL-based materials had a significant positive effect on students' learning across the different reading ability levels. In another study, Rappolt-Schlichtman and colleagues (2013) used randomized control trials with multilevel modeling to evaluate the effectiveness of UDL-based online science notebooks compared to traditional science notebooks and found that the UDL-based technologies resulted in greater learning outcomes for students with disabilities compared to traditional paper-and-pencil science notebooks. The authors also found that these findings were consistent regardless of students' reading and writing abilities.

3.0 Integrate and Evaluate Technology During Instruction

3.1 - Critically analyze and select technologies based on student strengths and needs, content objectives, and learning barriers. Studies examining the use of technology to support students with disabilities strongly state that these technologies must meet specific needs for specific learners, so it is critical to understand both the content and the needs of the learners (e.g., Burns, Kanive, & DeGrande, 2012; Fede, Pierce, Matthews, & Wells, 2013; Garrett et al., 2011; Okolo, Englert, Bouck, Heutsche, & Wang, 2011; Rule, Stefanich, Boody, & Peiffer, 2011; Seo & Bryant, 2010; Shippen, Morton, Flynt, Houchins, & Smitherman, 2012). For example, students with disabilities often have reading difficulties that limit their abilities to interpret complex events even when their verbal reasoning skills are at grade level (Okolo et al., 2011). The inability to fluently process expository text appears as a consistent barrier to student learning, notably at the secondary level and across all content areas, including science (e.g., Marino, Black, Hayes, & Beecher, 2010;

Mastropieri & Scruggs, 2005); mathematics (e.g., Fede et al., 2013); language arts (Lange, McPhillips, Mulhern, & Wylie, 2006); and social studies (Okolo et al., 2011). Shippen and colleagues (2012) noted that beyond literacy, other cognitive and social-emotional deficits must be considered as teachers analyze their students' strengths and areas for improvement.

Successful technology integration for students with disabilities requires a nuanced understanding of the characteristics of emerging technologies, which leads to informed selection, purchasing, implementation, and assessment of the efficacy of the technologies for content-area instruction. This starts with an understanding of the types of technology-based applications (i.e., AT and IT) available to students. Christensen, Overall, and Knezek (2006) identified two types of technology tools that are used in educational contexts. The first allows students to more efficiently complete everyday tasks (e.g., use the calendar on a smartphone) while the second allows students to communicate and synthesize information in new ways (e.g., use a graphic organizer made with e-presentation software). Cognitive supports within these tools accentuate learner performance beyond what could be achieved in a traditional education environment.

In a seminal description of technology's role in the learning process, Lajoie (1993) referred to education technologies as cognitive tools that can enhance students' content performance. These tools (a) support cognitive and metacognitive processes; (b) share cognitive load by providing information as needed to allow users to concentrate on higher order thinking processes; (c) allow users to conduct activities that would not be possible in traditional classroom environments; and (d) allow users to solve problems by generating hypotheses, collecting data, and interpreting results in a simulated environment. Knowledge of these types of tools allows teachers to use students' performance data to guide the selection and adoption of these tools during instructional planning so that the unique needs of individuals with disabilities can be met.

3.2 - Develop both general and content-specific technology toolkits for use with students alongside evidence-based instructional practices. There is a great deal of literature about technology as applied to general technologies and specific content to meet students' needs. Because of the wide range of available technologies, it is important to have a fairly broad understanding of these technologies in order to meet the needs of students with disabilities in the content areas. The literature, therefore, emphasizes the importance of both general and content-specific technology toolkits that provide cognitive and physical access to the curricular materials. See Appendix B for research studies focused on the content areas and on general and content-specific technologies. At the content level, Shippen and colleagues (2012) pointed out that technology-based interventions allow teachers to customize the learning materials so that students can receive individualized instruction even while they are participating in a class where students exhibit a wide range of variability in their skills. A teacher's toolkit for any given academic intervention can include images, captioned videos, simulations, video games, and virtual museums.

In a recent review of the literature examining computer-based graphic organizers for students with learning disabilities, Ciullo and Reutenbuch (2013) found high effect sizes on social studies measures and promising results related to written expression. The authors noted, however, that these technologies were only efficacious when accompanied by explicit instruction and guided practice.

Other recent research acknowledges the promise of online strategy instruction. For example, Vasquez and Slocum (2012) used a multiple baseline design across four participants with learning disabilities to investigate the effectiveness of reading instruction provided through synchronous online tutoring and found that this instructional delivery only increased students' reading skills. In another example, Fitzgerald, Miller, Higgins, Pierce, and Tandy (2012) used a multiple baseline design across five participants to investigate the use of online modules to teach students with disabilities the Word Identification Strategy that Lenz and colleagues (2007) developed. They found that all five participants in the study improved both their oral comprehension and reading comprehension. These technologies allow teachers and students to customize content delivery. Additionally, they readily provide accessible learning opportunities to students with Internet access and provide the ability to track student use of the technology tools and learning outcomes. Again, technology was the tool for delivering evidence-based instruction in a flexible manner that included instructional supports.

Garrett and colleagues (2011) noted that additional technologies, such as voice recognition software, are necessary to improve the writing performance of students with physical disabilities. However, given the ubiquitous nature of these technologies on modern mobile devices, speech recognition appears to be an essential and low-cost toolkit item. Supported eText is another general technology toolkit item that research identifies with potentially positive effects across age, grade level, and content area. This strategy has led to increasing academic performance in individuals ranging from students with traumatic brain injuries and other cognitive impairments to students with learning disabilities (Anderson-Inman, 2009; Izzo et al., 2009).

3.3 - Plan and implement instruction using a diverse range of technologies. McNamara and Shapiro (2005) noted that technology can enhance the cohesion (i.e., associations between concepts) and coherence (i.e., quality of the mental picture formed by the learner) of curricular materials by illustrating connections among symbols, vocabulary, and concepts. This includes question prompts and tracking tools that allow students to monitor their own behavior, make predictions, and connect the information they encounter prior to learning. A number of studies point out the positive effects associated with technologies that anchor instruction or situate learners in authentic problem-based learning environments (e.g., Marino, Black, et al., 2010; Okolo et al., 2011). While planning content-specific investigations, teachers should consider technologies that provide enhanced opportunities for individuals to actively learn in self-directed ways, either through independent study or collaboration with others (Kirschner & Erkens, 2006).

There are a number of factors to consider while choosing technologies (i.e., AT and IT) to support content-area instruction. For example, Boone and Higgins (2007) stated,

> with a dearth of information from educational software publishers concerning the production of their software, educators are basically on their own . . . . Often educators find that the software they have purchased is not adaptable, does not teach what it purports to teach, or does not support what is occurring in the classroom. (p. 138)

Examining new technologies such as apps, simulations, and video games through the lens of the UDL framework provides insights for meaningful classroom integration. In a technology-enhanced context, presenting information using graphics, simulations, video, and sound can accomplish this (Curry et al., 2006). See http://indicators.knowbility.org/resource-bank.html for resources.

Virtual learning environments hold potential because they are dynamic, allowing students to engage with instructional materials in multiple ways. For example, students can choose to have mathematical data presented in numeric form (e.g., table, chart). Likewise, they can problem solve on their own, discuss problem solutions with peers or their teachers, or receive explicit instruction from the virtual expert scientist. Assessment is also dynamic. There can be multiple solutions to every challenge students face. Marino and colleagues (2013) examined students' attitudes about learning through video games after engaging with science video games that included accessibility features such as text-to-speech support, virtual dictionaries, and explicit instruction through animated tutorials. Their sample included 876 students with and without disabilities and 34 science teachers. Students and teachers noted that these learning environments improved access to science content and allowed for increased social learning. In another example, Kennedy, Deshler, and Lloyd (2013) investigated the effects of multimedia vocabulary instruction through content acquisition podcasts (CAPs) on students' vocabulary learning through four conditions and found that students with learning disabilities who used CAPs through explicit instruction and with keyword mnemonic strategy instruction significantly outperformed other students with learning disabilities who used multimedia vocabulary instruction without these components. They concluded that explicit instruction must be tied to IT use for students with learning disabilities in order for them to fully benefit from these technologies. This study, along with the previously mentioned Ciullo and Reutenbuch (2013) literature review, points to the efficacy of technology to support students with disabilities—but only as it adheres to the use of evidence-based practices (EBPs) that support learning.

4.0 Integrate and Evaluate Technology During Assessment

4.1 - Develop a range of progress-monitoring techniques for use during technology-enhanced instruction and assessment. Technology-based interventions lead to accessible data that are easily managed and analyzed (Burns et al., 2012). Shippen and colleagues (2012) pointed out that computer-aided reading instruction allows for dynamic manipulation of the reading difficulty levels based on student performance data. The addition of technology-generated quantitative data allows teams to utilize a series of mixed-method assessments as they determine the efficacy of technology interventions. In addition, Edyburn (2006) suggested the use of the Time Series Concurrent Differential (TSCD) model for determining the impact AT or IT has on learning. The model requires measuring performance outcome data over time both with and without technology. For example, Burns and colleagues (2012) used a computer-based math fluency intervention with 216 struggling elementary students compared to 226 students in a control condition. The technology heavily relied on progress monitoring to provide students with immediate feedback on performance and data on time to completion. The authors found that this intervention improved learning outcomes for these learners, and, like previous studies, they expressed the importance of teacher-led instruction based on EBPs. Similarly, Strickney, Sharp, and Kenyon (2012) used a computerized mathematics practice and assessment system to provide learners with basic math computation practice and assess their math automaticity. Their system revealed that low-achieving students required more practice to achieve automaticity. These systems provide a hybrid between instruction and assessment that allow for progress monitoring that can provide a great deal of information to inform instruction.

4.2 - Incorporate technology-enhanced assessment options for students.

Technology-based assessments have the capability to customize the testing environment to include common accommodations such as text-to-speech support and increased font size. Additionally, researchers have questioned the reliability of traditional assessments for students with disabilities due to lack of accessibility features. In response, there is a movement to explore the effectiveness of technology-mediated assessments. Russell, Hoffmann, and Higgins (2009), for example, developed NimbleTools (http://nimbletools.com/), an assessment system focused on geometry that includes a number of accessibility tools derived from the UDL framework. Russell, Kavanaugh, Masters, Higgins, and Hoffmann (2009) conducted a randomized trial study using NimbleTools to support mathematics testing for students who are deaf and hard of hearing and found that with the signing accommodations, students reported ease of use in the online environment and had a strong preference for future computer testing. Students performed similarly with both the recorded human and avatar conditions. Dolan, Hall, Banerjee, Chun, and Strangman (2005) evaluated the effectiveness of such testing environments on the National Assessment of Educational Progress (NAPE) U.S. History Assessment for 10th-grade students with learning disabilities compared to the traditional paper-and-pencil assessment. The authors found that students with learning disabilities significantly performed higher on the technology-mediated assessment than on the paper-and-pencil version.

Other assessments include video game-play prediction, remediation, and dynamic scripting, all of which identify players' choices and alter the game environment to meet students' specific educational needs. These models are powerful, and previous studies (e.g., Marino, 2009) have noted that students with disabilities often require explicit instruction and prompting to use technology-based tools to their potential. Teachers may opt to include learning progressions in science, learning trajectories in mathematics, developmental continuums in reading, or learning maps. This detailed information is very important in the classroom, where it can be used as the first step in a formative assessment process to impact instructional decisions and provide feedback to students, ultimately improving student learning (Alonzo & Steedle, 2009). These studies showcase the power of technology-mediated assessments for both providing access and collecting data that can be used for immediate feedback to learners and their teachers.

Conclusions

We based our recommendations on policy initiatives and educational research that point toward the need to integrate both AT and IT into K-12 teaching and learning to support students with disabilities. This literature suggests that teacher educators should provide pre-service and in-service teachers with knowledge and skills related to technology in order to support learning for a diverse range of students. Therefore, teacher preparation programs, as well as in-service teacher

PD programs, should provide both general and special education teachers with the tools necessary to support diverse learners through meaningful use of technology.

References

Alonzo, A. C., & Steedle, J. T. (2009). Developing and assessing a force and motion learning progression. *Science Education*, *93*, 389-421. doi:10.1002/sce.2030

Anderson-Inman, L. (2009). Supported eText: Literacy scaffolding for students with disabilities. *Journal of Special Education Technology*, *24*(3), 1-7.

Anderson-Imnan, L., Knox-Quinn, C., & Homey, M. A. (1996). Computer-based study strategies for students with learning disabilities: Individual differences associated with adoption level. *Journal of Learning Disabilities*, *29*(5), 461-484. doi:10.1177/002221949602900502

Annemaria, J., & Barbetta, P. M. (2005). The effect of active student responding during computer-assisted instruction on social studies learning by students with learning disabilities. *Journal of Special Education Technology*, *20*(3), 13-23.

Bagley, E., & Shaffer, D. W. (2009). When people get in the way: Promoting civic thinking through epistemic gameplay. *International Journal of Gaming and Computer-Mediated Simulations* (IJGCMS), *1*(1), 36-52. doi:10.4018/jgcms.2009010103

Basham, J. D., Meyer, H., & Perry, E. (2010). The design and application of the digital backpack. *Journal of Research on Technology in Education*, *42*, 339-359. doi:10.1080/15391523.2010.10782555

Belson, S. I., Hartmann, D., & Sherman, J. (2013). Digital note taking: The use of electronic pens with students with specific learning disabilities. *Journal of Special Education Technology*, *28*(2), 13-24.

Berkeley, S., Marshak, L., Mastropieri, M. A., & Scruggs, T. E. (2011). Improving student comprehension of social studies text: A self-questioning strategy for inclusive middle school classes. *Remedial and Special Education*, *32*(2), 105-113. doi:10.1177/0741932510361261

Blankenship, T., Ayres, K. M., & Langone, J. (2005). Effects of computer-based cognitive mapping on reading comprehension for students with emotional behavior disorders. *Journal of Special Education Technology*, *20*(2), 15-23.

Boon, R. T., Burke, M. D., Fore, C., & Spencer, V. G. (2006). The impact of cognitive organizers and technology-based practices on student success in secondary social studies classrooms. *Journal of Special Education Technology*, *21*(1), 5-15.

Boone, R., & Higgins, K. (2007). The role of instructional design in assistive technology research and development. *Reading Research Quarterly*, *42*(1), 135-139. doi:10.1598/RRQ.42.1.5

Bottge, B. A., Rueda, E., Kwon, J. M., Grant, T., & LaRogue, P. (2009). Assessing and tracking students' problem solving performances in anchored learning environments. *Educational Technology Research and Development*, *57*, 529-552. doi:10.1007/s11423-007-9069-y

Bouck, E. C., Bassette, L., Taber-Doughty, T., Flanagan, S. M., & Szwed, K. (2009). Pentop computers as tools for teaching multiplication to students with mild intellectual disabilities. *Education and Training in Developmental Disabilities*, *44*(3), 367-380.

Bouck, E. C., Courtad, C. A., Heutsche, A., Okolo, C. M., & Englert, C. S. (2009). The virtual history museum: A universally designed approach to social studies instruction. *TEACHING Exceptional Children*, *42*(2), 14-20.

Bouck, E. C., Doughty, T. T., Flanagan, S. M., Szwed, K., & Bassette, L. (2010). Is the pen mightier? Using pentop computers to improve secondary students' writing. *Journal of Special Education Technology*, *25*(4), 33-47.

Bouck, E. C., Flanagan, S., Joshi, G. S., Waseem, S., & Schleppenbach, D. (2011). Speaking Math—A voice input, speech output calculator for students with visual impairments. *Journal of Special Education Technology*, *26*(4), 1-14.

Bouck, E. C., Flanagan, S., Miller, B., & Bassette, L. (2012). Technology in action: Rethinking everyday technology to meet students' IEP goals. *Journal of Special Education Technology*, *27*(4), 47-47.

Bouck, E. C., Joshi, G. S., & Johnson, L. (2013). Examining calculator use among students with and without disabilities educated with different mathematical curricula. *Educational Studies in Mathematics*, 1-17. doi:10.1007/s10649-012-9461-3

Bouck, E. C., Meyer, N. K., Joshi, G. S., & Schleppenbach, D. (2013). Accessing algebra via MathSpeak™: Understanding the potential and pitfalls for students with visual impairments. *Journal of Special Education Technology*, *28*(1), 49-62.

Burgstahler, S. (2003). The role of technology in preparing youth with disabilities for postsecondary education and employment. *Journal of Special Education Technology*, *18*(4), 7-19.

Burns, M. K., Kanive, R., & DeGrande, M. (2012). Effect of a computer-delivered math fact intervention as a supplemental intervention for math in third and fourth grades. *Remedial and Special Education*, *33*(3), 184-191. doi:10.1177/0741932510381652

Calhoon, M. B., Fuchs, L. S., & Hamlett, C. L. (2000). Effects of computer-based test accommodations on mathematics performance assessments for secondary students with learning disabilities. *Learning Disability Quarterly*, *23*(4), 271-282. doi:10.2307/1511349

Campbell, M. L., & Mechling, L. C. (2009). Small group computer-assisted instruction with SMART Board technology. *Remedial and Special Education*, *30*(1), 47-57.

Capobianco, B. M., Diefes-Dux, H. A., Mena, I., & Weller, J. (2011). What is an engineer? Implications of elementary school student conceptions for engineering education. *Journal of Engineering Education*, *100*(2), 304-328. doi:10.1002/j.2168-9830.2011.tb00015.x

Christensen, R., Overall, T., & Knezek, G. (2006). Personal education tools (PETs) for type II learning. *Computers in the Schools*, *23*(1), 173-189. doi:10.1300/J025v23n01_15

Cihak, D. F., & Bowlin, T. (2009). Computer-based signing accommodations: Comparing a recorded human with an avatar. *Journal of Special Education Technology*, *24*(4), 17-28.

Ciullo, S., & Reutenbuch, C. (2013). Computer-based graphic organizers for students with LD: A systematic review of literature. *Learning Disabilities Research & Practice*, *28*(4), 196-210. doi:10.1111/ldrp.12017

Clay, K., Zorfass, J., Brann, A., Kotula, A., & Smolkowski, K. (2009). Deepening content understanding in social studies using digital text and embedded vocabulary supports. *Journal of Special Education Technology*, *24*(4), 1-16.

Coleman, M. B., & Heller, K. W. (2010). The use of repeated reading with computer modeling to promote reading fluency with students who have physical disabilities. *Journal of Special Education Technology*, *25*(1), 29-41.

Courey, S. J., Tappe, P., Siker, J., & LePage, P. (2012). Improved lesson planning with Universal Design for Learning. *Teacher Education and Special Education*, *36*(1), 7-27. doi:10.1177/0888406412446178

Courtad, C. A., & Bouck, E. C. (2013). Assistive technology for students with learning disabilities. *Advances in Special Education*, *25*, 153-173. doi:10.1108/S0270-4013(2013)0000025011

Coy, K., Marino, M. T., & Serianni, B. (2014). Using Universal Design for Learning in synchronous online instruction. *Journal of Special Education Technology*, *29*(1), 63-74.

Cullen, J., Richards, S. B., & Frank. C. L. (2008). Using software to enhance the writing skills of students with special needs. *Journal of Special Education Technology*, *23*(2), 33-43.

Curry, C., Cohen, L., & Lightbody, N. (2006). Universal design in science learning. *The Science Teacher*, *73*(3), 32-37.

Dalton, B., Proctor, C. P., Uccelli, P., Mo, E., & Snow, C. E. (2011). Designing for diversity: The role of reading strategies and interactive vocabulary in a digital reading environment for fifth-grade monolingual English and bilingual students. *Journal of Literacy Research*, *43*, 68-100. doi:10.1177/1086296X10397872

Dalton, B., Winbury, N. E., & Morocco, C. C. (1990). "If you could just push a button": Two fourth grade boys with learning disabilities learn to use a computer spelling checker. *Journal of Special Education Technology*, *10*, 177-191.

Dolan, R. P., Hall, T. E., Banerjee, M., Chun, E., & Strangman, N. (2005). Applying principles of universal design to test delivery: The effect of computer based read-aloud on test performance of high school students with learning disabilities. *Journal of Technology, Learning, and Assessment*, *3*(7), 4-32.

Douglas, K. H., Ayres, K. M., Langone, J., Bell, V., & Meade. C. (2009). Expanding literacy for learners with intellectual disabilities: The role of supported eText. *Journal of Special Education Technology*, *24*(3), 35-44.

Douglas, K. H., Wojcik, B. W., & Thompson, J. R. (2012). Is there an app for that? *Journal of Special Education Technology*, *27*(2), 59-70.

Dymond, S. K., Renzaglia, A., Rosenstein, A., Chun, E. J., Banks, R. A., Niswander, V., & Gilson, C. L. (2006). Using a participatory action research approach to create a universally designed inclusive high school science course: A case study. *Research & Practice*, *31*, 293-308.

Edyburn, D. L. (2004). Rethinking assistive technology. *Special Education Technology Practice*, *5*(4), 16-23.

Edyburn, D. L. (2006). Searching for evidence of the effectiveness of assistive or instructional technology interventions. *Journal of Special Education Technology*, *21*(2), 74-78.

Edyburn, D. L. (2011). Searching for the right tool. *Journal of Special Education Technology*, *26*(1), 61-64.

Ely, R., Wall Emerson, R., Maggiore, T., Rothberg, M., O'Connell, T., & Hudson, L. (2006). Increased content knowledge of students with visual impairments as a result of extended descriptions. *Journal of Special Education Technology*, *21*(3), 31-40.

Englert, C. S., Wu, X., & Zhao, Y. (2005). Cognitive tools for writing: Scaffolding the performance of students through technology. *Learning Disability Research and Practice*, *20*(3), 184-198. doi:10.1111/j.1540-5826.2005.00132.x

Faggella-Luby, M. N., & Deshler, D. D. (2008). Reading comprehension in adolescents with LD: What we know; what we need to learn. *Learning Disabilities Research & Practice*, *23*(2), 70-78. doi:10.1111/j.1540-5826.2008.00265.x

Fede, J. L., Pierce, M. E., Matthews, W. J., & Wells, C. S. (2013). The effects of a computer-assisted, schema-based instruction intervention on word problem-solving skills of low performing fifth grade students. *Journal of Special Education Technology*, *28*(1), 9-21.

Fitzgerald, N. S., Miller, S. P., Higgins, K., Pierce, T., & Tandy, D. (2012). Exploring the efficacy of online strategy instruction for improving the reading abilities of students with learning disabilities. *Journal of Special Education Technology*, *27*(1), 33-47.

Garrett, J. T., Heller, K. W., Fowler, L. P., Alberto, P. A., Fredrick, L. D., & O'Rourke, C. M. (2011). Using speech recognition software to increase writing fluency for individuals with physical disabilities. *Journal of Special Education Technology*, *26*(1), 25-41.

Grunwald Associates LLC. (2013). Living and learning with mobile devices: What parents think about mobile devices for early childhood and K-12 learning. Retrieved from Learning First Alliance website: http://www.learningfirst.org/LivingandLearningwithMobileDevices

Hall, G. E., & Hord, S. M. (1987). *Change in schools: Facilitating the process*. Albany, NY: State University of New York Press.

Hall, G. E., & Hord, S. M. (2001). *Implementing change: Patterns, principles, and potholes.* Boston, MA: Allyn & Bacon.

Hall, G. E., Loucks, S. F., Rutherford, W. L., & Newton, B. W. (1975). Levels of use of the innovation: A framework for analyzing innovation adoption. *Journal of Teacher Education*, *26,* 52-56. doi:10.1177/002248717502600114

Hatfield, D., & Shaffer, D. W. (2006, June). *Press play: Designing an epistemic game engine for journalism: Proceedings of the 7th International Conference on Learning Sciences,* (pp. 236-242). Retrieved from http://edgaps.org/gaps/wp-content/uploads/press-play.pdf

Hernandez-Ramos, P., & De La Paz, S. (2009). Learning history in middle school by designing multimedia in a project-based learning experience. *Journal of Research on Technology in Education*, *42*(2), 151-173.

Hetzroni, O. E., & Shrieber, B. (2004). Word processing as an assistive technology tool for enhancing academic outcomes for students with writing disabilities in the general classroom. *Journal of Learning Disabilities*, *37*(2), 143-154. doi:10.1177/00222194040370020501

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, *55*, 223-252. doi:10.1007/s11423-006-9022-5

Hord, S. M., Rutherford, W. L., Huling-Austin, L., & Hall, G. E. (1987). *Taking charge of change*. Alexandria, VA: Association for Supervision and Curriculum Development.

Horney, M. A., Anderson-Inman, L., Terrazas-Arellanes, F., Schulte, W., Mundorf, J., Wiseman, S., . . . Frisbee, M. L. (2009). Exploring the effects of digital note taking on student comprehension of science texts. *Journal of Special Education Technology*, *24*(3), 45-61.

Individuals With Disabilities Education Act, 20 U.S.C. § 1400 (2004).

Israel, M., Marino, M., Basham, J., & Spivak, W. (2013). Fifth graders as app designers: How diverse learners conceptualize educational apps. *Journal of Research on Technology in Education*, *46*(1), 53-80. doi:10.1080/15391523.2013.10782613

Israel, M., Ribuffo, C., & Smith, S. (2014). *Universal Design for Learning innovation configuration: Recommendations for teacher preparation and professional development* (Document No. IC-7). Retrieved from University of Florida, Collaboration for Effective Educator, Development, Accountability, and Reform Center website: http://ceedar.education.ufl.edu/tools/innovation-configurations/

Izzo, M. V., Yurick, A., & McArrell, B. (2009). Supported eText: Effects of text-to-speech on access and achievement for high school students with disabilities. *Journal of Special Education Technology*, *24*(3), 9-20.

Jackson, R. (2004). *Technologies supporting curriculum access for students with disabilities*. Wakefield, MA: National Center on Accessing the General Curriculum. Retrieved from http://www.CAST.org/publications

Jameson, J. M., Thompson, V., Manuele, G., Smith, D., Egan, H., & Moore, T. (2012). Using an iTouch to teach core curriculum words and definitions: Efficacy and social validity. *Journal of Special Education Technology*, *27*(3), 41-54.

Jeffs, T., Behrmann, M., & Bannan-Ritland, B. (2006). Assistive technology and literacy learning: Reflections of parents and children. *Journal of Special Education Technology*, *21*(1), 37-44.

Kennedy, M. J., Deshler, D. D., & Lloyd, J. W. (2013). Effects of multimedia vocabulary instruction on adolescents with learning disabilities. *Journal of Learning Disabilities.* Advance online publication. doi:0022219413487406

Kingsley, K. V., & Boone, R. (2008). Effects of multimedia software on achievement of middle school students in an American history class. *Journal of Research on Technology in Education*, *41*(2), 203-221. doi:10.1080/15391523.2008.10782529

Kirschner, P. A., & Erkens, G. (2006). Cognitive tools and mindtools for collaborative learning. *Journal of Educational Computing Research*, *35*, 199-209. doi:10.2190/R783-230M-0052-G843

Krathwohl, D. R. (2002). A revision of Bloom's Taxonomy: An overview. *Theory into Practice*, *41*(4), 212-218. doi:10.1207/s15430421tip4104_2

Lajoie, S. P. (1993). Computer environments as cognitive tools for enhancing learning. In S. P. Lajoie & S. J. Derry (Eds.), *Computers as cognitive tools* (pp. 261-226). Hillsdale, NJ: Lawrence Erlbaum.

Lange, A. A., McPhillips, M., Mulhern, G., & Wylie, J. (2006). Assistive software tools for secondary-level students with literacy difficulties. *Journal of Special Education Technology*, *21*(1), 13-22.

Lee, S. H., Simpson, R. L., & Shogren, K. A. (2007). Effects and implications of self-management for students with autism: A meta-analysis. *Focus on Autism and Other Developmental Disabilities*, *22*(1), 2-13. doi:10.1177/10883576070220010101

MacArthur, C. A. (2009). Reflections on research writing and technology for struggling writers. *Learning Disabilities Research and Practice*, *24*(2), 93-103. doi:10.1111/j.1540-5826.2009.00283.x

Mackiewicz, S. M., Wood, C. L., Cooke, N. L., & Mazzotti, V. L. (2011). Effects of peer tutoring with audio prompting on vocabulary acquisition for struggling readers. *Remedial and Special Education*, *32*(4), 345-354. doi:10.1177/0741932510362507

Maloney, J. H., Peppler, K., Kafai, Y., Resnick, M., & Rusk, N. (2008). Programming by choice: Urban youth learning programming with Scratch. *ACM SIGCSE Bulletin*, *40*(1), 367-371. doi:10.1145/1352135.1352260

Mansoor, A., Ahmed, W. M., Samarapungavan, A., Cirillo, J., Schwarte, D., Robinson, J. P., & Duerstock, B. S. (2010). AccessScope project: Accessible light microscope for users with upper limb mobility or visual impairments. *Disability and Rehabilitation: Assistive Technology*, *5*(2), 143-152. doi:10.3109/17483100903387630

Marino, M. T. (2009). Understanding how adolescents with reading difficulties utilize technology-based tools. *Exceptionality*, *17*(2), 88-102. doi:10.1080/09362830902805848

Marino, M. T. (2010). Defining a technology research agenda for elementary and secondary students with learning and other high-incidence disabilities in inclusive science classrooms. *Journal of Special Education Technology*, *25*(1), 1-28.

Marino, M. T., Black, A., Hayes, M., & Beecher, C. C. (2010). An analysis of factors that affect struggling readers' comprehension during a technology-enhanced STEM astronomy curriculum. *Journal of Special Education Technology*, *25*(3), 35-48.

Marino, M. T., Coyne, M. D., & Dunn, M. W. (2010). Technology-based curricula: How altered readability levels affect struggling readers' passage comprehension. *Journal of Computing in Mathematics and Science Teaching*, *29*(1), 31-49.

Marino, M. T., Gotch, C., Israel, M., Vasquez, E. III, Basham, J. D., & Becht, K. (in press). UDL in the middle school science classroom: Can video games and alternative text heighten engagement and learning for students with learning disabilities? *Learning Disability Quarterly*. doi:10.1177/0731948713503963

Marino, M. T., Israel, M., Beecher, C. C., & Basham, J. D. (2013). Students' and teachers' perceptions of using video games to enhance science instruction. *Journal of Science Education and Technology*, *22*, 667-680. doi:10.1007/s10956-012-9421-9

Marino, M. T., Marino, E. C., & Shaw, S. F. (2006). Making informed assistive technology decisions for students with high incidence disabilities. *Teaching Exceptional Children*, *38*(6), 18-25.

Marino M. T., Sameshima, P., & Beecher, C. C. (2009). Integrating TPACK in pre-service teacher education: Frameworks for promoting inclusive educational practice. *Contemporary Issues in Technology and Teacher Education*, *9*(2), 186-207.

Mastropieri, M. A., & Scruggs, T. E. (2005). Feasibility and consequences of response to intervention: Examining the issues and scientific evidence as a model for the identification of individuals with learning disabilities. *Journal of Learning Disabilities*, *38*(6), 525-531. doi:10.1177/00222194050380060801

McKissick, B. R., Spooner, F., Wood, C. L., & Diegelmann, K. M. (2013). Effects of computer-assisted explicit instruction on map-reading skills for students with autism. *Research in Autism Spectrum Disorders*, *7*, 1653-1662. doi:10.1016/j.rasd.2013.09.013

McNamara, D. S., & Shapiro, A. M. (2005). Multimedia and hypermedia solutions for promoting metacognitive engagement, coherence, and learning. *Journal of Educational Computing Research*, *33*, 1-29. doi:10.2190/7N6R-PCJL-UMHK-RYPJ

Mechling, L. C., Gast, D. L., & Thompson, K. L. (2008). Comparison of the effects of SMART board technology and flash card instruction on sight word recognition and observational learning. *Journal of Special Education Technology*, *23*(1), 34-46.

Meo, G. (2008). Curriculum planning for all learners: Applying Universal Design for Learning (UDL) to a high school reading comprehension program. *Preventing School Failure*, *52*(2), 21-28. doi:10.3200/PSFL.52.2.21-30

Messinger-Willman, J., & Marino, M. T. (2010). Universal Design for Learning and assistive technology: Leadership considerations for promoting inclusive education in today's secondary schools. NASSP Bulletin, *94*(1), 5-16.

Meyer, A., Rose, D., H., & Gordon, D. (2013). *Universal Design for Learning: Theory and practice*. Wakefield, MA: CAST.

Miller, B. T., Krockover, G. H., & Doughty, T. (2013). Using iPads to teach inquiry science to students with a moderate to severe intellectual disability: A pilot study. *Journal of Research in Science Teaching*, *50*(8), 887-911. doi:10.1002/tea.21091

Mirenda, P., & Turoldo, K. (2006). The impact of word prediction software on the written output of students with physical disabilities. *Journal of Special Education Technology*, *21*(3), 5-12.

Moorman, A., Boon, R. T., Keller-Bell, Y., Stagliano, C., & Jeffs, T. (2010). Effects of text-to-speech software on the reading rate and comprehension skills of high school students with specific learning disabilities. *Learning Disabilities: A Multidisciplinary Journal*, *16*(1), 41-49.

Newman, L., Wagner, M., Knokey, A. M., Marder, C., Nagle, K., Shaver, D., . . . Schwarting, M. (2011). *The post-high school outcomes of young adults with disabilities up to 8 years after high school. A report from the National Longitudinal Transition Study-2 (NLTS2)* (NCSER 2011-3005). Menlo Park, CA: SRI International.

Nordness, P. D., Haverkost, A., & Volberding, A. (2011). An examination of hand-held computer-assisted instruction on subtraction skills for second grade students with learning and behavioral disabilities. *Journal of Special Education Technology*, *26*(4), 15-24.

Okolo, C. M., Englert, C. S., Bouck, E. C., Heutsche, A., & Wang, H. (2011). The virtual history museum: Learning U.S. history in diverse eighth grade classrooms. *Remedial and Special Education*, *32*, 417-428. doi:10.1177/0741932510362241

Peterson-Karlan, G. R., & Parette, P. (2005). Millennial students with mild disabilities and emerging assistive technology trends. *Journal of Special Education Technology*, *20*(4), 27-38.

Quinlan, T. (2004). Speech recognition technology and students with writing difficulties: Improving fluency. *Journal of Educational Psychology*, *96*(2), 337-346. doi:10.1037/0022-0663.96.2.337

Rao, K., Dowrick, P. W., Yuen, J. W., & Boisvert, P. C. (2009). Writing in a multimedia environment: Pilot outcomes for high school students in special education. *Journal of Special Education Technology*, *24*(1), 27-38.

Rappolt-Schlichtmann, G., Daley, S. G., Lim, S., Lapinski, S., Robinson, K. H., & Johnson, M. (2013). Universal Design for Learning and elementary school science: Exploring the efficacy, use, and perceptions of a web-based science notebook. *Journal of Educational Psychology*, *105*(4), 1210. doi:10.1037/a0033217

Reed, P., Kaplan, M., & Bowser, G. (2009). *The assistive technology trainer's handbook*. Roseburg, OR: National Assistive Technology in Education Network.

Rose, D., Meyer, A., & Hitchcock, C. (2005). *The universally designed classroom: Accessible curriculum and digital technologies.* Cambridge, MA: Harvard Education Press.

Roy, P., & Hord, S. M. (2004). Innovation configurations chart a measured course toward change. *Journal of Staff Development*, *25*(2), 54-58.

Rule, A. C., Stefanich, G. P., Boody, R. M., & Peiffer, B. (2011). Impact of adaptive materials on teachers and their students with visual impairments in secondary science and mathematics classes. *International Journal of Science Education*, *33*(6), 865-887. doi:10.1080/09500693.2010.506619

Russell, M., Hoffmann, T., & Higgins, J. (2009). Meeting the needs of all students: A universal design approach to computer-based testing. *Innovate: Journal of Online Education*, *5*(4).

Russell, M., Kavanaugh, M., Masters, J., Higgins, J., & Hoffmann, T. (2009). Computer-based signing accommodations: Comparing a recorded human with an avatar. *Journal of Applied Testing Technology*, *10*(3). Retrieved from http://www.editlib.org/p/75608

Sanchez, J., & Elias, M. (2007). Science learning by blind children through audio-based interactive software. *Annual Review of Cybertherapy and Telemedicine*, *5*, 185-191.

Seo, Y., & Bryant, D. (2010). Multimedia CAI program for students with mathematics difficulties. *Remedial and Special Education*, *33*(4), 217-225. doi:10.1177/0741932510383322

Shaffer, D. W. (2007). Epistemic games as career preparatory experiences for students with disabilities. *Journal of Special Education Technology*, *22*(3), 57.

Shippen, M. E., Morton, R. C., Flynt, S. W., Houchins, D. E., & Smitherman, T. (2012). Efficacy of a computer-based program on acquisition of reading skills of incarcerated youth. *Remedial and Special Education*, *33*, 14-22.

Silio, M. C., & Barbetta, P. M. (2010). The effects of word prediction and text-to-speech technologies on the narrative writing skills of Hispanic students with specific learning disabilities. *Journal of Special Education Technology*, *25*(4), 17-32.

Silver-Pacuilla, H. (2006). *Moving toward solutions: Assistive & learning technology for all students*. Washington, DC: National Center for Technology Innovation. Retrieved from http://www.nationaltechcenter.org/

Smith, B. R., Spooner, F., Jimenez, B. A., & Browder, D. (2013). Using an early science curriculum to teach science vocabulary and concepts to students with severe developmental disabilities. *Education and Treatment of Children*, *36*(1), 1-31.

Smith, B. R., Spooner, F., & Wood, C. L. (2013). Using embedded computer-assisted explicit instruction to teach science to students with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *7*, 433-443.

Smith M. B., Ferguson, H., & Hagiwara, T. (2007). Using a personal digital assistant to improve the recording of homework assignments by an adolescent with Asperger Syndrome. *Focus on Autism and Other Developmental Disabilities*, *22*(2), 96-99.

Sorrell, C. A., Mee Bell, S., & McCallum, R. S. (2007). Reading rate and comprehension as a function of computerized versus traditional presentation mode: A preliminary study. *Journal of Special Education Technology*, *22*(1), 1-12.

Spooner, F., Baker, J. N., Harris, A. A., Ahlgrim-Delzell, L., & Browder, D. M. (2007). Effects of training in Universal Design for Learning on lesson plan development. *Remedial and Special Education*, *28*(2), 108-116.

Stang, K. K., Carter, E. W., Lane, K. L., & Pierson, M. R. (2009). Perspectives of general and special educators on fostering self-determination in elementary and middle schools. *The Journal of Special Education*, *43*(2), 94-106.

Strickney, E., Sharp, L. B., & Kenyon, A. S. (2012). Technology-enhanced assessment of math fact automaticity: Patterns of performance for low- and typically achieving students. *Assessment for Effective Intervention*, *37*(2), 84-94.

Twyman, T., & Tindal, G. (2006). Using a computer-adapted, conceptually based history text to increase comprehension and problem-solving skills of students with disabilities. *Journal of Special Education Technology*, *21*(2), 5-16.

Unzueta, C. H., & Barbetta, P. M. (2012). The effects of computer graphic organizers on the persuasive writing of Hispanic middle school students with specific learning disabilities. *Journal of Special Education Technology*, *27*(3), 15-30.

U.S. Department of Education. (2010a). *A blueprint for reform: The reauthorization of the Elementary and Secondary Education Act*. Retrieved from http://www2.ed.gov/policy/elsec/leg/blueprint/blueprint.pdf

U.S. Department of Education. (2010b). Transforming American education: Learning powered by technology. *National Education Technology Plan 2010*. Retrieved from http://www.ed.gov/technology/netp-2010

U.S. Government Accountability Office. (2012). *Students with disabilities: Better federal coordination could lessen challenges in the transition from high school.* (Report No. GAO-12-594). Retrieved from http://www.gao.gov/assets/600/592329.pdf

Vasquez, E., & Slocum, T. A. (2012). Evaluation of synchronous online tutoring for students at risk of reading failure. *Exceptional Children, 78*(2), 221-235.

Wang, L. C., & Chen, M. P. (2010, April). Learning programming concepts through game design: A PCT perspective. *DIGITEL '10 Proceedings of the 2010 Third IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning, USA*, 219-221. doi:10.1109/DIGITEL.2010.47

Wehmeyer, M. L., Palmer, S. B., Smith, S. J., Davies, D. K., & Stock, S. (2008). The efficacy of technology use by people with intellectual disability: A single-subject design meta-analysis. *Journal of Special Education Technology*, *23*(3), 21-30.

Wood, C. L., Mustian, A. L., & Cooke, N. L. (2012). Comparing whole-word and morphograph instruction during computer-assisted peer tutoring on students' acquisition and generalization of vocabulary. *Remedial and Special Education, 33*(1), 39-47.

Yaw, J. S., Skinner, C. H., Parkhurst, J., Taylor, C. M., Booher, J., & Chambers, K. (2011). Extending research on a computer-based sight-word reading intervention to a student with Autism. *Journal of Behavioral Education, 20*, 44-54.

Zhou, L., Griffin-Shirley, N., Kelley, P., Banda, D. R., Lan, W. Y., Parker, A. T., . . . Derrick, W. (2012). The relationship between computer and Internet use and performance on standardized tests by secondary school students with disabilities. *Journal of Visual Impairment and Blindness*, *106*, 609-62.

Appendix A

Innovation Configuration for Supporting Content Learning Through Technology for K-12 Students With Disabilities

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0** There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	**Level 1** Must contain at least one of the following: reading, test, lecture/presentation, discussion, modeling/ demonstration, or quiz.	**Level 2** Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	**Level 3** Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	**Rating** Rate each item as the number of the highest variation receiving an X under it.
1.0 Technology and the IEP					
1.1 - Make assistive technology (AT) determinations and decisions and evaluate the success of AT for meeting students' instructional needs both as general and content-specific supports. 1.2 - Teach students to identify and advocate for the use of specific technologies (i.e., AT and instructional technology [IT]) across the content areas. 1.3 - Integrate content-specific technologies with students' career goals and transition plans.					

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
2.0 Fundamental Technology Knowledge					
2.1 - Identify student-specific barriers that occur during content instruction and assessment that can be remedied through technology. 2.2 - Select and use accessibility features within common technologies found in schools. 2.3 - Describe and apply the Universal Design for Learning (UDL) framework related to technology use in lesson and unit planning.					

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
3.0 Integrate and Evaluate Technology During Instruction					
3.1 - Critically analyze and select technologies based on student strengths and needs; content objectives (e.g., foundational skills, conceptual understanding, expression of learning); and identified learning barriers. 3.2 - Develop both general and content-specific technology toolkits for use with students alongside evidence-based instructional practices. 3.3 - Plan and implement instruction using a diverse range of technologies.					

Essential Components	Implementation Levels				
Instructions: Place an X under the appropriate variation implementation score for each course syllabus that meets the criteria level from 0 to 3. Score and rate each item separately.	**Level 0**	**Level 1**	**Level 2**	**Level 3**	**Rating**
	There is no evidence that the component is included in the syllabus, or the syllabus only mentions the component.	Must contain at least one of the following: reading, test, lecture/presentation, discussion, modeling/ demonstration, or quiz.	Must contain at least one item from Level 1, plus at least one of the following: observation, project/activity, case study, or lesson plan study.	Must contain at least one item from Level 1 as well as at least one item from Level 2, plus at least one of the following: tutoring, small group student teaching, or whole group internship.	Rate each item as the number of the highest variation receiving an X under it.
4.0 Integrate and Evaluate Technology During Assessment					
4.1 - Develop a range of progress-monitoring techniques for use during technology-enhanced instruction and assessment. 4.2 - Incorporate technology-enhanced assessment options for students.					

Appendix B

Content-Specific Technology Studies

Science		
Elementary	Middle (Grades 5–8)	High
Ely, R., Wall Emerson, R., Maggiore, T., Rothberg, M., O'Connell, T., & Hudson, L. (2006). Increased content knowledge of students with visual impairments as a result of extended descriptions. *Journal of Special Education Technology*, *21*(3), 31-40. McKissick, B. R., Spooner, F., Wood, C. L., & Diegelmann, K. M. (2013). Effects of computer-assisted explicit instruction on map-reading skills for students with autism. *Research in Autism Spectrum Disorders*, *7*, 1653-1662. doi:10.1016/j.rasd.2013.09.013 Smith, B. R., Spooner, F., Jimenez, B. A., & Browder, D. (2013). Using an early science curriculum to teach science vocabulary and concepts to students with severe developmental disabilities. *Education and Treatment of Children*, *36*(1), 1-31.	Horney, M. A., Anderson-Inman, L., Terrazas-Arellanes, F., Schulte, W., Mundorf, J., Wiseman, S., . . . Frisbee, M. L. (2009). Exploring the effects of digital note taking on student comprehension of science texts. *Journal of Special Education Technology*, *24*(3), 45-61. Israel, M., Marino, M., Basham, J., & Spivak, W. (2013). Fifth graders as app designers: How diverse learners conceptualize educational apps. *Journal of Research on Technology in Education*, *46*(1), 53-80. doi:10.1080/15391523.2013.10782613 Marino, M. T. (2009). Understanding how adolescents with reading difficulties utilize technology-based tools. *Exceptionality*, *17*(2), 88-102. doi:10.1080/09362830902805848	Mansoor, A., Ahmed, W. M., Samarapungavan, A., Cirillo, J., Schwarte, D., Robinson, J. P., & Duerstock, B. S. (2010). AccessScope project: Accessible light microscope for users with upper limb mobility or visual impairments. *Disability and Rehabilitation: Assistive Technology*, *5*(2), 143-152. doi:10.3109/17483100903387630 Miller, B. T., Krockover, G. H., & Doughty, T. (2013). Using iPads to teach inquiry science to students with a moderate to severe intellectual disability: A pilot study. *Journal of Research in Science Teaching*, *50*(8), 887-911. doi:10.1002/tea.21091 Zhou, L., Griffin-Shirley, N., Kelley, P., Banda, D. R., Lan, W. Y., Parker, A. T., . . . Derrick, W. (2012). The relationship between computer and Internet use and performance on standardized tests by secondary school students with disabilities. *Journal of Visual Impairment and Blindness*, *106*, 609-621.

Science		
Elementary	Middle (Grades 5–8)	High
	Marino, M. T., Black, A., Hayes, M., & Beecher, C. C. (2010). An analysis of factors that affect struggling readers' comprehension during a technology-enhanced STEM astronomy curriculum. *Journal of Special Education Technology*, *25*(3), 35-48. Marino, M. T., Coyne, M. D., & Dunn, M. W. (2010). Technology-based curricula: How altered readability levels affect struggling readers' passage comprehension. *Journal of Computing in Mathematics and Science Teaching*, *29*(1), 31-49. Marino, M. T., Gotch, C., Israel, M., Vasquez, E. III, Basham, J. D., & Becht, K. (in press). UDL in the middle school science classroom: Can video games and alternative text heighten engagement and learning for students with learning disabilities? *Learning Disability Quarterly*. doi:10.1177/0731948713503963	

Science		
Elementary	Middle (Grades 5–8)	High
	Marino, M. T., Israel, M., Beecher, C. C., & Basham, J. D. (2013). Students' and teachers' perceptions of using video games to enhance science instruction. *Journal of Science Education and Technology*, *22*, 667-680. doi:10.1007/s10956-012-9421-9 Sanchez, J., & Elias, M. (2007). Science learning by blind children through audio-based interactive software. *Annual Review of Cybertherapy and Telemedicine*, *5*, 185-191. Smith, B. R., Spooner, F., & Wood, C. L. (2013). Using embedded computer-assisted explicit instruction to teach science to students with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *7*, 433-443.	

Social Studies		
Elementary	Middle (Grades 5–8)	High
Annemaria, J., & Barbetta, P. M. (2005). The effect of active student responding during computer-assisted instruction on social studies learning by students with learning disabilities. *Journal of Special Education Technology*, *20*(3), 13-23.	Clay, K., Zorfass, J., Brann, A., Kotula, A., & Smolkowski, K. (2009). Deepening content understanding in social studies using digital text and embedded vocabulary supports. *Journal of Special Education Technology*, *24*(4), 1-16. Hernandez-Ramos, P., & De La Paz, S. (2009). Learning history in middle school by designing multimedia in a project-based learning experience. *Journal of Research on Technology in Education*, *42*(2), 151-173. Kingsley, K. V., & Boone, R. (2008). Effects of multimedia software on achievement of middle school students in an American history class. *Journal of Research on Technology in Education*, *41*(2), 203-221. doi:10.1080/15391523.2008.10782529 Okolo, C. M., Englert, C. S., Bouck, E. C., Heutsche, A., & Wang, H. (2011). The virtual history museum: Learning U.S. history in diverse eighth grade classrooms. *Remedial and Special Education*, *32*, 417-428. doi:10.1177/0741932510362241	Boon, R. T., Burke, M. D., Fore, C., & Spencer, V. G. (2006). The impact of cognitive organizers and technology-based practices on student success in secondary social studies classrooms. *Journal of Special Education Technology*, *21*(1), 5-15. Smith M. B., Ferguson, H., & Hagiwara, T. (2007). Using a personal digital assistant to improve the recording of homework assignments by an adolescent with Asperger Syndrome. *Focus on Autism and Other Developmental Disabilities*, *22*(2), 96-99. Twyman, T., & Tindal, G. (2006). Using a computer-adapted, conceptually based history text to increase comprehension and problem-solving skills of students with disabilities. *Journal of Special Education Technology*, *21*(2), 5-16.

Reading		
Elementary	Middle (Grades 5–8)	High
Campbell, M. L., & Mechling, L. C. (2009). Small group computer-assisted instruction with SMART Board technology. *Remedial and Special Education*, *30*(1), 47-57. Coleman, M. B., & Heller, K. W. (2010). The use of repeated reading with computer modeling to promote reading fluency with students who have physical disabilities. *Journal of Special Education Technology*, *25*(1), 29-41. Mackiewicz, S. M., Wood, C. L., Cooke, N. L., & Mazzotti, V. L. (2011). Effects of peer tutoring with audio prompting on vocabulary acquisition for struggling readers. *Remedial and Special Education*, *32*(4), 345-354. doi:10.1177/0741932510362507 Sorrell, C. A., Mee Bell, S., & McCallum, R. S. (2007). Reading rate and comprehension as a function of computerized versus traditional presentation mode: A preliminary study. *Journal of Special Education Technology*, *22*(1), 1-12.	Fitzgerald, N. S., Miller, S. P., Higgins, K., Pierce, T., & Tandy, D. (2012). Exploring the efficacy of online strategy instruction for improving the reading abilities of students with learning disabilities. *Journal of Special Education Technology*, *27*(1), 33-47. Lange, A. A., McPhillips, M., Mulhern, G., & Wylie, J. (2006). Assistive software tools for secondary-level students with literacy difficulties. *Journal of Special Education Technology*, *21*(1), 13-22. Wood, C. L., Mustian, A. L., & Cooke, N. L. (2012). Comparing whole-word and morphograph instruction during computer-assisted peer tutoring on students' acquisition and generalization of vocabulary. *Remedial and Special Education*, *33*(1), 39-47. Yaw, J. S., Skinner, C. H., Parkhurst, J., Taylor, C. M., Booher, J., & Chambers, K. (2011). Extending research on a computer-based sight-word reading intervention to a student with autism. *Journal of Behavioral Education*, *20*, 44-54.	Douglas, K. H., Ayres, K. M., Langone, J., Bell, V., & Meade. C. (2009). Expanding literacy for learners with intellectual disabilities: The role of supported eText. *Journal of Special Education Technology*, *24*(3), 35-44. Jameson, J. M., Thompson, V., Manuele, G., Smith, D., Egan, H., & Moore, T. (2012). Using an iTouch to teach core curriculum words and definitions: Efficacy and social validity. *Journal of Special Education Technology*, *27*(3), 41-54. Mechling, L. C., Gast, D. L., & Thompson, K. L. (2008). Comparison of the effects of SMART board technology and flash card instruction on sight word recognition and observational learning. *Journal of Special Education Technology*, *23*(1), 34-46.

Reading		
Elementary	Middle (Grades 5–8)	High
Vasquez, E., & Slocum, T. A. (2012). Evaluation of synchronous online tutoring for students at risk of reading failure. *Exceptional Children*, *78*(2), 221-235.		

Writing		
Elementary	Middle (Grades 5–8)	High
Englert, C. S., Wu, X., & Zhao, Y. (2005). Cognitive tools for writing: Scaffolding the performance of students through technology. *Learning Disability Research and Practice*, *20*(3), 184-198. doi:10.1111/j.1540-5826.2005.00132.x Silio, M. C., & Barbetta, P. M. (2010). The effects of word prediction and text-to-speech technologies on the narrative writing skills of Hispanic students with specific learning disabilities. *Journal of Special Education Technology*, *25*(4), 17-32.	Cullen, J., Richards, S. B., & Frank. C. L. (2008). Using software to enhance the writing skills of students with special needs. *Journal of Special Education Technology*, *23*(2), 33-43. Hetzroni, O. E., & Shrieber, B. (2004). Word processing as an assistive technology tool for enhancing academic outcomes for students with writing disabilities in the general classroom. *Journal of Learning Disabilities*, *37*(2), 143-154. doi:10.1177/00222194040370020501 Mirenda, P., & Turoldo, K. (2006). The impact of word prediction software on the written output of students with physical disabilities. *Journal of Special Education Technology*, *21*(3), 5-12. Quinlan, T. (2004). Speech recognition technology and students with writing difficulties: Improving fluency. *Journal of Educational Psychology*, *96*(2), 337-346. doi:10.1037/0022-0663.96.2.337	Bouck, E. C., Doughty, T. T., Flanagan, S. M., Szwed, K., & Bassette, L. (2010). Is the pen mightier? Using pentop computers to improve secondary students' writing. *Journal of Special Education Technology*, *25*(4), 33-47. Garrett, J. T., Heller, K. W., Fowler, L. P., Alberto, P. A., Fredrick, L. D., & O'Rourke, C. M. (2011). Using speech recognition software to increase writing fluency for individuals with physical disabilities. *Journal of Special Education Technology*, *26*(1), 25-41. Rao, K., Dowrick, P. W., Yuen, J. W., & Boisvert, P. C. (2009). Writing in a multimedia environment: Pilot outcomes for high school students in special education. *Journal of Special Education Technology*, *24*(1), 27-38.

Writing		
Elementary	Middle (Grades 5–8)	High
	Unzueta, C. H., & Barbetta, P. M. (2012). The effects of computer graphic organizers on the persuasive writing of Hispanic middle school students with specific learning disabilities. *Journal of Special Education Technology*, *27*(3), 15-30.	

Math		
Elementary	Middle (Grades 5–8)	High
Burns, M. K., Kanive, R., & DeGrande, M. (2012). Effect of a computer-delivered math fact intervention as a supplemental intervention for math in third and fourth grades. *Remedial and Special Education*, *33*(3), 184-191. doi:10.1177/0741932510381652 Nordness, P. D., Haverkost, A., & Volberding, A. (2011). An examination of hand-held computer-assisted instruction on subtraction skills for second grade students with learning and behavioral disabilities. *Journal of Special Education Technology*, *26*(4), 15-24. Seo, Y., & Bryant, D. (2010). Multimedia CAI program for students with mathematics difficulties. *Remedial and Special Education*, *33*(4), 217-225. doi:10.1177/0741932510383322	Bouck, E. C., Bassette, L., Taber-Doughty, T., Flanagan, S. M., & Szwed, K. (2009). Pentop computers as tools for teaching multiplication to students with mild intellectual disabilities. *Education and Training in Developmental Disabilities*, *44*(3), 367-380. Bouck, E. C., Joshi, G. S., & Johnson, L. (2013). Examining calculator use among students with and without disabilities educated with different mathematical curricula. *Educational Studies in Mathematics*, 1-17. doi:10.1007/s10649-012-9461-3 Fede, J. L., Pierce, M. E., Matthews, W. J., & Wells, C. S. (2013). The effects of a computer-assisted, schema-based instruction intervention on word problem-solving skills of low performing fifth grade students. *Journal of Special Education Technology*, *28*(1), 9-21.	Bouck, E. C., Flanagan, S., Joshi, G. S., Waseem, S., & Schleppenbach, D. (2011). Speaking Math—A voice input, speech output calculator for students with visual impairments. *Journal of Special Education Technology*, *26*(4), 1-14. Bouck, E. C., Meyer, N. K., Joshi, G. S., & Schleppenbach, D. (2013). Accessing algebra via MathSpeak™: Understanding the potential and pitfalls for students with visual impairments. *Journal of Special Education Technology*, *28*(1), 49-62. Cihak, D. F., & Bowlin, T. (2009). Computer-based signing accommodations: Comparing a recorded human with an avatar. *Journal of Special Education Technology*, *24*(4), 17-28. Rule, A. C., Stefanich, G. P., Boody, R. M., & Peiffer, B. (2011). Impact of adaptive materials on teachers and their students with visual impairments in secondary science and mathematics classes. *International Journal of Science Education*, *33*(6), 865-887. doi:10.1080/09500693.2010.506619

Math		
Elementary	Middle (Grades 5–8)	High
		Russell, M., Kavanaugh, M., Masters, J., Higgins, J., & Hoffmann, T. (2009b). Computer-based signing accommodations: Comparing a recorded human with an avatar. *Journal of Applied Testing Technology*, *10*(3). Retrieved from http://www.editlib.org/p/75608