ABSTRACT

Title of Document: ASSISTIVE TECHNOLOGY USE AMONG SECONDARY SPECIAL EDUCATION TEACHERS IN A PRIVATE SCHOOL FOR STUDENTS WITH SPECIFIC LEARNING DISABILITIES: TYPES, LEVELS OF USE AND REPORTED BARRIERS.

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Special education teachers are expected to integrate assistive technology (AT) for students with disabilities per Individuals with Disabilities Education Act (IDEA). However, the legal mandates do not provide clear guidelines regarding the type, the frequency, and the purpose for which AT can be used and, often, the decision of AT integration is left up to teachers and members of Individualized Educational Plan (IEP) teams who may or may not have complete knowledge of the AT implementation strategies. This research study provides an overview of how teachers of different content areas in a technology-rich self-contained secondary program for students with learning disabilities implemented AT in their daily instruction. Teacher reports and observations reflected discrepancies in how teachers may perceive their teaching with AT and revealed that, in spite of having access to a variety of technologies, there continues to be a focus on using low and medium AT (less complex technology). Specific factors (barriers) that influenced the integration of technology for students with learning disabilities are also investigated and described.

ASSISTIVE TECHNOLOGY USE AMONG SSECONDARY SPECIAL EDUCATION TEACHERS IN A PRIVATE SCHOOL FOR STUDENTS WITH SPECIFIC LEARNING DISABILITIES: TYPES, LEVELS OF USE, AND REPORTED BARRIERS.

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2015

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Dedication

I dedicate this dissertation to my beautiful daughter, Camille, who has shown infinite patience for my work commitment while completing this doctorate program. I hope to serve as inspiration to her one day as much as she did for me throughout all this time.

Acknowledgements

I would like to acknowledge my doctoral advisor, Dr. Margaret McLaughlin, whose mentorship, help, and patience have made it possible for me to complete this journey. Thank you very much, Dr. McLaughlin!

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Chapter 1: Introduction

Integrating technology in the classroom has been a topic of discussion among educators for over thirty years (Lowther, Strahl, Inan, & Ross, 2008) and the debate has deepened in today's world where students are spending virtually all their free time immersed in technology. These students have grown up knowing the Internet and using computers, cell phones, and other digital media in almost everything they do (An & Reigeluth, 2011-12). Thus, it becomes essential that schools provide opportunities for students to learn to operate in the information age we live in through the use of newer and more advanced technologies (Bingimlas, 2009). Additionally, over the years there have been many technological advances in the underlying operating systems and application technologies specifically designed to assist students with disabilities in everyday life (Peterson-Karlan, 2011).

According to Cuban (2001), making the leap from accessing technology to instructional effectiveness using technology has been lacking in schools where the focus should be on learning *from* technology rather than *with* technology. Beckett, Wetzel, Chishlom, Zambo, Buss, Padgett, Williams, and Odom (2003) and Gorder (2008) supported this statement by explaining that technology integration, in general, is no longer about the availability of technology but more about teachers' effective use of it. According to Gorder,

> Effective integration of technology is the result of many factors, but the most important factor is the teacher's competence and ability to share instructional technology activities to meet students' needs. (p. 63)

Therefore, in a world inundated with application software, web-based services, wireless devices, and interactive media, teachers must determine ways to incorporate technology into their practice and guide students to employ them in their learning (Beckett et al., 2003).

Models for Technology Use in Education

In the Technology and Engineering Literacy Framework for the 2014 National Assessment of Educational Progress (known as the *Nation's Report Card*), technology is defined as "any modification of the natural world done to fulfill human needs or desires" (nagb.org, 2012). Throughout decades of development, technology has gradually transformed from being related to arts, crafts, or skill (from the Greek root of technology, *techné*) to techniques (Rooney, 1996) and, more recently, to encompassing the most advanced technologies such as the virtual technologies in the form of micro-electronics (hardware and software). In education, the use of technology early on meant the use of basic text-based, locally networked, or stand-alone computer-assisted instruction applications, which have been gradually replaced by complex devices, graphic-rich applications, and networked environments (Honey, Culp, & Carrigg, 2000).

The ultimate goal of integrating technology in education is, to some, to completely redefine how teachers teach and students learn, and it implies the processes and technological resources by which teachers can facilitate learning and improve student performance (Puentedura, 2006). For this purpose, Puentedura's recent taxonomy on the use of technology for educational purposes, SAMR, categorizes the levels of implementation of technology in the classroom based on the role it plays in relation with the instructional task. The researcher identified four levels of use: Substitution, Augmentation, Modification, and Redefinition. Across levels, starting with Substitution where technology serves as a mere substitute (learning *with* technology) for tasks that could be easily completed without such support, technology's role shifts gradually towards learning *from* technology. An analogy for this taxonomy could be that tech supports that are used to compensate or by-pass learning deficits fall under Substitution and Augmentation whereas in the case when the instructional task is being modified in its conceptual level by the use of technology, we are experiencing Modification and Redefinition of the learning process.

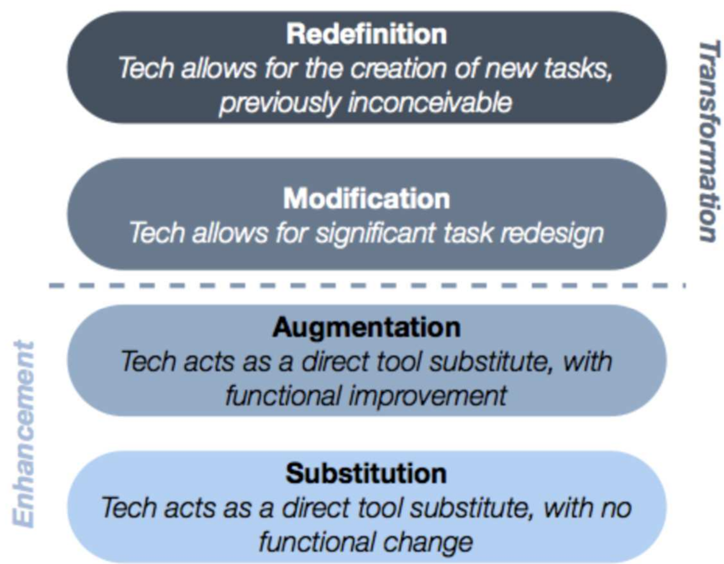
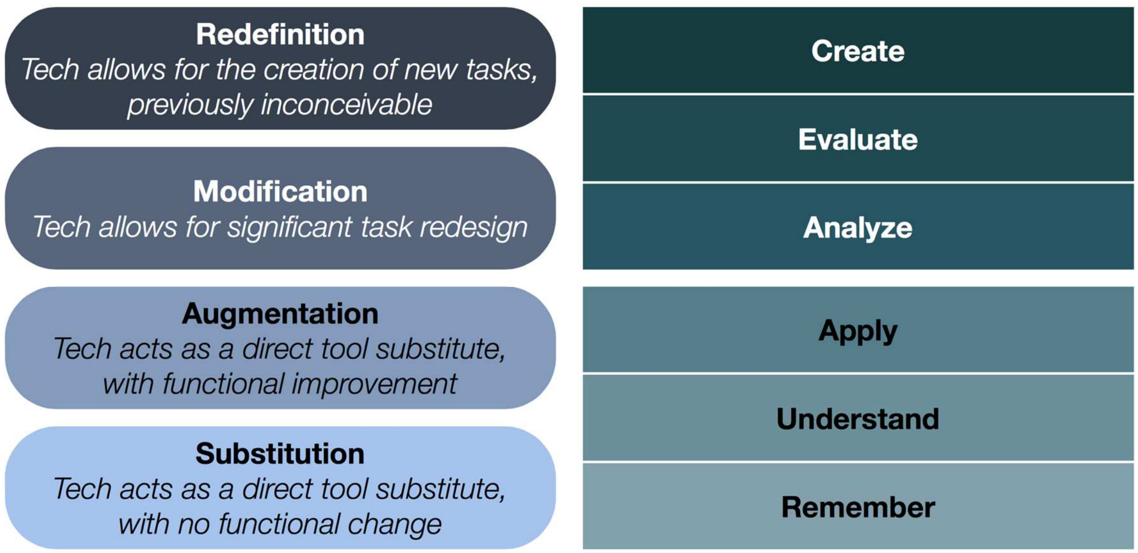


Figure 1. SAMR model (Puentedura, 2006)

More recently, Puentedura (2015) linked the SAMR model to Bloom's taxonomy in that Bloom's levels of intellectual behavior are demonstrated at different SAMR levels. Based on this, the SAMR levels, although individually defined, have the potential to overlap within the two different categories: Enhancement and Transformation. Bloom's cognitive domain taxonomy dictates that learning at higher levels be grounded in having mastered lower level knowledge. Therefore, the intersection between Bloom's taxonomy and the SAMR levels appear to indicate that technology used for Substitution and Augmentation (the lower levels) is expected to assist students in their academic tasks with lower cognitive tasks such as remembering, understanding, and applying knowledge, whereas Modification and Redefinition levels (the SAMR upper bounds) are likely to have students engage in analysis, evaluation, and creation of knowledge with the help of technology. In figure 2 below, Puentedura (2015) connects Bloom's taxonomy levels to the SAMR levels.

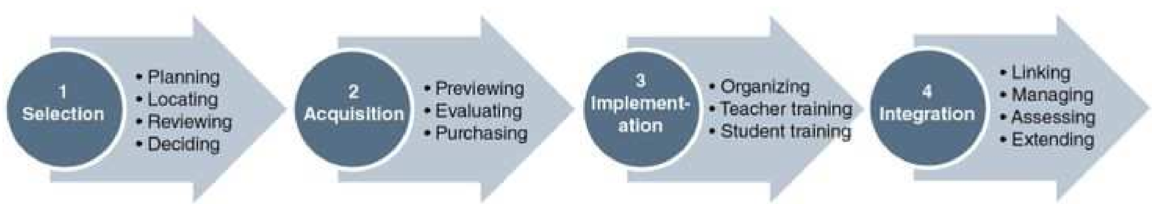
Figure 2. SAMR levels and Bloom's taxonomy (hippasus.com, 2015)



To date, the SAMR model has not been tested in social sciences experimental research but it has been referred frequently in the field of education as the taxonomy to help us understand the integration of technology in the classroom. In a dissection of SAMR, Green (2014) found it to be similar to the three functions of technology previously identified by Hughes (2005), which are to replace, amplify, or transform tasks. Romrell (2014) reviewed the literature on mobile learning (the use of mobile devices for learning) among higher education teachers with the intent to identify SAMR levels corresponding to how the devices were used. Of the 10 studies included, he found half to fit the description of task transformation. Currently, SAMR provides guidance for Maine Learning Technology Initiative. Also, Hudson (2014) mentioned SAMR in a recent White Paper, "The Importance of Evaluating Digital Curricula", as a valuable evaluation tool.

Two other technology integration models have been used for reference in the literature such as TPACK (2007) and Edyburn's Model of Technology Integration (1998). The TPACK is a framework that identifies the knowledge that teachers need in order to teach effectively with technology. This model combines three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK) as well as their intersection with Pedagogical Content Knowledge, Technological Content Knowledge, and Technological Pedagogical Knowledge and Technological Pedagogical Content Knowledge (tpack.org, n .d.). Edyburn's Model of Integrating Technology (1998) outlines the ways to integrate technology into the curriculum by identifying the major tasks involved in selecting, acquiring, implementing, and integrating instructional technologies into the curriculum. This process is divided into four phases: selection, acquisition, implementation, and integration; each of these phases are further comprised of individual tasks (Figure 3) which must be completed in order to advance to the next phase. Each phase must, also, be completed for each new product (Edyburn, 2001).

Figure 3. Edyburn's Assistive Technology Model (Edyburn, 2001)



The selection of the SAMR model over the other models of technology integration in the literature has been justified by the content, which relates directly to student academic tasks. Both TPACK and the Edyburn's Model, although valuable in addressing teacher knowledge and school resources, do not focus specifically or exclusively on the parameters of technology integration from the perspective of student learning.

The Use of Assistive Technology for Students with Disabilities

It is important to distinguish between technology used for instruction in general education classrooms and the technology used specifically to accommodate the learning and other needs of students with disabilities. When used in the general education classroom instruction with nondisabled students, the wide range of hardware, software, and technical equipment used to promote learning has often been referred to as *educational technology* (Strobel, Arthanat, Bauer, & Flagg, 2007). However, when used by students with disabilities to support their learning and participation in the general education curriculum the term has been known as *assistive technology* (AT) (Edyburn, 2000).

The Consortium for School Networking (CoSN) attempted to develop an initiative to combine all technology (instructional and assistive) under a single category and remove AT from "the purview of special education and integrate it into the educational technology offering in terms of procurement, training, and support", (Technology Voices, December 2008. p. 2). In an interview for the Family Center on Technology and Disability, Dr. Martin Blair, a classroom technology policy expert, stated that,

> We need to look at technology as a means of improving student outcomes. If we continue to simply see AT as just for the special ed kids and instructional technology for everyone else, we may miss the tremendous benefits of technology in terms of student outcomes for all students as well as for education professionals, experts, administrators and teachers. (M. Blair, personal communication, December 2008)

Indeed, in the current context of constantly changing landscape of educational technology, students and teachers now have access to wearable technology, devices and/or programs that allow for personal customization and interaction, online research and learning, and social media. Distinguishing between AT and educational technology no longer seems necessary or easy as new technologies are designed to cater to individual learning needs. This use of technology is the foundation of Universal Design for Learning (UDL), which originated from the use of AT but has broadened to include all students. To date, AT is considered an essential component of UDL and is specifically referenced in the IDEA as a consideration for students who receive special education.

Categories of AT. In special education, AT devices are typically grouped into one of three categories (Center for Performance Technology in Florida, 2009; LD online, 2010): low-tech, including such things as adapted furniture, tools or utensils, raised-line, colored or grid paper, correction tape and pens, highlighters, magnifiers, large print text books, pencil grips, line guides, manual communication boards and others; mid-tech, which refers to easy-to-operate electronic devices (tape and digital recorders, electronic dictionaries or organizers, audio books, special lighting and acoustic treatments, adapted keyboards, and audible word scanning devices); and high-tech which includes the more advanced generation of technologies that are relatively expensive and contain microcomputer components for storage and retrieval of information (talking calculators or word processors, word prediction, graphic organizers, flowchart software, on-screen math, computer calculations, etc.). In contrast, AbleData (abledata.org, n.d) has developed a taxonomy of 20 categories of AT: aids for daily living, blind and low vision, communication, computers, controls, deaf and hard of hearing, deaf blind, education, □environmental, adaptations, □housekeeping, □orthotics, □prosthetics, recreation, □safety and security, seating, □therapeutic aids, transportation, walking, wheeled mobility and workplace. This database was funded by the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR) and is meant to serve as a rich resource for AT to improve productivity and ease with life's tasks.

In general, when applied to special education, states have tended to adopt the three-category classification. For instance, according to their AT Guidance Manual, the state of Illinois shows using the low/medium/high classification as well as the AbleData taxonomy (Wojcik & Douglas, 2012). The state of Massachusetts also uses the three-level AT categories (Chester, 2012)) as do numerous other states such as MD (mdtao.org, 2015), VA (vats.org, 2013), PA (Disability Rights Network, 2014), DC (atpdc.org, 2015), and Georgia (gpat.org, 2014). For a full list of assistive technology state implementation models, please see the Rehabilitation Engineering and Assistive Technology Society of North America (2014).

How states define the AT within each category differs, however. For example, according to the Illinois Assistive Technology Guidance Manual (2012), low AT refers to "tools that are typically more widely available, lower in cost, and relatively easier to use" (p. 10) while the high AT category includes tools that "may be more specialized, not widely available, higher in cost, and more complex to operate" (p. 11). Another example is the state of Massachusetts, which is using the Wisconsin Assistive Technology Initiative model and defines low AT as "typically portable and easy to use, their use may be virtually transparent" (Chester, 2012, p. 4). There is not a universal categorization of AT that specifically assigns devices or software applications to a specific level. However, for the most part, the continuum of low to high AT seems to be based on cost, general availability and level of technical sophistication.

For the purpose of this dissertation, I have used the low-medium-high classification model, which I have projected against the technology inventory provided by the school where the research study was conducted. In doing so, I have also based my classification of AT on the guidelines provided by the Center for Performance Technology in Florida (2009). A breakdown of the school's technology inventory and classification is included in Appendix E.

Legal entitlements to AT for students with disabilities. In 1988, the Assistive Technology Act ("Tech Act", Pub. L. No. 100-407) was passed to promote access to technology for individuals with disabilities of all ages in all areas of life, including education. Originally, the law authorized funding for states to conduct assessments to identify the need for comprehensive statewide programs of technology-related assistance for all individuals with disabilities. The Tech Act provided the first definition of the AT device as "any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities", and the AT service as "any service that directly assists an individual with a disability in the selection, acquisition, or use of an AT device" [29 U.S.C. Sec 3002(3)]. Both definitions were also included in the 1997 reauthorization of IDEA (Pub. L. No. 105-17), and its subsequent reauthorizations including 2004 (Pub. L. No. 108-446). Additionally, since 1997, IDEA has also mandated that all students receiving special education services be given access to both AT devices or services if the child's Individualized Education Program (IEP) team determines they are needed to provide a free and appropriate public education (IDEA, 1997, §300.105).

Assistive technology has also been a foundational concept in the development of the Universal Design for Learning (UDL), which targets the inclusion of diverse learners in the general education community. The beginnings of UDL, an adaption of the architectural design to the field of education, focused on helping individuals adapt or "fix" (CAST, 2011, p. 3) themselves to overcome their disabilities to learn within the general education curriculum. According to CAST (2011), the initial emphasis on using AT as compensatory tools (such as spellcheck) and skill-building software (such as computerized programs providing practice opportunities for academic skills, social skills, typing skills) has shifted and UDL has evolved into a curriculum design approach meant to increase flexibility in teaching and to decrease barriers that frequently limit student access to materials and learning in classrooms. However, AT continues to play a key role in the implementation of UDL (Rose & Meyer, 2002). Rose, Hasselbring, Stahl, and Zabala (2005) wrote that, "while different, AT and UDL are completely complementary – much like two sides of the same coin" (p. 507). In 2007, Morrison concluded that a UDL classroom would need:

> ...the use of screen readers, voice recognition technology, optical character recognition, spell check, and word prediction technologies to provide students with independent access to the curriculum where access would otherwise have been difficult, if not impossible. The use of this technology is designed to establish equal access to learning opportunities and to support those with learning problems. (p. 83)

According to a 2012 report by the UDL Learning Center, *The UDL Initiative on The Move*, 20 states across the United States are engaged in implementing UDL or UDL-related projects such as differentiated instruction, UDL-aligned curriculum, UDL principles applied to state technology plans, and using AT aligned to UDL guidelines (UDL Learning Center report, 2012). The 2004 reauthorization of the Individuals with Disabilities Education Act (IDEA) formally makes reference to and defines "universal design" as a scientifically valid framework for guiding educational practice that: (1) provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged; and (2) reduces barriers in instruction; provides appropriate accommodations; and supports, challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient (Pub. L. No. 89-329). Given this recognition in the special education legislation, the implementation of UDL will likely continue to expand and children with disabilities will receive the benefits of AT (ECTA Center, 2013).

The role of AT in the instruction of students with disabilities. Many researchers in the past decade have clearly established that AT could be a powerful instructional support for students with disabilities due to its ability to bypass or compensate for an individual's learning deficits (Raskind & Stanberry, 2008). In all its forms, AT has been documented in research as providing extensive benefits for students with disabilities (Bausch, Jones Ault, Quinn, Behrman, & Chung, 2009; Edyburn, 1998; Lewis, 1998; Zascavage & Winterman, 2009). Additionally, AT has been considered to be, "a necessary supplementary aid in the educational setting if its presence (along with other necessary aids) supports the child sufficiently to maintain his or her placement whereas its absence would require the student's removal to a more restrictive setting" (Parrett & Murdick, 1998, p. 263). The use of AT to support the participation and learning of students with disabilities in the broad general education environment has been well supported. Zascavage and Winterman (2009) noted technology in special education is necessary to make autonomy and integration seamless for many students with diverse education needs. Bausch, Jones Ault, Quinn, Behrman, and Chung (2009) stated that, "There is a wide belief that AT may compensate for a lack of sensory or physical ability that inhibits access to traditional instructional modalities" (p. 10). Edyburn (2004) also noted that AT could provide direct access to instruction and serve as a "compensatory tool" (p. 21). Other research has confirmed the improved academic performance of children with disabilities when technology has been coupled with effective instruction in the areas of reading (Strangman & Dalton, 2005), writing (Sitko, Laine, & Sitko, 2005) and math (Behrmann & Jerome, 2002; Fried-Oken (2007; Maccini & Gagnon, 2005) agreed that, when AT is available as an accommodation, it could serve as a powerful learning tool that specifically compensates for deficits in reading, writing, and information processing skills.

In particular, using AT to access print curriculum can be very helpful for students in special education for whom reading of print text is a challenge and presents as one of the most notorious barriers to curriculum (Hall, Strangman, & Meyer, 2003). This is the case for a large number of students in special education. Students with Specific Learning Disabilities (SLD), who mostly struggle with reading, represented 36% of the student population receiving special education services in US schools in 2012 (US Department of Education, National Center for Education Statistics [NCES], 2013). Additionally, students with other educational disabilities such as Attention Deficit Hyperactive Disorder (ADHD), who represent about 11.6%, and speech and language impairments, who represent 24%, also experience problems with reading. In addition, the number of English Language Learners who also exhibit reading and learning disabilities has also been increasing (Huang, Clarke, Milczarski, & Raby, 2011).

Technological supports could assist older students with disabilities with their inability to obtain meaning from print which is most pressing when combined with the need for timely access to curricular needs (Strobel et al., 2007). As students move to higher grades, text is a central feature of the curriculum and teachers rely heavily on printed word as an instructional tool (Dyck & Pemberton, 2002). Content area classes continue to use complex expository texts as the primary mode of knowledge acquisition (Dyck & Pemberton, 2002) and expect students with significant reading deficits to utilize concepts and vocabulary at a pace and readability level that they struggle to achieve (Maccini, Gagnon, & Hughes, 2002). Therefore, integrating AT in the educational programming of students with disabilities has become equally important from both legal as well as best instructional practice perspectives.

Finally, AT use in instruction can promote inclusion of students with disabilities in general education classrooms and resulted in the call for an increase in the development and use of accessible electronic text, online curricula, and digitized resources (Anderson-Inman & Horney, 2007; Boone & Higgins, 2007; Hodges, 1999; Rose & Meyer, 2006).

Teachers and Assistive Technology

In order for students with disabilities to benefit from AT, special education teachers must demonstrate the capacity to select AT that is well-suited to the individual and the setting's demands. “Successful special educators understand the needs of students, the requirements of classroom tasks, and how assistive technology can be used to foster independence” (Fisher, Frey, & Thousand, 2003, p. 46). The research related to teachers' use of AT has focused on both how teachers used AT as well as the perceived barriers to its use, with the latter receiving predominant attention. For example, during an investigation into how special education teachers used AT, Ashton (2005) found that the participants reported to be consistently challenged by the lack of knowledge and time to learn new technologies along with limited devices and materials due to insufficient funding. Similarly, Marino and Beecher (2008) explored the use of AT with students who had reading disabilities and found that teachers were limited in their AT implementation efforts by institutional, situational, and dispositional barriers. Institutional and situational barriers included the ambiguity of the AT's legal definition as well as gaps between AT policy and practice in various school contexts as well as the lack of appropriate teacher training and funding. Dispositional barriers focused on teachers' attitudes about how AT can be useful in instruction and were exemplified by situations in which student performance without AT was perceived to be more valuable than the student's success with such devices. Nam, Bahn, and Lee (2013) also established that, when teachers received organizational and technical infrastructures support and had the necessary resources and knowledge about how to use the technology, their level of use of AT was positively influenced. Finally, Benton-Borghi (2013) discussed how, even for those teachers who had the knowledge to use technology in their personal lives, they did not transfer or apply that knowledge in their teaching. In fact, they continued to teach the way they were taught using the print modality of the 20th century. Benton-Borghi concluded that, "Teachers need to develop a strong efficacy to effectively integrate technology in teaching and learning" (p. 252) and a UDL model infused with technological, content, and pedagogical knowledge would "enable all teachers to consider the multimodal affordances that technologies (e.g., assistive technology, multi-user virtual reality environments) provide diverse and exceptional learners in today's classrooms" (p. 252).

Overall, research related to teachers' use of AT has been consistent in revealing that teachers mostly perceive their AT use to be impacted by factors such as insufficient planning time and lack of knowledge as well as access to AT devices. Of those studies reviewed in Chapter 2, more than 75% (Abbit, 2011; Christensen, 2002; Flanagan et al., 2013; Franklin, 2007; Gorder, 2008; Lowther et al., 2008) focused mostly on first-order (school) barriers. Only a few studies (Balanskat, Blamire, & Kefala, 2006; Becta, 2004; Ertmer, 1999; Ertmer et al., 2000; Pelgrum, 2001) delved into teacher-specific barriers such as perceptions, opinions, thinking processes in using technology but, even these studies, ultimately reported mostly issues still related to school barriers (first-order barriers). Additionally, the literature captures little of the integration of technology for students with disabilities and only three studies (Derer et al., 1996; Huntinger et al.; Lahm & Seizemore, 2002; Todis, 1996) specifically included special education teachers in their samples. In all three cases, the special education teachers worked with students who had either physical and/or severe disabilities and were using AT that addressed particular needs for individual augmentative communication in self-contained classrooms or programs, therefore leaving out the medium to higher-end technology available for higher incidence disabilities. There has been considerably less research that attempts to understand the impact of factors such as teachers' beliefs, attitudes and pedagogy on teachers' use of AT in instruction. Abbit (2011) investigated the relationship between the self-efficacy beliefs of preservice teachers and the measures of the Technological Pedagogical Content Knowledge (TPACK), a conceptual framework developed by Mishra and Koehler (2006) based on the theory of Pedagogical Content Knowledge (Shulman, 1986), resulted in "a representation of the complex interactions among the types of essential knowledge for successful teaching with technology" (Abbit, 2011, p. 135). A more recent model, the SAMR by Puentedura (2006), has been receiving attention in the aftermath of being internalized by education professionals as a taxonomy for technology integration rather than a model identifying teacher motivators or enablers of using technology.

A framework for considering barriers to teacher use. Brickner (1995) developed a theoretical framework to explain barriers-to-change experienced by teachers when integrating novel resources such as technology in their instruction. The model is grounded in the concepts of three distinct developmental theories describing the concept of change: Cuban's (1993) *Constancy and Change;* Fullan's (1991) *Meaning of Educational Change*, and Roger's (1983) *Diffusion of Innovation*. Together these theories explained educational change as a developmental process rather than an isolated event in time. According to these theories, change occurs through a series of phases such as awareness of innovation, collecting information, making the choice to implement, the actual implementation, and evaluation. Specific factors related to each phase are proposed as influencing the change process.

Brickner (1995) used the theories as a basis for her research with 23 math teachers who had little or no experience in using computers for instruction. In general, Brickner found that teachers continue teaching "the way they were taught" (p. 125) and reached out primarily to more traditional methods of teaching without seeking to take on new risks and challenges in their performance. She identified two categories of barriers that can alter the successful use of technology by teachers in schools: *first-order* and *second-order*. First-order barriers were defined as "obstacles which impede the effective implementation of a projected change or innovation" (Brickner, 1995, p. 6) and include inaccessible or missing resources such as equipment, training, lack of support, and funds as well as organizational factors such as insufficient time allocated for teachers to plan their lessons and related policies. Second-order barriers were defined as those factors that were intrinsic to teachers and included things such as their underlying beliefs about teaching and how learning occurs that guided their practice.

Summary

There has been consistent acknowledgment of the benefits of using technology in education overall and, specifically, in giving access to curriculum to students with disabilities. However, a number of researchers have established that there is variation in how teachers use AT and they report various barriers to use. First, although the literature has consistently reported barriers, most of the research has focused on first-order barriers that are related to availability of devices and professional development. Teacher-specific barriers (i.e., second-order) have received considerably less attention. In part, this may be due to the settings in which the research was conducted and where there was limited or perceived limitations to AT devices and teacher support.

Second, there has been scarce research related to the use of AT with students with disabilities that has systematically examined the levels or purpose of that use. Ertmer et al. (1999) used three levels of technology use for their investigation of how award-winning educators used technology: supplementing existing curriculum, supporting existing curriculum, and facilitate emerging curriculum. Only one of seven teachers demonstrated higher use of technology in order to facilitate emerging curriculum while most of the teachers used technology to supplement curriculum. More recently, the TPACK and SAMR are two most frequently mentioned models in the body of literature relate to the level of use of technology. The TPACK, which stands for technological pedagogical and content knowledge, is a framework for understanding how teachers incorporate content and pedagogical knowledge during technology implementation. However, TPACK is not a model of technology integration but rather "a construct for measuring teacher's knowledge and capacity to integrate technology in instruction" (Green, 2014, p. 41). SAMR, on the other hand, is looked at as a model of leveled-integration of technology based on complexity and nature of task. SAMR has emerged in recent years and, despite lack of experimental research evidence, is currently being used to guide the Maine Learning Technology Initiative (professional development and tools to middle and high schools across Maine) as well as schools in Vermont and Sweden.

Therefore, with all of the evidence pointing toward the benefits of integrating technology in the education of students with disabilities as well as considering the legal requirements for use of technology in special education, it is important to understand how special education teachers make use of the *entire* AT continuum (low to high) in their practice, including the specific motivators that can impact their technology use.

Purpose of the Study

Given the issues noted above with the current knowledge base, notably the fact that the research was conducted in settings that may not have had an array of AT, this study was designed to examine teacher use of AT with students with learning disabilities in a private special education school for middle- and high-school students with learning disabilities. The school has a strong commitment to and philosophy of the infusion of technology throughout all instruction. The mission of the school is to provide maximum access to instruction in all content areas in order for students to become college- and career-ready. The school's AT inventory is extensive and includes any AT required by student IEPs as well as more general technologies that are to be provided throughout all instruction such as organizational supports, online learning platforms (such as Moodle, an open-source program utilized by many educational programs K-12 and higher education, smart technology, and reading-assist programs such as Lexia, NewsELA, screen readers). Given the school's mission and the availability of technology in the school's inventory, this site provided a unique opportunity to explore in greater depth how a group of special education teachers use a variety of technology in their instruction and to examine their perceptions of the types of barriers.

Chapter 2: Review of the Literature

Technology has come to play an increasingly important role in the lives of all persons in the United States. It is now widely used in the conduct of business, in the functioning of government, in the fostering of communication, in the conduct of commerce, and in the provision of education (National Dissemination Center for Children with Disabilities [NICHCY], 2009). For many, including individuals with disabilities, access to technology means augmented participation in employment and other daily activities in their communities. In education, technology is used to support class-wide learning and provide additional opportunities for students to master and practice new skills while it is also viewed as an important way to enhance student participation in those classrooms where obstacles to learning - both physical and non-physical – are present (Means & Olson, 1997).

Policymakers have long recognized the importance of using technology to assist individuals with disabilities. In 1988, the Assistive Technology Act (Pub. L. No. 105-394), also known as the Tech Act, was passed. The purpose of this law was to promote public awareness of assistive technology (AT) and access to technology devices and services for individuals with disabilities (NICHCY, 2009). The law, which has been reauthorized four times since its passage (i.e., 1994, 1998, 2004, and 2010), defines AT as:

> Any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities. [29 U.S.C. Sec 2202(2)]

The Tech Act's 1994 reauthorization further required that states and related agencies, including school districts, develop, enact, and monitor the progress of programs designed to fulfill technology access and subsequent integration (Smith & Jones, 1999). The 1997 reauthorization of IDEA also acknowledged the importance of technology in educating students with disabilities. Specifically, the 1997 amendments mandated that all students receiving special education services under IDEA be given access to both AT devices or services if the child's Individualized Education Program (IEP) team determines they are needed to provide a free and appropriate public education (IDEA, §300.105). Upon its most recent reauthorization in 2004, IDEA has maintained these provisions [IDEIA, 20 U.S.C. §1401(1)].

But, while it is clear that policy makers and educational professionals share expectations that appropriate technologies be identified and used to facilitate access to the general education curriculum and rehabilitative programming, the school districts have frequently balked at providing them to students with disabilities (Smith & Jones, 1999). The barriers often encountered by school administrators and teachers are related to funding, difficulty gaining access to technologies, creating working technology infrastructures, as well as lack of training, pedagogy, or attitudes towards computers (Christensen, 2002; Flanagan et al., 2013; Franklin, 2007; Lowther et al., 2008).

Historical Context of Technology Integration in Special Education

The use of technology for students with disabilities has been historically associated with devices and services designed to assist students who are blind, visually impaired, deaf, hard of hearing, or physically impaired (Edyburn, 2004). Such devices increase involvement in programs and activities that promote independent functioning (such as mobility) as well as facilitate communication, enable early childhood development, and support educational achievement (Netherton & Deal, 2006). Applications of technology serving as cognitive prostheses have been considerably less accepted and understood (Edyburn, 2004) although using technology as such can facilitate the student's move to independence by reducing his or her dependence on others to perform tasks such as reading, writing, listening, and organizing (Anderson-Inman et al., 1999). According to Edyburn (2002), this stems from a traditional focus by teachers on remediating skills versus compensating for deficits, but other researchers believe that factors such as the teachers' attitudes and lack of training or school policies and limited resources (Ertmer et al., 1999; Ertmer at al., 2012; Flanagan et al., 2013) may be at the root of this. Also, in the context of standards-based reform whose central component is large-scale assessment, students with disabilities have witnessed a strong presence of AT in their schools, but most often as part of testing accommodations to help minimize the impact of their disability on assessments (Dolan, Hall, Banerjee, Chun, & Strangman, 2005). Thurlow, Seyfarth, Scott, and Ysseldyke (1997) also researched the topic and asserted that, in order for students to receive assessment accommodations, they should already be using these accommodations during classroom instruction. For example, Thompson, Johnstone and Thurlow (2002) proposed computer-based classroom assessments as a means of addressing diverse learners but they also suggested that various technological tools might be used to provide *both* test and instructional accommodations. Examples of such tools include:

1. Text-to-speech (TTS) technology or speech synthesis: software that reads text aloud through an audio format;
2. Electronic reading supports: software that adds spoken voice, visual highlighting, document navigation, or page navigation to any electronic text;

3. Alternative access devices: these allow the use of devices such as special mouse, track ball, or other alternate means for keyboard access such as a switch. (p. 21)

Clearly, technology is an important part of the current educational requirements for students with disabilities and will be essential to eliminate the artificial boundaries between students with disabilities and their typical peers (Edyburn, 2004). But, although technology has been known to be an effective way to widen educational opportunities, Bauer and Kenton (2005) found that teachers did not apply knowledge that they, in fact, held on how to use AT for teaching and engaging their students.

Students with disabilities and technology. The inability to gather meaning from print remains a most important educational concern for all students, but especially those students identified with disabilities who often struggle with reading (Strobel et al., 2007). As these students move into higher grades where curricular expectations accelerate and content demands (e.g., history, science) are markedly different (Kennedy & Deshler, 2010), text remains a central feature of most subjects and teachers rely heavily on the printed word and complex expository texts as the primary instructional tool and mode of knowledge acquisition (Dyck & Pemberton, 2002). Additionally, the texts students are expected to utilize present concepts and vocabulary at a pace and readability level that students with disabilities, especially those with reading disabilities, struggle to achieve (Maccini, Gagnon, & Hughes, 2002). And so, the research has shown that students with learning disabilities, who fit the profile of struggling readers, face increasingly heavier curriculum demands as they progress through school and educators struggle to prepare them to successfully respond to these challenges (Deshler, Schumaker, Lenz, Bulgren, Hock, Knight et al., 2001). Marino

(2009) offered an alternative to these educational concerns by establishing the symbiotic relationship among inclusive teaching practices, technology, and instruction holds “particular merit” (p. 88) for adolescents with reading disabilities.

Ertmer, Conklin, Lewandoski, Osika, Selo, and Wignall (2003) indicated beginning teachers, including special educators, lacked the knowledge on how to integrate technology in teaching and learning, although they aspired to have the adequate technical abilities. Similarly, Hew and Brush (2006) indicated that educators’ beliefs in the advantages and disadvantages of teaching with technology influenced the integration of the technology in the classroom beyond the lack of specific technology knowledge and skills such as technology-supported-pedagogical knowledge and skills, and technology-related-classroom management knowledge and skills. Even among award-winning teachers, Ertmer et al. (2012) found both school-level (first-order) and teacher-level (second-order) barriers continued to be present during integration of technology in the classroom. The researchers made clear mention that, despite the efforts to provide adequate technology resources to teachers and their students, little will be gained ultimately if knowledge and skills along with attitudes and beliefs are not addressed.

Technology Integration Models

There have been a few attempts to understand how technology is being implemented in the classroom, although none of the models included AT specifically. One of the most frequently referred to models in the literature, the TPACK (Mischra & Koehler, 2006) is a framework addressing the specific needs for pedagogy and content knowledge rather than how technology can be implemented. TPACK identified three domains – Pedagogical Knowledge, Content Knowledge, and Technology Knowledge – whose intersection is believed to produce a successful level of technology implementation. A study by (Abitt, 2011) on the use of TPACK is reviewed in the subsequent section. In turn, The SAMR (Puentedura, 2006) model categorizes levels of use of technology by taking into account how much the tech-assisted task shifts from traditional tasks in its complexity. Edyburn's Model of Technology Integration (1998) is also present in the discussion regarding technology integration in the classrooms, although not often included in the literature given its focus on the actual stages of integration and not on the student's learning process.

Perhaps one of the most frequently acknowledged study regarding how teachers make use of technology is Brickner (1995)'s classification of barriers that educators face when planning instruction with technology. The concept of first- and second-order barriers (this framework has been described in Chapter 1) has made the interest of numerous researchers although the research lenses varied in how this model was used.

Review of the Research Literature

To further explore the research on teaching practices with the help of technology in the education of secondary students with learning disabilities, a comprehensive review of the literature was conducted. In this section, the search strategies followed by inclusion criteria and a review and critique of the studies identified through the search are presented.

Search Methods

The literature included in this review drew from the results of an electronic search of the research port at the University of Maryland College Park, EBSCO, Google Scholar, and ancestral resources using the following key words (and their combinations): "assistive technology", "(assistive) technology integration", "barriers to integration", "level of technology use", "SAMR", "educational technology", "special education teacher beliefs", "special education teacher perceptions", "pedagogy and technology", "influencing factors", "teaching with technology", and "learning disabilities". The ancestral search was conducted on the reference lists of all the selected articles if their titles included any of the key words mentioned above. Search on relevant websites was conducted including: the National Center for Learning Disabilities (NCLD), the National Dissemination Center for Children with Disabilities (NICHCY), the U.S. Department of Education (ERIC), the Office of Special Education Programs, the National Center for Education Statistics, the Council for Exceptional Children, and the Individuals with Disabilities Education Data (IDEAdata).

Inclusion Criteria

Upon review of the abstracts, only those studies that addressed the following criteria were selected: 1) published in a peer-reviewed journal since 1988 after the passage of the Tech Act, 2) specifically addressed issues concerning teachers' use of technology (to include barriers and/or incentives to integration of educational or assistive technology, level of use), and 3) used samples comprised of K-12 teachers or students. Both quantitative and qualitative studies were considered and included if they fit the criteria above.

The initial searches yielded a total of 462 results but after removing articles that did not match the inclusion criteria (position and scholar papers, studies and reports sampling student population in other countries), only 22 remained to be included for review (15 quantitative, four qualitative, and three mixed methods). One of the studies, Brickner (1995), which provided one of the theoretical models for my proposed research study, was a dissertation study that does not appear to have published in peer-reviewed journal. However, given its conceptual value, I decided to include it in the literature review.

The following review has been divided in quantitative and qualitative studies due to different criteria of evaluation given their research designs. The content analyses consider purpose, samples, variables, results of the studies, and methodological critiques followed by conclusions. The body of literature selected focuses primarily on the factors influencing teachers when integrating technology in the classrooms and it ranges from 1996 to 2013. All but two studies sampled teacher population exclusively, both in-service and pre-service educators. Also, 11 studies used survey research methods in their investigations while five chose qualitative research to examine their hypotheses.

Content Analysis – Quantitative Studies

The review of the quantitative literature follows below and is divided in two main sections: content analysis and critique of the literature.

Purpose. The use of technology in the classroom in relation to the benefits and barriers associated with such use was predominant among the researchers' hypotheses. Most recently, Flanagan, Bouck, and Richardson (2013) explored which factors middle school teachers perceived to hinder or encourage their use of AT along with how frequently and in what manner they used AT. In 2011, Jost and Mosley surveyed teachers (preservice and in-service) specifically to probe into the levels of AT literacy (teacher awareness of AT, working knowledge of AT, and transformative perspectives related to AT) among general education teachers while Franklin (2007) conducted similar research but only sampled elementary school teachers to inquire about the factors that influenced their use of computer technology for instructional purposes. Ertmer, Ottenbreit-Leftwich, and York (2006-2007) worked with a select group of exemplary technology-using teachers and focused on enablers rather than barriers teachers perceived when implementing technology. An and Reigeluth (2011) also investigated teachers' perceptions of support needs and barriers to creating technology-enhanced, learner-centered classrooms as well as their beliefs and attitudes toward the use of technology in learning and teaching. In Gorder (2008), the research hypotheses focused on the use of instructional technology in the classroom by analyzing (also via survey methods, too) the teacher perceptions of how technology is and should be integrated in the classroom. The secondary purpose of her study was to examine the degree to which the teachers, who had been trained to use and integrate technology into teaching and learning, perceived that technology was fully integrated in their classroom. In addition to survey items, Gorder (2008) also used individual characteristics of teachers (age, teaching experience, grade level, content area, and educational level) to further explore correlations among the variables. Teacher characteristics, such as formal training for technology integration for learning, were also predictors investigated by Lei (2009) and Abbitt (2011). Lei (2009) brought into discussion the "digital natives", an older concept coined by Prensky (2001) to refer to individuals who grew up in the tech-booming world, and studied their assumptions, beliefs, attitudes, and experiences regarding technology integration as they prepared to enter teaching careers. In turn, Abbit (2011) investigated the relationship between the self-efficacy beliefs of preservice teachers and the measures of the Technological Pedagogical Content Knowledge (TPACK), a conceptual framework developed by Mishra and Koehler (2006) based on the theory of Pedagogical Content Knowledge (Shulman, 1986). "TPACK is a representation of the complex interactions among the types of essential knowledge for successful teaching with technology" (Abbit, 2011, p. 135). Lowther, Inan, Strahl, and Ross (2008) tested the effectiveness of a Tennessee's funded initiative focused on removing key barriers to integration of technology (based on research) and its impact on teachers' skill levels and attitude towards use of technology. Likewise, Barron, Kemker, Harmes, and Kalaydjian (2003) analyzed survey responses by teachers about the specific ways in which they integrated technology, specifically as a research tool for students, a problem solving/decision making tool, a productivity tool, and a communication tool, to identify instructional models related to technology implementation in the context of National Education technology Standards (NETS) regulations. In 2002, Lahm and Sizemore utilized their self-developed survey of 26 questions to also interview teachers on factors (client goals, environmental demands, family/client demands, funding, client diagnosis) that influenced their decision-making when considering the use of technology with young children with disabilities (for work, self-care, play, learning, communication, goal achievement). The only studies to observe children in the context of teacher's use of technology and factors that impact it were Abner and Lahm (2002), whose sample was comprised exclusively of students with visual impairments, and Christensen (2002) who also collected data on how teachers' use of technology impacts student attitudes towards utilizing technology in their learning. Also, among earlier research, was Lesar's (1998) examination of the link between the use of AT for young children with disabilities and their teachers' preparation, knowledge and usage, and training needs. The study incorporated the impact of family involvement on technology use in the classroom as well and concerns related to the intersection of parents with the integration of instructional technology. Derer, Polsgrove, and Rieth (1996) focused specifically on a project meant to increase the bank of knowledge regarding the use of technology by teachers which included a general survey of assistive technology use in early childhood special education classrooms across programs in Indiana, Kentucky, and Tennessee. The researchers focused their attention on the potential relation between the use of technology and the profiles of the settings surveyed (rural versus small town versus urban programs, type of classroom – self-contained, resource room, multiple settings, level of education cycle – elementary, middle, high school – as well the type of computer systems used – Apple, Commodore, IBM, MacIntosh, Radio Shack). Additionally, data were collected on child-related demographics (type of disability, number of children using AT, the average number of students under teacher caseload), teacher profile (respondent's role – special educator, consultant, therapist – and level of preparation – in-service, consultation, continuing education, pre-service, self-taught, experience, no training) and the participants' perceptions on major barriers and benefits of using AT. Finally, Brickner (1995) produced the initial results regarding barriers to educators using technology from her study of the relationship between barriers to change to the degree and the nature of computer usage by mathematics teachers.

Samples. The majority of the quantitative studies (13) used exclusively in-service and/or pre-service teachers in their samples. Three exceptions were Christensen (2002), Lahm and Seizemore (1998), and Derer et al. (1996) who also included students and other educational professionals such as therapists and technology suppliers and specialists (see Appendix D for the sample summary matrix). Brickner (1995) selected 25 participants from schools in rural areas in Indiana (23 math teaches in grades 5-12, 1 assistant principal, and 1 computer coordinator) who had little to no experience in using computers. One teacher's data was not consistent and, therefore, not used. The sample was mostly female (n = 13) teaching in middle (n = 14) and high school programs (n = 3). Derer et al. (1996) distributed 1,266 surveys to teachers already working in public schools in Indiana, Kentucky, and Tennessee and recorded a return rate of 32% (n = 405). Of the 405 returned surveys, the majority belonged to elementary school teachers (48%) followed by high school educators (24%) and middle school teachers (14%). The predominant respondents were teachers from large urban areas (43%) and smaller towns (35%) followed by educators from rural areas (22%). Additionally, 45% taught in resource rooms, 30% in self-contained special education classrooms, 17% served students with disabilities in multiple settings, and 6% provided services in other settings. Lesar (1998) used a systematic sampling procedure to select 169 professionals working in early childhood special education settings in North Carolina and Tennessee who completed surveys (40% return rate) focusing on assistive technology preparation, knowledge and usage, training needs, family involvement, and concerns related to integrating technology in the classroom. The participants were recruited from the 1995 North Carolina Preschool Handicapped Training and Technical Assistance Directory (88 names were selected randomly) and from the 1995 Tennessee Public Schools Directory (81 names of teachers were selected who were distributed among 34 preschool programs). The sample for Lahm and Sizemore (2002) included 15 service providers such as speech and language pathologists (n = 6), technology suppliers (n = 4), educators (n = 2), one occupational therapist, and two AT practitioners who answered questions related to factors that influenced their decision making for technology use with young children. The majority of the participants (n = 10) had between 8-15 and 15+ years of professional experience while three counted between 2-5 years of experience and only one fit the 5-8 years category. Their experience with the use of technology included eight participants having used AT for more than 8 years (8-15 and 15+), three between 5-8 years, two between 2-5, and one less than two years. Based on the demographical data, the more experienced technology users appeared to be the speech-language pathologists. In terms of level of education for the sample, the Master's degrees were most encountered (n = 7), followed by Bachelors (n = 4), No degree (*n* = 3), and one Ph.D.

Abner and Lahm (2002) studied the survey responses provided by 72 certified in-service and pre-service teachers of students with visual impairments in programs in Kentucky. The return rate on the surveys was 54% and the majority (71%) of the respondents were itinerant teachers while 21% were educators at the KY School for Blind and 6% provided services in resource rooms and other settings (the sample also included one teacher of children with visual impairments in a hospital setting). A large percentage (94%) of the participants were certified teachers with remaining four working toward the completion of their certification training programs. The educational levels of the teachers varied from bachelor's degrees plus additional credits (7%), master's and master's plus hours of experiences (49%), bachelor's plus 60 credits or more (43%), and one doctorate degree. Overall, the number of years of teaching ranged from 1 to 26 with a mean of 10.1 and the student population that teachers had served throughout their careers included educational disabilities beyond visual impairment (such as multiple disabilities, intellectual disabilities, speech or language impairments, severe emotional disabilities, orthopedic impairments, autism, traumatic brain injury, other health impairments, or specific learning disabilities). Most teachers worked in elementary school programs (43%), followed by middle school (28%), high school (20%), preschool (6%), and infant/toddler programs (3%). Christensen (2002) included 60 elementary teachers in its experimental (suburban) school group and 900 students in PreK-5 of which 65% were Hispanic, 18% White Caucasian, 10% African American, and 7% from other ethnic groups. No demographic information was provided for the teachers. Barron et al. (2003)'s survey sample counted 2,156 respondents (17% male and 83% female) representing a return rate of 35%. Their educational backgrounds reflected more than half of the teachers (61%) holding a bachelor's degree, 36% with a master's degree, 2% with a specialist or doctoral degree, and 1% that did not fit in any of the above categories. Additionally, a little over half of the survey participants (51%) taught in elementary schools, 26% in middle schools, and 23% in high school. The most experienced teachers (with more than 20 years of experience) were reported in high school (44%) while middle school and elementary teachers had similar percentages (ranging from 33-37%) for the categories of 2-10 years and more than 20 years of experience. Of the entire sample, almost one quarter (*n* = 547) taught content areas such as English (33%), math (28%), science (20%), and social studies (19%).

Ertmer et al. (2006-2007) recorded 25 teachers (16 females and 9 males) who responded to the surveys. Of these, all were award winners in technology educator programs across the Midwest. Almost half (*n* = 12) had been teaching for 13 years or less with an average overall indicating 16 years of practice. All participants reported high (9) or very high (16) computer skills.

K-12 teachers were, also, the subjects in Gorder's study (2008) of educators' perceptions of instructional technology integration in the classroom. The surveys were returned by 174 teachers (58% return rate) who were attending, at the time, the Advanced Technology for Teaching and Learning Academy in South Dakota. The sample was primarily female (84%) with almost half (48%) reporting between 11-15 years of teaching experience (41% had 26+ years of experience and 11% had less than 10 years of experience). Just as in previous research, Gorder continued to focus on teachers across grade levels with 33% of teachers serving students grades K-5, another 33% serving high school students, 13% in grades 6-8, and 21% taught in multiple grade levels; the content areas were divided in 21%

teaching multiple disciples, 17% taught math/science, 17% business/computers, 16% English/foreign Language, 5% fine arts, 4% social studies, and 20% other areas. The teachers' education levels reflected a majority (62%) holding Bachelor's degrees, 34% held Master's degrees, and 4% had doctorate degrees. Lowther et al. (2008) observed sampled 927 teachers (n = 486 in comparison programs and n = 441 in control groups) and 12, 420 students nested in 26 schools throughout three years (2003-2006).

Jost and Mosley (2011) secured a large sample (n = 224) of teachers (both preservice and inservice) to collect data via their online survey on teacher awareness of AT, working knowledge of AT, and transformative perspectives related to AT.

Both An and Reigeluth (2011-12) and Abbitt (2011) also used online surveys to investigate hypotheses about teachers across K-12. An and Reigeluth reported on the beliefs, perceptions, barriers, and support needs of 126 teachers when integrating technology to create learner-centered classrooms while 45 preservice teachers participated in Abbitt's (2011) study of the relationship between teachers' self-efficacy beliefs about technology integration and TPACK. An and Reigeluth (2011-12) recorded 32% response rate from their respondents of which 93% were female teachers across 14 elementary schools, 4 middle schools, and 9 high schools in northeast Texas and southwest Arkansas. The teachers also had a mean of 10.2 years of teaching experience and ranged in age from 20-60 years old (with the largest percentage – 21% in the 26-30 age bracket and the smallest – 1% - in the 61-65 age category). In contrast, Abbitt's (2011) sample included a single cohort of pre-service teachers averaging 21.3 years old and without prior teaching experience. They were attending an early childhood education program and, at the time of the study, were enrolled in a one-credit course focusing on technology integration into teaching. The majority (96%)

of the cohort was female population. Similarly, Lei (2009) inquired preservice teachers (the "digital natives") about their level of preparation in technology integration. The sample included 55 freshmen students in a teacher education program at a large northeastern university, predominantly female (84%).

Flanagan et al. (2013) examined the perceptions and use of technology of special educators teaching literacy to middle school students with high incidence disabilities in a Midwestern school district. The final sample included 51 teachers across 166 middle schools with a large majority (*n* = 46) of female participants whose mean age ranged from 31 to 40, their levels of experience between 1-5 years to over 25 years, and the highest levels of education reflected 33 teachers holding Master's degrees.

Franklin's (2011) study population included 121 elementary teacher program graduates from 2000-2002 cohorts, with residences in the United States. The degrees that had been conferred to them by a mid-Atlantic university were dual Bachelor of Arts and Master of Teaching (BA/MT) or postgraduate Master of Teaching (PG/MT). No further sample demographics were provided except for the mention that "the majority of the respondents" were already occupying teaching positions (up to three years of practice) in K-6 self-contained classrooms and 41% had graduated in 2001, 30% in 2002, and 28% in 2000.

Research designs and variable constructs. The predominant research methodology among the reviewed literature was the survey. In fact, with four exceptions, Brickner (1995), Christensen (2002), Lowther et al. (2008), and Abbitt (2011), all remaining 10 quantitative research studies included in the literature review used survey methodologies. Both Brickner (1005), a case study design, and Ertmer et al. (1998), a mixed-methods study, also used survey methods but included methodology such as site observations, participant interviews, and document reviews to triangulate their data.

A simple quantitative survey involves multiple independent variables and one dependent variable (Punch, 1998). In Derer et al. (1996), the survey's 78 items collected data on the demographics of special education teachers participating in the study as well as characteristics of children using AT (13 questions), on the barriers and benefits of using AT (2 open-ended questions), and on the AT devices most commonly used along with the settings and purposes for which they were used (63). Lesar (1998) developed a survey to include 40 items divided in four parts which focused on demographic data of the participants (age, gender, ethnicity, years of education, professional discipline, type and location of the program), on the types of educational experiences related to the use of AT with young children with disabilities as well as their effectiveness (Likert-type scale), on their knowledge of specific AT (Likert-type scale: *nonexistent* to *expert* range), and on the extent to which problem areas exist in their current work setting plus a scale to rate different potential training (Likert-type scale: *helpful* to *least helpful* range). Lahm and Sizemore's (2002) instrument included 26 questions and collected data on demographics of the participants, their educational background and philosophy (6 items), and the implementation and role of the teams in AT decision-making process. Abner and Lahm (2002) used a census survey method that comprised of four sections to record: 1) basic demographic information, including educational background, years of teaching experience, number of students currently served, and the type of service delivery model (resource room, itinerant, or consultant), 2) information on teachers' personal and professional use of technology and their proficiency level using technology, 3) the computer-based technology the students were using, and 4) supports available to teachers during implementation of AT. In Christensen

(2002), one of the only two non-survey studies, the teachers in the treatment group received a needs-based assessment on their use of technology at the beginning of the school year. This was followed by two days of intensive training tailored to the outcome of the assessment as well as additional training sessions every six weeks throughout the school year. Christensen collected pre- and posttest data on teacher attitudes towards computers such as anxiety, confidence, liking, importance, enjoyment, relevance, understanding, teacher and classroom productivity, acceptance, and enthusiasm before and after the training. The primary instrument used to collect data was the Teachers' Attitudes Toward Computers Questionnaire (TAC Ver. 2.21), which included 16 variables that were used for factor analysis. Additionally, four constructs from the Computer Attitude Survey (Loyd & Gressard, 1996) and three constructs from the Young Children's Computer Inventory (Knezek et al., 1995) were included. Barron et al.'s (2002) survey was made available to respondents both as a paper version as well as web-based and was divided in four focal points regarding the integration and support of technology in the classroom, the preparation, confidence, and comfort of teachers using technology as well as their attitudes toward computer use. Ertmer et al. (2006-2007) constructed a survey tool with help from similar surveys in the prior literature (Bullock, 2004; Hadley & Sheingold, 1993, Iding, Crosby, & Speitel, 2002; Lumpe & Chambers, 2001). They recorded a reliability coefficient (Cronbach alpha) of 0.76.

Franklin (2007)'s survey targeted data collection on factors related to the integration of technology such as access and availability, teacher preparation and training, leadership and time. For Gorder (2008) study, the teachers responded to items (35 items) about the organization and integration of technology in the classroom with the purpose of enhancing the learning and teaching process. The survey was developed by Mills and Tincher (2003) based on their model for determining technology integration by teachers, known as the Technology Integration Standards Configuration Matrix (TISCM). The teachers' level of technology use in a barrier-free environment was tested in Lowther et al. (2008) and measured using the Formative Evaluation Process for School Improvement: Technology Package (FEPSI/TP) developed by the Center for Research in Educational Policy (CREP) (Lowther & Ross, 2003). The process includes seven components (direct classroom observations, surveys, student performance assessments, interviews, focus groups, school-development technology benchmarks, and student achievement analysis) of which Lowther et al. (2008) only reported on classroom observations, surveys, and student achievement analysis.

Lei's (2002) study of digital natives as pre-service teachers, which surveyed freshmen in teacher education programs, focused on general technology use information, such as ownership of technology devices, time spent on computers, and other technology activities, also attitudes and beliefs toward technology, proficiency in 51 specific common technologies and interest in learning these technologies, experiences and opinions on using technology in education. The survey also included sections on identifying the level of difficulty of technology used (basic, lower and upper intermediate, and advanced). In their survey, Jost and Mosley (2011) incorporated the entire Edyburn's 2003 framework for teacher knowledge based on the theories related to change and the adoption of innovations (which resulted in three levels of technology integration: awareness, working knowledge, and transformation) and added a section on teacher demographics. Similarly, An and Reigeluth (2011-12) developed their own survey based on previous literature guidelines by Brush, Glazewski, and Hew (2008) regarding the development of an instrument to measure pre-service teachers technology skills, technology beliefs, and technology barriers. An and Reigeluth collected initial feedback from 11 teacher participants in pilot testing the instrument. The final version included 10 questions to both Likert-scale and open-ended items about the use of technology in the classroom, the variety of technologies used in the classroom as well as teachers' perceptions on the importance of technology for teaching and learning and their willingness to learn and/or keep up with new technologies. In an experimental study,

Abbitt (2011) used a single-group, pre-posttest research design to assess the relationship between self-efficacy beliefs toward technology integration and perceived knowledge in TPACK domains. However, Abbitt (2011) also used two web-based surveys as part of data collection; one include 47 questions and measured perceived knowledge in the TPACK domain and the second one, CTIS, counted 16 items relating to perceived confidence in successfully integrating technology into teaching practice. Franklin (2005) constructed her own survey to test the factors that influence the ways in which teachers used computers as well as the kinds of use being employed for instructional purposes. The researcher's instrument was inspired from two earlier surveys: the *Teaching, Learning, and Computing: 1998 Survey* [TLC] (Becker & Anderson, 1998) and the *Fast Response Survey System* [FRSS] (NCES, 2000). The final product included items divided in four categories: General Information (years of experience, graduation year, philosophy), Computer Information (philosophy, access, types of use), Factors (incentives, assistance, barriers), and Preparation (teacher training).

More recently, Flanagan et al. (2013) used a 20-item survey, which included single-selection, rating scales, multiple-selection items, and open-ended responses to obtain teacher responses with regard to the use and effectiveness of low-tech AT, use and effectiveness of high-tech AT, and general AT use (factors that acted as incentives and/or barriers for use). The variables in Brickner (1995)'s study were the degree of computer use, teacher demographics (age, gender, education, teaching experience), perceived value of computers, computer anxiety, self-perception of innovativeness, participant reasons for computer use, technological self-efficacy. The survey, specifically, included 18 items organized into four sections: instructional applications, computing instructing, personal use, and computer ownership. The results rendered three levels of computer use for teachers: user, not personally using, and nonuser.

Data analysis. Most studies (11) used descriptive statistics to report their results (percentages, mean, SD, cross-tabulation) of which four also conducted qualitative analyses such as coding and identifying patterns among the surveys' open-ended answers. Inferential statistics were used in Barron et al. (2003) who used the Chi-Square test of independence and a correlation coefficient, Cramer's V, to investigate the study's categorical variables, Christensen (2002) who used factor analysis, regression, and time-lag regression analysis while, Brickner (1995), Ertmer et al. (2006-2007), and Flanagan et al. (2013) who analyzed their data using correlations as well as the *t*-tests and pattern seeking techniques for qualitative data. Abbit (2011) used an analysis of bivariate relationships and multiple regression, a method was also used by Franklin (2007). A summary of the data analysis techniques used is included in Appendix D.

Findings of quantitative studies. The findings of the quantitative studies reviewed revealed consistent interest among the researchers in understanding how teachers used technology in the classrooms and the factors that influence the integration of technology in their instruction. The results were divided into three sections in order to reflect these patterns:

factors influencing the integration of technology, teacher characteristics, types of technology.

Factors influencing the integration of technology. The teachers in the studies published in the first decade since 1998 reported similar barriers to using technology. In Brickner (1995), the results showed that teachers encounter barriers related to the environment (first-order) and their own dispositions (second-order). The level of use the participants initially reported did not influence the type of barriers they reported while most of the barriers perceived were first-order. There were moderate correlations between use of computer and computer anxiety ($r = -.58$, $p < .05$) and technological self-efficacy ($r = .63$, $p < .05$). Additionally, a key finding by Brickner (1995) was that the more first-order barriers were alleviated, the more second-order barriers emerged among teachers. Derer et al. (1996)'s participants also identified mostly first-order barriers through their answers with the highest percentage (27.6%) (average across all three states surveyed: IN, KY, TN) indicating that lack of availability of funds to purchase equipment, lack of training (25.6%), difficulty to obtain the equipment (22.3%), and lacking sufficient time for integration (13.6%) were the major factors impacting their practice. The lowest percentages reported were related to school policies (1.6%), appropriateness of software reflected (1.6%), sharing the equipment (2%), and class size (2.3%). Second-order barriers were also present in Derer et al. (1996), although the respondents attributed less importance to factors such as resistance to using technology (3.3%) and rejection of use (1%). Likewise, Lesar (1998) found that 50% of the respondents claimed lack of training and technical assistance as major barriers in integrating technology (in this study, the focus was on AT). When asked to rank the source of their knowledge to use AT for teaching purposes, 77% of the participants in the study (early childhood professionals) said they relied on personal experiences which they considered to be most effective (39%), followed by 69% who used printed guides (but only 2% found it to be an effective), and an average of 58% who drew their partial knowledge from in-service activities, conferences/seminars, and workshops, (with 10.6% effectiveness). The least ranked venue (47%) was completed coursework on using technology in the classroom but this source of knowledge was only perceived to be 3% effective. Other factors influencing teachers in their use of AT with their students were: availability and funding of AT (52%), and ineffective AT assessment process (45%), problems with the maintenance and repair of AT (37%).

Even after the year 2000, teachers continued to report barriers that related to access to technology, including resources and training. In Abner and Lahm (2002), 99% of their sample participants believed they needed more training and, in fact, 51% indicated that they were only at the "apprentice level" for using technology during instruction thus impacting the successful integration. Jost and Mosley (2011) also found that lack of training was a barrier to 60% of the teachers while An and Reigeluth's (2011-12) sampled teachers ranked the most frequent barriers they perceived when integrating technology (1 not a barrier, 3 a major barrier) as follows: lack of technology (M = 1.74, SD = 0.74), lack of time for implementation (M = 1.71, SD = 0.69), assessment-related issues (M = 1.66, SD = 0.73), institutional barriers (school leadership, schedule, rules) (M = 1.46, SD = 0.59), lack of knowledge about learner-centered instruction (methods training) used in the school (M = 1.44, SD = 0.59), lack of knowledge about ways to integrate technology (M = 1.44, SD = 0.59), lack of tech support (M = 1.39, SD = 0.62), academic subject culture (practices and expectations for a specific school subject) (M = 1.35, SD = 0.54), teacher attitude towards learner-center instruction used in the school (M = 1.05, SD = 0.29), and teacher attitude toward technology (*M* = 1.03, *SD* = 0.22).

Lahm and Sizemore (2002) found that their participants were influenced in using (or recommending use of) assistive technology mostly by their client/student goals (average of 95% found it extremely important), environmental demands (average of 95% found it extremely important), family demands (average of 78% found it extremely important), funding (average of 60% found it extremely important), and client/student disability (average of 63% found it extremely important). In Flanagan et al. (2013), 75% of the teachers reported the high costs of technology obstruct its use and 47%, respectively 43%, said they needed additional training and additional time to set-up and use. Also, 37% of the teachers found it difficult to use technology during instruction due to lack of additional needed products. With less than 20% were barriers such as the technology was difficult to use for the student (19%), there was insufficient support on how and when to use it (18%), school computers did not support the technology (18%), could not figure out how to use quickly (16%), there was no knowledge of how to use the product or what it was for (12%), and it was difficult to use by the teacher (6%). Flanagan et al. (2013) also identified factors that encouraged the use of technology such as it increases learning (92%), it assists students individually (84%), it is user friendly to integrate in the classroom and instruction (51%), it can be quickly customized for a student (39%), and it requires little additional training (33%). The only study to reveal second-order barriers for teachers was Ertmer et al. (2006-2007) whose sample mostly reported that inner drive (*M* = 4.84, *SD* = .37), personal beliefs (*M* = 4.84, *SD* = .37), commitment (*M* = 4.76, *SD* = .52), and confidence (*M* = 4.64, *SD* = .64) were the largest barriers to integrating technology in the classroom.

Teacher characteristics. Flanagan et al. (2013) reported teachers' confidence in integrating AT was significantly related to their perceived ability to use AT during instruction ($r = 0.562$, $p < 0.05$) although the correlations were not significant against different type of AT (low or high-tech AT). But, in connection with this finding, 32% of the participants stated that they did not feel prepared to use, choose, or implement AT for specific content areas such as literacy. The findings reported by Abbitt (2011) whose sample reported consistent growth throughout a one-semester course focusing on technology integration in teaching. According to the descriptive statistics provided for pre- and posttest, the mean differences indicated positive average values of 0.37 all across TPACK subscales (technological knowledge, social studies content knowledge, mathematics content knowledge, science content knowledge, literacy content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, technological pedagogical content knowledge, self-efficacy for technology integration.

An and Reigeluth (2011-12) found teachers supported the use of technology in the classroom ($M = 4.83$, $SD = 0.39$), the importance of technological variety for student learning ($M = 4.78$, $SD = 0.45$), and the role of technology in assisting with task completion more effectively and efficiently ($M = 4.73$, $SD = 0.48$) as well as its important part of teaching and learning ($M = 4.64$, $SD = 0.61$). The participants also expressed willingness to learn and use new technologies ($M = 4.52$, $SD = 0.39$) and stated that incorporating technology in the curriculum was a teacher's job ($M = 4.39$, $SD = 0.75$). However, when discussing practices for creating learner-centered classrooms (the program used by An and Reigeluth), most of the teachers (M = 4.14, SD = 0.63) perceived that they needed to know more about it and that learner-centered instruction was challenging (M = 4.14, SD = 0.73).

Gorder (2008) found most of the teacher participants (M = 4.01, SD = 0.73) were *technology operators* (basic file management tasks, operating common technology, communication and collaboration, software productivity tools, locating, evaluating, and collecting educational research, applying double-shooting strategies) rather than *technology facilitators* (M = 3.83, SD = 0.77) which was reflected by practicing and modeling responsible use of tech, facilitating equitable access to tech, managing student learning activities in a tech-enhanced environment, evaluating and selecting information and education, using multiple tech contexts and productivity tools, and demonstrating strategies to assess validity and reliability of data gathered with tech. *Integrating technology* such as using tech to provide learning context requiring problem solving, critical thinking, implementing tech-based learning experiences, using tech to collect, analyze, interpret, and communicate learner performance was the role least assumed by teachers (M = 3.07, SD = 0.86). Lei (2009), who focused on identifying beliefs, attitudes, experiences, and expertise of the "digital natives" preparing to become teachers, hypothesized that the first generations of digital natives should be enthusiastic users of technology. But the findings indicated that, although 100% strongly agreed that they were interested in learning how to teach with technology, only 79.3% believed that technologies could help students learn better while 10.4% were not interested in learning new technologies.

In Lowther et al. (2008), the teachers in the treatment group (where the program purposely removed barriers to technology implementation) also showed improved readiness to integrate technology (mean difference of 0.54, SD ranged from 0.59 to 0.78), positive impact on students and classroom instruction, and positive perception of available overall and technical support. Franklin (2007) reported most of his teacher sample (76.5%) also agreed that computers have considerable potential for student discovery and construction of ideas while 10.3% only found computers useful for drill and practice, 5% thought of computer technology to have limited use, and 4.4% believed that computers didn't fit their teaching style. Additionally, 77% of the teachers reported to have teaching philosophies aligned with constructivism, the only study where the connection with learning theories was explored. Christensen (2002) results revealed significant differences for teacher attitudes following the needs-based training provided (teachers who received IT training improved their attitudes on 13 out of 22 scale factors, $p < 0.5$), for the use of technology by the treatment teachers (18 out 19 teachers in the treatment group reported increases in use of computer through frequency recording), and for the teacher positive attitudes influenced student perception of computer importance ($ß = 0.14$, $p < .03$).

Use of technology. The findings of the quantitative literature indicate patterns across studies although the use of classroom technologies (including AT) showed a variety of purposes. Chronologically (from earlier to more recent studies), technology was used by teacher participants for communication, teacher and classroom productivity (to create charts, reports, and other presentation products), student research projects, and access to curriculum. In Derer et al. (1996), the teachers mostly used (≥25%) computers, software, tape recorders, and video technology for academic purposes, followed by books on tape, closed circuit TV, and productivity devices reported by 10-24%, and adapted calculators, language devices, large type books, and communication boards used by only 5-9% of the participants. Barron et al. (2003) found their teacher subjects utilized technology mostly as a communication tool (elementary – 59%, middle – 54%, high – 48%), for productivity (elementary – 37%, middle – 40%, high – 38%), and as a research tool (elementary – 32%, middle – 34%, high – 40%). Using technology as a problem-solving tool came in last with 29% of the elementary school teachers using it for this purposes, followed by 23% by middle schools, and 20% by high schools. Across subject areas, science teachers were most likely to use technology for research (51%) followed by social studies teachers (44%), English teachers (30%), and math teachers (24%). Additionally, only 12% of the entire sample (n = 2,156) used technology for research needs (such as Internet research) at least once a week and only 8% for problem solving and data analysis. Abner and Lahm's (2002) findings evidenced that computers were mostly used for word processing (16.6%), recreation (9.5%), and Internet research (7.9%). Among the technology with the least amount of use were access to e-text, calendar planning, and spreadsheets. Also, the most frequently utilized technologies were screen-enlargement programs (31.9%), standard, unadapted systems (27.7%), screen-reader programs (19.5%), switch interfaces (12.5%), and refreshable braille (2%). The preservice teachers in Franklin (2007) indicated they mostly used computers to locate and gather materials (such as accessing research and best practices for teaching) ($R_{varimax} = 0.815$), communicate with colleagues and other professionals ($R_{varimax} = 0.872$), to post homework or other class requirements ($R_{varimax} = 0.748$), and to create instructional materials (handouts, etc.) ($R_{varimax} = 0.774$). Then, Gorder's (2008) results evidenced that teachers used technology primarily for professional productivity (such as basic file management tasks, operate common technology, communicate and collaborate, presentation software, locate, evaluate, and collect educational research, and apply trouble-shooting strategies) (M = 4.01, SD = 0.73), followed by facilitating and delivering instruction (such as manage student learning activities) (M = 3.83, SD = 0.77), and to integrate such resources into teaching and learning (problem solving, critical thinking, assessments, data analysis, electronic portfolios) (M = 3.07, SD = 0.86). The top most used technologies were word processing software (M = 4. 41, SD = 0.84), Internet research (M = 3.68, SD = 0.98), presentation software (M = 3.65, SD = 1.03), and digital camera and scanners (M = 3.37, SD = 1.02). With less than 3% were drawing software, spreadsheet software, computer-based digital technology, email, database software, concept mapping, student web pages, and course management software. Lowther et al. (2008) reported that computers were mostly used (scale 0 – 4; 0 = not observed, 4 = extensively observed) for instructional delivery in the treatment group (M = 1.91, SD = 1.37) as well as a learning tool or resource (M = 1.55, SD = 1.05) and for cooperative learning (M = 1.55, SD = 1.00). With mean values less than 1 was the use of technology for project-based learning and student independent inquiry/research.

Critique of Quantitative Studies

This methodological critique defines and reports concerns with the generalizability of the findings based on research limitations. Since the studies reviewed predominantly utilized cross-sectional survey methodology (11 out 13), the potential threats to their validity are directly related to sampling and questionnaire/item construction and administration, to include return rates and instrument reliability. The remaining three quasi-experimental studies will be analyzed separately.

Sampling limitations. Only three studies (Abner & Lahm, 2002; Flanagan et al., 2013; Lesar, 1998) of the entire body of quantitative literature identified included exclusive samples of special education teachers. Additional two studies (Derer et al., 1996; Lahm & Sizemore, 2002) had samples that combined special education teachers with consultant and related services personnel. Furthermore, of the five studies to work with special education teachers, only one (Flanagan et al., 2013) was completed in recent years while all the rest, having been published prior to 2002, are not likely to be still representative of the tech-user profiles in today's classrooms given the progress of the technological field. The remaining studies (10) used general education teachers and students, although based on their setting descriptions (large school districts, Title I schools, and urban schools), one might assume that special educators were included. However, due to the lack of specific subject information as well the type of technology they were observed or reporting using, sampling continues to be a limitation. Finally, some of the studies also used preservice teachers in combination with inservice teachers who are not likely to be fully acquainted to specific classroom and/or school barriers.

Questionnaire construction. The 13 studies that employed survey methodology included areas related to the use of technology by teachers. For the five studies that included special education professionals in their samples, the questions were focused on the use of AT rather than educational technology. Except for three (Barron et al., 2003; Derer et al., 1996; Gorder, 2008) who used exclusively close-ended questions, all other surveys combined close-ended (Likert-scale and rating scales) with open-ended items. According to Schober and Conrad (1997), when interviewers are free to clarify the meanings of questions and response choices through additional open-ended questions, the validity of reports increased substantially, therefore indicating the strength of the current literature. Additionally, although not all the survey instruments were made available in the published version of the studies, the results evidenced units of analysis appropriate to the hypothesis constructs. A few studies (Abbitt, 2011; Christensen, 2002; Gorder, 2008; Lowther et al., 2008) utilized previously designed and validated survey instruments while all rest administered self-designed tools (two of the studies having included previously used items in the literature), which were tested for construct accuracy before implementation.

Questionnaire administration and return rates. The surveys were mostly administered via mail (Abner & Lahm, 2002; Derer et al., 1996; Lesar, 1998; Franklin, 2007; Gorder, 2008). Only three studies used exclusively online administration (Ann & Reigeluth, 2011; Ertmer et al., 2006-2007; Jost & Mosley, 2011), two utilized both mail and web (Barron et al., 2003; Flanagan et al., 2013), and one (Lahm &Sizemore, 2002) surveyed their subjects via phone. Lei (2009) did not mention how the survey was administered.

The return rates varied from 30.7% (Flanagan et al., 2013) to 100% (Lahm & Sizemore, 2002). The two other studies to have reported the highest return rates were Franklin (2007) with 89% and Lei (2009) with 78.5%. Excluding Lahm and Seizemore (2002) whose sample was small (*n* = 16) and interviewed by phone after prior contacts to obtain participation agreement (thus, ensuring 100% return rate), the average return rate for the survey studies was 49.9%.

Ethical issues and design threats. In his “Small-Scale Social Survey Methods”, Gillham (2008) contends that survey tools are most valid in terms of accuracy and meaningfulness when gathering “relatively straightforward information (personal details, behavior, simple judgments, and preferences of a non-abstract character)” (p. 4). However, one of the ethical issues surrounding survey methodology focuses on the nature of the participant responses, which constitute self-reports. In the field of education, interviewing teachers about their teaching practices with technology can be an accurate measure of their perceptions but not the actual classroom reality. Self-report responses are a product of experiential, psychological, sociological, linguistic, and, ultimately, contextual variables, which may have little to do with the construct of interest (Harrison, McLaughlin, & Coalter, 1996; Lanyon & Goodstein, 1997). But, some constructs are by definition perceptual in nature and, therefore, are appropriately measured by self-report as is the case for values, attitudes and affective responses (Schmitt, 1994; Spector, 1994). In fact, Howard (1994) contends that self-report is generally a suitable methodology for the study of human characteristics, and may even be superior to other approaches.

A secondary ethical issues in investigating factors that affect teachers in their classroom work involving the integration of technology could be that, under the pressure of observations, they will likely alter their instruction to achieve a level of performance perceived by them as observation worthy. Additionally, in the context of observing teachers against the implementation of their students' IEPs, teachers may believe to be limited in their creative ways by the actual binding document and its specifications.

Evaluation of quasi-experimental studies. Abbitt (2011), Christensen (2002), and Lowther et al. (2008) employed research designs during which the participants were exposed to treatments or performed in modified instructional environments for comparison purposes. In Christensen (2002), teachers in the treatment group received training on the integration of computers into classroom learning activities. Lowther et al. (2008) tested the effectiveness of a program of technology integration once the barriers to implementation had been removed while Abbitt (2011) pre- and posttested his participants on the relationship between their self-efficacy beliefs toward technology integration and perceived knowledge in domains of TPACK (participants were preservice teachers who attended a semester-long one-credit course on technology integration in teaching). Although Christensen (2002) utilized multiple assessments to establish whether the teacher training resulted in significant differences between treatment and control group, the study does not provide demographical data for its participants except to mention the type of school program (suburban, public). This is a major limitation as the sample characteristics could have potentially influenced the results. Similarly, Abbitt (2011) only provided limited information on his participants (age and gender). Finally, Lowther et al. (2008) claimed he matched their treatment and control group based on criteria of locale, grade levels, number of students, and student achievement but no further information is available. Since the researchers used student achievement as a dependent variable, a threat to the study's external validity presents itself as achievement was only assessed for 5^{th} and 8^{th} grade although treatment and control had been matched for different content areas in each cluster of grades (elementary = reading and math, middle school = algebra, and high school = biology). Self-report concerns on teacher attitude and perceptions regarding integration of technology also apply to all three mentioned studies.

Summary of Quantitative Literature

The quantitative literature spans across 17 years during which the world of educational and assistive technologies has changed. Additionally, the expectations and requirements of both general and special education teachers have been frequently revisited and revised in the past decade. And, although, the findings revealed important aspects of the dynamics between teachers and technology during instruction, little can be used to inform the education of students with high incidence disabilities who receive services in the general education classrooms. To notice a persistent focus on the use of technology in the general education settings could have been an indication that this was in preparation for the inclusion of students with high incidence disabilities. But, most often, these were not mentioned by the studies. Moreover, the few studies that included investigations among teachers using assistive technologies were either outdated or focused on low incidence disabilities.

Review of Qualitative Studies

Five qualitative studies met the criteria for review and are included below. A separate review and critique of these studies is conducted by following specific criteria listed below. Building on previous evaluation criteria of qualitative research published by Cohen and Crabtree (2008), Northcote (2012), and Tracy (2010) and formulated five key markers for assessing quality in qualitative research: 1) contribution in advancing wider knowledge about topic, 2) rigor (methods used to gather, analyze, interpret and present the data), 3) defensibility (the provision of a research strategy that can address the evaluative questions posed), and 4) credibility (the findings must be supported by evidence). These guidelines will be used to evaluate the qualitative studies included in this literature review.

Rigor and defensibility. Of all the studies, four used case study methodology while Hughes, 2005 followed a multiple-case exploratory study design. All studies collected data through interviews and observations. Huttinger et al. (1996) observed their sample in school placements as well as at home. The observations occurred twice per month (for 20 months) in the school settings during instructional times with and without technology while summer vacation and school holidays were used for in-home observations at times that were deemed convenient to the families. The time of the observations ranged from seven minutes to one hour and averaged at 30 minutes. Overall, the total observation time per subject was eight to sixteen hours. During observations, the researchers maintained field notes on the behaviors of children such as vocalizations, social interactions, level of independent, prompting, reinforcement, and child affect during classroom work both in the presence and absence of technology. The interviews involved both family members and staff working with the children and they occurred in three formal sessions of which the first session was scheduled prior to any child observation. The question items used during interviewed focused specifically on the children's use of AT and the interviewees' perceptions of the benefits as well as effects of this use.

Todis (1996) conducted a study to examine the AT user perspectives and benefits. The researcher was able to also identify teacher barriers (first order) while assisting AT users with the implementation of technologies, and difficulty with servicing and repairing the devices as well as the need for too much assistance from another person when. Todis (1996) also discussed the AT decision-making process which often does not involve the user which, subsequently, may lead to lack of involvement on the user's side and, further, dismissal of the device.

In Ertmer et al. (1999), the researchers conducted one-hour observations in seven K-2 classrooms or the school's technology labs during a period of six weeks. These were followed by semi-structured interviews with the seven teachers of those classrooms. In the beginning of the study, all participants responded to a survey collecting data on years of teaching experience, computer experience, comfort with software applications, goals for classroom technology use, and a personal definition of technology integration.

Hughes (2005) conducted observations and life-history interviews (adapted from Kelchtermans & Vandenberghe, 1994) that addressed questions related to education, career history, technology experience and use in the classroom, technology learning, curriculum, and instructional approaches to teaching English. The results of the study indicated that "the power to develop innovative technology-supported pedagogy lies in the teacher's interpretation of the technology's value for instruction and learning in the classroom" (p. 297).

In Ertmer et al. (2012), the first-order barriers were not found to be particularly impactful on integrating technology in the classroom. However, among the highest rank barriers (1-5 scale with 1 being not a barrier and 5 being very much a barrier) many were external and institutional barriers such as technology support (*M* = 3.0, *SD* not provided), state standards (*M* = 2.83, *SD* not provided), money (*M* = 2.83, *SD* not provided), technology access (*M* = 2.67, *SD* not provided), time (*M* = 2.58, *SD* not provided), assessments (*M* = 2.50, *SD* not provided), and others (*M* < 2.50, *SD* not provided).

Samples. Huttinger et al. (1996) resorted to using a purposive sample of 14 children with multiple disabilities who had AT experience from early childhood years and focused on studying any changes in their behaviors, skills, or attitudes throughout years as the children continued to use AT in school or at home. At the beginning of the observations, the sample was divided in two groups to include children ranging in age from 2.8 to 13.2 years old. Of these, some of the children (3) were infants or toddlers when they had first been introduced to AT while the rest were in their preschool through kindergarten years. The study lasted approximately two years and, so, most of the sample attended elementary or middle school year upon the conclusion of the study. Todis (1996) had a sample of 13 students with disabilities whom they observed weekly over a one-year period and, also, interviewed their family members and peers as well as the professionals who worked with them regarding the integration of technology in their lives.

Ertmer et al. (1999)'s sample was drawn from an elementary school (no school district provided), located in an urban area, where 281 students attended, including 31 with special needs. The socio-economic profile of students indicated a mixture of lower and middle class. No race information was provided. All seven teachers who participated in the study were females and averaged 12 years of teaching experience. Except for one (with limited tech training), all teachers had had informal technology training (workshops and inservices) but, overall, all they all reported to be moderate to very comfortable with word processing and instructional software. In Ertmer et al. (2012), the researchers sampled 12 teachers (7 females and 5 males) across K-12 (6 elementary grades, 5 middle school, and 1 high school) who had been recipients of ISTE honors for their teaching practices with technology. All but one teacher held Master's degrees in curriculum and instructional technology, teaching and learning, and science education. The one teacher without a graduate degree was working towards her Master's in elementary education.

Hughes (2005)'s four subjects were English Language Arts upper school teachers, grades 5th through 9th, who ranged in teaching (3-26 years) and technology learning experience. The sample was recruited via listserv advertisement.

Data collection and analysis. Hutinger et al. (1996) conducted data analysis on situational observations, interviews, videotapes, questionnaires, school records, child products, and other relevant materials through coding systems. Similarly, Ertmer et al. (1999) and Todis (1996) used a constant analysis techniques (Glaser & Strauss, 1967) which supposes searching for patterns and themes in the data. The data included field notes from observations of teaching integrating technology in the classroom and interview transcriptions with focus on teachers' beliefs related to the role of technology in the classroom. The teacher profiles were, then, compared against the first- and second-order barriers framework as the final analysis step. Ertmer et al. (2012) collected data for their study of the relationship between teacher beliefs and their technology integration practices from the participant teachers' websites and individual semi-structured interviews with the teachers. The data was analyzed using Strauss and Corbin's (1998) constant comparison method, which requires a deductive analysis and search for specific evidence in support of the variables. Ertmer et al. (2012) also ran descriptive statistics on teachers' ratings of barriers to implementation of technology in

Technology resources. The technology resources most often observed included older generations computers and instructional software (Ertmer et al., 1999; Hutinger et al., 1996; Todis, 1996). Ertmer et al. (1999) witnessed the use of instructional computer games and informational CD-ROM or laserdiscs such as encyclopedias or subject-specific databases but also office processors (AppleWorks software). Todis (1996) observed the used to speech synthesizers as well as low-tech peripheral devices such as tablets, wireless keyboards, scanners, cameras, touchscreens, switches and so on. For Huttinger et al. (1996), the teachers also reported using computers and peripheral devices as well as switch toys and some dedicated-speech devices (specifics not available). In turn, Hughes (2005)'s sample used a wide variety of technology (word processing, hypertext technologies, presentation software, chat and database software, and spreadshseets). The teacher participants in Ertmer et al. (2012)'s study also used a myriad of technological resources with their students including smart boards, laptops, projectors, iPads, digital cameras, netbooks, as well as personal equipment such as iPhones and iPods.

Contribution to the field. Huttinger et al. (1996) investigated the state of practice of using of AT applications in educational programs for children with multiple disabilities. Huttinger et al. (1996) was the first qualitative study focusing on the use of AT to use a modified longitudinal approach and case study. The researchers set four target goals with their research inquiry which focused on describing how AT is used in educational and related settings as well as the effects of AT use, analyzing the benefits, challenges and barriers related to AT use, and determining the implications for AT use in the education of children. Later the same year, Todis (1996) replicated the case study design to describe the results of a two-year qualitative study during which she observed 13 students who had been using AT. Perhaps, one of the strongest contributions to the field of the four studies is Ertmer et al. (1999) who examined the relationship between the level of use of technology in elementary classrooms and the specific barriers encountered by teachers when integrating technology in their teaching. Ertmer et al. (1999) used Brickner's (1995) concept of first-order and second-order change to address the barriers to change faced by teachers in their current practices. The barriers to change reflect "the extrinsic and intrinsic factors that affect a teacher's innovation implementation efforts" (Brickner, 1995, p. xvii, cited in Ertmer et al., 1999). Subsequently, the first-order barriers are related to the teachers' current practices and institutional factors such as insufficient time to plan technology-infused instruction, inadequate technical resources and support, and/or lack of access to computers and software. The second-order barriers emphasize the teachers' beliefs and attitudes about the use of technology in the classroom, which might be rooted in their pedagogical philosophy. In a similar design, Ertmer et al. (2012) worked with award-winning teachers for their technology practices to observe how the pedagogical beliefs and classroom tech practices align and identify enabling factors to the use of technology. Hughes (2005)'s contribution to the body of literature is very unique in that the researcher provided a framework to understand the role of teacher knowledge and learning experiences in forming technology-integrated pedagogy.

Results and credibility. All six students portrayed in Hutinger et al.'s (1996) case study reported improvement in at least one functional living or academic area during or following the use of assistive technology. Hutinger at al. (1996) wrote that,

> "The major themes that emerged when synthesizing the information from individual case studies related to the nature of the children's educational placement and transitions, the purpose and patterns of technology use, and the means by which technology was acquired." (p. 26)

According to the results, the parents of the students reported more often improvement than the academic staff working with the students with the greatest and most uniform (between staff and parents) area of improvement being the social-emotional functioning to include enhanced self-concept, independence, social interaction, cooperation, and exploratory play. At the opposite end, the lowest ranked areas of improvement by both staff and parents were cognition, communication, and motor development. Regarding barriers to using AT, teachers identified financial resources, training and implementation outcomes, equipment concerns, problems with software, and lack of collaboration as the most challenging roadblocks to integration. Additional barriers further identified by both staff and parents included: lack of comprehensive technology plans for each child (either developed of forwarded as children transitioned through programs), lack of ongoing technology reassessments, different levels of competencies among staff in other programs, equipment availability (again, from program and program) and maintenance as well as discrepancies between families and staff regarding expectations and objectives for the technology. Ertmer et al. (1999) also concluded that most of the barriers encountered by their sample were first-order barriers identified such as lack of equipment, lack of time to integrate technology, and classroom management and practices. These first-order barriers were claimed by the teachers who were all award-winning educators for their technology abilities, as consistent roadblocks to successful integration of technology in their teaching. In fact, only one of the seven teachers attempted to use technology to facilitate emerging curriculum (Ertmer et al. (1999) established gradually increasing levels of use of technology as follows: supplementing existing curriculum, supporting existing curriculum, and facilitate emerging curriculum) while others reported various levels of tech implementation, which mostly supported and enriched the existing curriculum. Finally, four teachers focused on using technology as a supplement to their lessons and consistently expressed their concern about the relevance of technology (a second-order barrier).

In Ertmer et al. (2012), the most impactful barriers to using technology in the classroom were, in fact, claimed by the respondents to be the attitudes and beliefs of other teachers/peers ($M = 3.17$, *SD* not provided) while own attitudes and beliefs were rated the lowest ($M = 1.00$, *SD* not provided) along with own knowledge and skills in technology ($M = 1.42$, *SD* not provided). Nine out of 12 teachers specifically identified such internal barriers as the "biggest barriers overall" (p. 429) in technology integration in their programs. These further clarified their beliefs by exemplifying that they have colleagues who are not implementing technology because they either might be intimidated by it, not have the necessary knowledge and skills, or just see it as "one more thing to do" (p. 429).

Limitations. Except for Ertmer et al. (2012) and Hughes (2005), the qualitative literature on factors influencing the integration of technology in the classroom is outdated. The three earlier studies, although valuable in furthering the knowledge of the field and identifying gaps, at the time, in research, present outcomes that are not entirely applicable to the technology and (special) education world as both fields have evolved considerably in the last decade. Additionally, the teacher case-study approach is limited in its external validity and, therefore, power of generalizability as pre-service educators in schools today face renewed requirements for certification and standards for performance.

Summary of the Literature

Overall, all 21 studies reported evidence to support the presence of factors that influence teachers' abilities to integrate technology in the classroom. Most studies focused on identifying the barriers (Abner & Lahm, 2002; An & Reigeluth, 2011-12; Derer et al., 1996; Flanagan et al., 2013; Lahm & Sizemore, 2002; Lesar, 1998) rather than the positive influences on teachers' use of technology (Flanagan et al., 2013). Additionally, the literature has only sometimes included secondary data on how (and why) the technology is being used (Flanagan et al., 2013; Lahm & Sizemore, 2002; Lesar, 1998). Notwithstanding, the research, which spans from 1996 to 2013, focused primarily on technology integration in general education and, even when the use of AT was investigated, the studies analyzed rather the use of low (and older generation) AT for sensory disabilities. But students with high-incidence disabilities, such as learning disabilities, are often users of new technologies that are viewed as cognitive prostheses intended to augment their cognitive abilities and improve learning. However, despite this, high AT such as screen readers, speech-to-text, and word prediction software that have been found to be effective tools to support literacy instruction are frequently reported as "*never* being used" (Flanagan et al., 2013, p. 29). Also, most of the researchers continued to report that teachers' perceptions were still focused on lack of access to technology versus other influencing factors.

With regard to samples, although five out of 21 studies included special educators and/or students with disabilities among the study participants, none of the research questions attempted to make the connection between the reported (or observed) use of AT and the documented use of technology as stated in IEPs. Finally, three studies (Abner & Lahm, 2002; Lesar, 1998; Todis, 1996) have focused on the use of AT for low incidence disabilities which included specific AT (low tech) and only one study (Lahm & Sizemore, 2002) investigated whether teachers are more or less likely to consider the use of AT (including mid and high) under different instructional circumstances.

Barriers to Integration of Technology

First-order barriers to technology integration are “extrinsic” to teachers and are the result of lack of access to equipment and technology resources, insufficient time to plan and/or inadequate technical and administrative support while second-order barriers refer to attitudes and beliefs toward the use of computers in teaching, classroom practices, and willingness (or lack of) to change these beliefs (Ertmer, 1999). Of the entire literature selected for review, the majority of the studies found that technology integration in schools is impacted by lack of (or insufficient) training, financial-related factors (monetary expenses and funds availability), and difficulty handling or knowing how to use certain devices. Other factors such as class size, policy, space, staffing needs, software appropriateness, malfunctioning and/or inappropriate and ill-designed equipment, portability and obtainability of the equipment have been included. These findings go as far back as the earlier studies (Derer et al., 1996, Lesar, 1998).

Among the studies that reported second-order barriers are Derer et al. (1996) who identified a cluster of interpersonal issues related to the integration of technology in classrooms such as the respondents’ concerns about technology consultants (3.3%), negative peer reactions (3%), stigma (3.3%), and unity of service delivery (7.3%) as well as teacher resistance to using technology (3.3%). However, all categories had significantly small percentages attached to them. Hutinger et al. (1996) had also found that lack of collaboration amongst the school and parents, with specific emphasis on mismatch between teacher's beliefs and philosophy regarding the use of technology and those of parents, acted as a second-order barrier. In Ertmer et al. (1999), all teacher participants shared concerns about the actual relevance of technology in teaching. Also, two teachers were invested more in using technology to support the current curriculum and only one reached out to higher levels of use of technology by including it in instructional planning and allowing students to create projects as opposed to be presentation witnesses. In fact, this subject did not appear to experience any second-order barriers. The "digital native" teacher candidates in Lei (2009) provided strong positive responses in the direction of the use of technology in teaching but, when surveyed, most of them (79.3%) reported making use of technology primarily for personal use (social networking, online chatting and emails). Abbitt (2011) and An & Reigeluth (2011-12) reached similar conclusions in that teacher attitudes toward integrating technology in technology-enhanced their performance and did not, in fact, act as barriers. Perhaps two of the most unique studies in this literature review are Jost and Mosley (2011), whose focus on AT literacy stepped outside of the boundaries of barriers in a way that it tried to identify specific predictors related to how such teacher factors may impact the use of technology, and Ertmer et al. (2006-2007) whose results were predominant in indicating second-order barriers had the largest influence on teachers.

Conclusion

This body of literature, although small given the timespan of the review, has provided sufficient evidence to indicate there are many factors of nature to impact the use of technology in the classroom. Whether being faced with first- and second-order barriers or, in the contrary, experiencing the positive effects of an instructional environment where technology is valued, teachers must be aware of such potential influences on their practice. The literature on effectiveness of using technology in the learning process is abundant but consistent research on specific determinants that can hinder or encourage embedding technology in the curriculum is missing. The attention dedicated by researchers to how technology can be implemented and what might affect its successful use in the classroom as well as the results of their studies stand as proof that this research continues to need exploration. Especially in the context of the debate surrounding the similarities and differences between educational technology and assistive technology, understanding the parameters of using both of these categories in educating students is essential. While technology in the general education classroom may appear to be dominated by first-order barriers rather, when it comes to serving students with disabilities, teachers were still reporting lack of knowledge and training to incorporate AT as well as lack of resources. And, so, the gap in research identified by the current literature review points toward further exploring the facets of use of technological supports for students with disabilities as well as the importance to address whether teacher self-reports of tech use correlates with their classroom practice. Finally, pinpointing specific predictors for special education who work under the pressure of an IEP must, also, be addressed.

Chapter 3: Methodology

The literature examining the use of technological resources by special education teachers indicates that most of the challenges to implementing technology have been lack of technology and insufficient training. This study was able to examine teacher use of AT within a school that provided both a wide variety of AT as well as professional development and support for its use. Therefore, I was able to gather data from both teacher reports as well as independent observations regarding the types of AT used in instructing students with learning disabilities as well as the frequency of AT use, and the purpose of use (based on the SAMR levels). In addition, I collected data from teachers on their perceived barriers to AT integration.

In this chapter, I present the methodology I used to address the research questions that guided my investigation. The methodological components are as follows: (a) design, (b) participants and setting, (c) procedures and instrumentation, and (e) data analyses. These sections will describe the methods and procedures I used to address the following research questions:

(1) Given the school's technology instructional inventory, which AT do middle and secondary content area teachers report using, for what purpose, and how frequently?

(2) Are there observed and reported differences in type of device and level of use between English Language Arts teachers who teach reading and other content area teachers who do not provide direct reading instruction?

(3) Which first and second-order barriers do teachers report as influencing their decisions to use or not use AT?

(4) How do the observed and reported AT use with students with SLD align with the types of AT and their use documented in the students' IEPs?

Design Models

The research study combined two models as foundation for building the research questions and analyses of data. First, I used Brickner's (1995) framework, which categorizes the barriers experienced by teachers when implementing new resources such as technologies. Secondly, I used the SAMR taxonomy of technology implementation developed by Puentedura (2006), which outlines four different levels of technology use for instruction.

First- and second-order barriers. Brickner (1995) categorized the factors influencing teachers in their use of technology for instructional purposes into first-order barriers and second-order barriers. The researcher conceptualized the barriers in terms of factors outside of and within a teacher's control (see Chapters 1 and 2), which I used to build the questions for my survey and teacher interviews.

The SAMR model. Puentedura's (2006) model defines four levels of technology use, which can be used to evaluate how technologies are being used in the classroom. The four levels, *Substitution*, *Augmentation*, *Modification*, and *Redefinition (SAMR)* informed my items included in the web-based teacher survey and subsequent interviews as well as the data collection tools for classroom observations.

Research Design

The proposed research project was an exploratory study focused on deepening the understanding of how teachers used AT for students with SLD in a middle and secondary setting that is well equipped with AT devices, and what factors influenced teachers' use (or non-use) of certain devices. I found the exploratory design to be most appropriate for this proposed research inquiry as Stebbins (2001), citing Glaser and Strauss (1967), stated that, "exploration produces hypotheses, tentative generalizations about the group, process, activity, or situation being studied" (p. 25). As noted also by Stebbins, "in effect, exploratory studies aim both to test some of the generalizations that have come down from earlier explorations and to extend the scope of the ever-emerging grounded theory" (p. 25). As noted, this study was built on Brickner's barriers-to-change model (1995) and Puentedura's (2006) model defining level of technology use. Thus, I attempted to test some of the findings from prior research through more in-depth investigation of teachers' practices and perceptions concerning AT.

The methods, which are described in detail below, included both quantitative and qualitative approaches. I collected and analyzed data that allowed me to describe teachers' use of AT in instruction including type of AT, frequency and level (SAMR) of use. I also examined how teachers' reported use of AT devices aligned to the AT devices listed in students' IEPs under technological accommodations. The data collection sources included a survey questionnaire that was administered to all the teachers in the school, classroom observations followed by individual interviews with a subset (seven) of those teachers, and a review of the accommodations sections of the IEPs of all students in the program. The collection of various sources of data was supported by the rationale that, in order to establish exploration validity (Stebbins, 2001), multiple sources of data should be used for complementarity.

When used in combination, quantitative and qualitative methods complement each other and allow for a more complete analysis (Green, Caracelli, & Graham, 1989; Tashakkori & Teddlie, 1998). In the following sections, I first describe the setting and participants followed by two separate sub-sections outlining the procedures and instruments, and data analyses considerations.

Study Site and Participants

This research study was conducted between December 15th, 2014 and January 20th, 2015 in a private special education school in a mid-Atlantic state designed for middle and high school students (grades 5-12) with primarily language-based learning disabilities, which manifest themselves in low reading ability. As of the beginning of school in September 2014, the school reported an enrollment of 60 students and employed 21 content area middle and secondary teachers (including remedial reading teachers), six administrators, and other support staff (administrative assistant, nurse, human resources and finances staff, and related services personnel).

The school has been enrolling students with SLD since the early 1970s and started out by serving students with a diagnosis of SLD, specifically in reading. According to the program's instructional model, upon enrollment, each student is assigned to a daily 45 minute instructional period in reading which is dictated by one of each student's three levels of need: phonics, fluency, and reading comprehension. The model relies on student needs-based profiling and planning as well as continuous monitoring of effectiveness of various programs and student progress using student performance data. The daily tutorials use small groups with a maximum of three students and are led by a reading teacher. Other content area courses have a maximum of eight students and these teachers typically have dual certification in a content area and special education.

The middle and secondary curriculum includes instruction in Reading, English Language Arts, Mathematics (Basic Math, Pre-Algebra, Algebra, Calculus, Probability and

Statistics, and Geometry), Science (Biology, Chemistry, Physics), Social Studies (US and DC History, World History and Geography), Art/Graphic Arts, Music, Careers/Transition, Foreign Language (Spanish), Technology and Media, Health, and PE. The students receive instruction throughout eight 45-min periods each day including one period for lunch and recess. Perhaps the most unique aspect of the school is the philosophical approach, which embeds literacy skills throughout the curriculum and fosters the use of specialized and advanced technological literacy among students. The teachers and students have access to a variety of educational and assistive technology ranging from low-tech supports (such as highlighters, calculators) to medium and high-tech such as screen readers, word prediction software, and other more complex technology. Also, the school utilizes PowerSchool which is a web-based portal for teachers to enter classroom-specific data (including grading) and maintain communication between the school and parents and students, Moodle as an online learning platform designed to provide the teachers, administrators and students with a single, integrated system to create personalized learning environments, and OnCourse a web-based lesson planner.

Student profiles. The students admitted to the school must be formally eligible for special education services under the category Specific Learning Disability or other disabilities involving reading disorders (Other Health Impairments, Attention Deficit Hyperactivity Disorder, and Autism Spectrum Disorders). Most of the students in the school program demonstrate difficulty with reading and spelling, comprehending lengthy passages, writing with grammatical accuracy, and translating their ideas into a coherent written form. Additional difficulties include computing math problems, learning and retaining math facts, and applying math facts and concepts in problem solving. Students may also demonstrate problems that impede their ability to take notes from a lecture, copy notes from the board, sustain attention and focus, and apply organizational skills. At the time of the study, the school had enrolled 15 students in the middle school division (ages 10-13) and 45 students in the high school division (ages 14-18). The majority (91%) of the students are referred to the program by the local public school systems while 9% students attend the school on private funding.

Teacher participants. For this research study, I invited all 21 teachers in the school to participate in the survey. Of these, 19 consented to complete the web-based survey (but only 17 completed surveys that could be used for analysis) and seven volunteered to participate in the classroom observations and follow-up interviews. At the time of their consent in fall of 2014, all these teachers taught one or more content area classes and held either special education and/or content area certification.

Procedures

The following section includes a discussion of the methods and instruments I used throughout the various phases of the research study. A review chart indicating the relation between the data collection venues and the research questions is included below in Table 1. I did not seek to establish statistical significance for any of the research questions in this research study due to the large variance among the small sample of teachers and the lack of control for other variables of AT use such as student-specific factors.

Table 1

Research Questions, Methods and Data Sources

Research Question	Research Methods	Question/Item #
RQ1. Given the school's technology instructional inventory, which AT do middle and secondary content area teachers report using, for what purpose, and how frequently?	Survey (SQ) Teacher Interviews (TI)	SQ#12, 13, 15 – 19 TIQ#2, 4, 5, 9, 10
RQ2. Are there *observed* and *reported* differences in type of device and level of use between English Language Arts teachers who teach reading and other content area teachers who do not provide direct reading instruction?	Survey (SQ) Teacher Interviews (TI) Classroom Observations	SQ#12, 13, 15 – 19 TIQ#7
RQ3. Which first and second-order barriers do teachers report as influencing their decisions to use or not use AT?	Survey (SQ) Teacher Interviews (TI)	SQ23, 25 TIQ#6-9, 11-19
RQ4. How do the *observed* and *reported* AT use with students with SLD align with the types of AT and their use documented in the students' IEPs?	Survey (SQ) Teacher Interviews (TI) Classroom Observations IEP Review	SQ15-19 TIQ#3

Recruitment. To recruit teachers into the study, I met with the teachers and the school administrators and presented an overview of the research study along with the participation options (survey only, classroom observations and teacher interviews only, or both/none). I also provided information regarding the incentives for being a participant in this research study. All the participants in the web-based survey received a $5 Amazon.com gift card and a list of four- and five-star ranked educational apps, which were sent to the email addresses that were used to distribute the survey. With regard to the participants in the observation-interview phase of the study, their names were entered into a drawing for one Kindle tablet along with a list of four- and five-star ranked educational apps compatible to the tablet's operating system. Based on the preliminary meeting with the school, if a teacher requested to be entirely excluded from the research study, I did not administer the survey to that individual.

AT categories. The list of AT devices and software that was used in the study came from the school's technology inventory. This included any AT that might have been specified in a student's IEP as well as an array of other technologies that could be embedded in instruction for all students across all content areas. The inventory of AT that was available at the time of the study is in Appendix E. Using the guidelines provided by the Center for Performance and Technology in Florida (2009), I categorized the inventory into low, medium and high tech. This meant that any technology item that was non-computer-based and not battery-operated was included in the low AT category; for the medium AT category, I included technology that did not require complex implementation and assisted with basic academic tasks; finally, the category of high AT listed any technology item or program that fit the model's classification criteria of complex use, expensive (including higher maintenance cost) and greater capabilities. In the list of AT provided for teachers during the survey, I have included items from the school inventory (which included the instructional technology embedded across content areas for all students regardless of IEP provisions such as Powerschool, an online grade keeping system, Moodle, an online interactive learning platform, Kurzweil (text-to-speech software), Dragon Naturally Speaking (speech-to-text software), and BrightLink smartboard systems) as well as AT specified in the student IEPs.

SAMR levels. Purpose of AT use was defined in terms of Puentedura's levels of technology integration (Puentedura, 2006). In order to provide a framework for both the survey as well as observations, I needed to provide observable teacher behaviors that corresponded to each of the levels. To do so, I have used the corresponding intellectual behaviors connected by Puentedura's SAMR to Bloom's taxonomy (Figure 3).

Barriers to use. The list of barriers included in the teacher survey reflected the findings of the pertinent literature reviewed in Chapter 2 and were organized according to Brickner's (1995) first- and second-order barriers framework. Thus, I defined barriers as follows: 1) first-order barriers such as limited or no access to desired AT, limited or no access to AT training, classroom and planning time constraints, student refusal of AT, IEP compliance, teacher evaluation requirements, and 2) second-order barriers such as beliefs regarding benefits of AT use and teaching practices.

Teacher survey. The purpose of the survey was to collect data on the type and frequency of AT used, the SAMR level of AT use, and the factors influencing the teachers' use of AT. The survey was built and administered through *Qualtrics Research Suite* and *Survey Mailer (*Qualtrics, Provo, UT). The final version of the survey is included in Appendix A.

For the purpose of identifying content area differences, the survey required the teachers to select up to two subject areas they teach (English Language Arts, Math, Social Studies, Science, and Other). Based on their choices, the survey automatically provided lists of ATs individualized per content areas (I used the school's technology inventory to divide the available AT per each content area listed above). Subsequently, teachers were asked to identify which AT they used (type), how frequently they used it and for which purpose

(SAMR). They were also asked to identify barriers to the overall use of AT as well as other factors influencing the integration of AT in their lessons. Each teacher was asked to only respond for their specific content areas (skip and display logic functions were used to facilitate this; for example, if the teachers selected their content area to be ELA, then the survey automatically displayed the list of AT available for ELA only). This procedure was employed in order to avoid display of AT that was not particular to each content areas such as specific reading instruction software, specialized manipulatives like talking calculators, timeline software so on, and to only present teachers with a realistic list of technologies.

The survey also included items on teacher demographics (age, number of years of teaching, teaching area and certification, experience in various types of special education settings, types of disability previously taught, and the level of training on using AT) which were used to describe the sample but, also, to establish how the profiles of the seven teachers who participated in the classroom observations and interviews mirrored the overall profile of the teaching staff.

Throughout the survey, the teachers were asked to rank items rather than rate items in order to guarantee that each category received a unique value whose sum equaled a constant; additionally, ranking required teachers to differentiate between items that may have been viewed as equivalent (Alwin & Krosnick, 1985). Alwin and Krosnick mentioned that, although ranking may be more “difficult and taxing for survey respondents” (p. 536) due to demanding additional concentration and time to measure the item values, rating can reduce the quality of the data precisely due to participants expediting their responses and show less “willingness to make more precise distinctions about the relative importance of the valued qualities” (p. 537).

Prior to sending the survey, all 21 teachers had agreed to be included in the survey dissemination but, of these, only 19 actually attempted the surveys; one teacher ended up declining the consent due to her busy schedule and another one never accessed the survey link despite repeated reminders. In the end, upon closing the survey, only 17 surveys were fully completed and usable (one of the teachers partially completed the survey twice, therefore her responses were invalidated). The survey invitations were emailed to the teachers' school email addressed and included a link to the web-based survey as well as details regarding the purpose of the study, the areas of interest across the survey items, the estimated length of the survey, and the intended use of results. Additionally, the opening page of the survey contained the Informed Consent Form. The survey was launched in December 2014, during the week before winter break, and remained open until the third week in January 2015. This provided opportunity for teachers to complete the survey prior to or after the holiday break. Electronic reminders were emailed in the beginning of each week that the survey was open. These emails provided a refresher on the purpose of the study and the importance of teacher participation as well as a reminder of the closing date and the active link to the survey. An offer to have the survey made available to the participant as a hard copy was also made each time a reminder was emailed.

Classroom observations. Concomitant with the administration of the online survey, I conducted classroom observations of the seven teachers who had volunteered to participate in the classroom observations while they were engaged in instruction and to be interviewed. The purpose of these observations was to document and record the types of AT devices these teachers requested or allowed to students to use and for what purpose. I conducted two full-day observations of each of the selected seven teachers, which resulted in a total of 14 observations (which, in turn, equated to 84 observed instructional periods as each teacher's daily schedule included six instructional periods of 45 minutes each; the lunch and planning periods were not included). After I completed all of the classroom observations, I conducted a semi-structured interview with each of the seven teachers to allow them to further elaborate on aspects of their AT implementation during instruction.

Observation protocols. Each teacher was observed across two consecutive full-days of instruction, which were predetermined to be typical instructional days (a full day without any specific events that would require modifications to the schedule or instruction). There was prior agreement with the teachers on selecting the days. For two teachers, the observations were not consecutive days due to school closing caused by inclement weather.

The observation protocol was based on the levels of AT use according to the SAMR model (see Appendix C for the protocol). During the observations, I recorded the *frequency*, *type* and *level* of AT use during English Language Arts, Math, Social Studies, Science, and Other. The sampling intervals were the 45-minute class periods, which resulted in recording the same type of data for each of the six daily instructional periods. The observation protocols also allowed me to capture additional environment context through field notes.

Teacher interviews. Following the classroom observations, I conducted semi-structured interviews with each of the observed teachers to gain further insight into their AT practice. Five of the interviews were scheduled at the end of the two-day observation during the time intervals between student dismissal (3:30pm) and teacher dismissal hours (4:30pm). Two other interviews occurred during teacher planning periods as requested by the teachers. I used semi-structured interviews, which allowed me, as a researcher "to enter into the other person's perspective" (Patton, 2002, p. 340-341). According to Merriam (2009), the use of open-ended and less structured interviews allow for flexibility to obtain specific data from the respondents. Finally, according to Schober and Conrad (1997), when interviewers were free to clarify the meanings of questions and response choices through additional open-ended questions, the validity of reports increased substantially. The teachers were provided with a set of 19 guiding questions to assist them in previewing the topics that were addressed during the interview (see Questions in Appendix B). However, the interviews included additional, spontaneous questions depending on teacher responses and as needed at the time of the interviews. Some of the interview items drew directly from the classroom observations and inquired specifically about the level of AT use observed and the determining factors in teacher decisions to use or not use certain AT during a particular observation. I also included questions related to the first- and second-order barriers (such as instructional models/teaching philosophy, organizational context, personal beliefs about technology, and openness to change). All interviews were audio recorded or transcribed with the use of ExpressScribe software.

Classroom setting. The seven classrooms selected for the observations shared both similarities and differences. Except for one of the ELA/Reading and the Careers/Transition classrooms, the rooms were all equipped with student and teacher desks, white board, and BrightLink projectors. The rooms were also large enough to accommodate up to a group of eight students (the maximum number of students per class). All seven classrooms had clusters of desks in the middle of the room for whole group instruction and 2-4 student computer stations (PCs) along one of the walls. Additionally, all rooms used organization systems for homework pick-up and drop-off, make-up work as well as small table bins for writing tools (including highlighters). One of the ELA/Reading room and Careers/Transition, as stated earlier, showed noted differences. They were very small in size and did not have BrightLink capabilities although they did have white boards. The number of student computer stations was also reduced to maximum three. All classrooms observed hosted a mix of both middle and high school students during observations; the groups size range between 3 and 8.

IEP reviews. I conducted a review of the IEPs of all 60 students enrolled in the school. I only reviewed those sections of the IEPs that specified the Instructional Accommodations and the Supplementary Aids that were to be provided to the student. The IEP section specifically addressing testing accommodations was not reviewed. The purpose of the IEP review was to provide hypothetical boundaries for the *expected* use of AT with the students in the program.

Pre-testing Procedures for the Instruments

In advance of the study, I piloted the teacher survey and the teacher interview questions with three non-participant education professionals (a special education secondary teacher and two school administrators) in order to identify potential lack of clarity of instrument items as well as receive feedback regarding level of user friendliness for items included, potential items that may lead to biased answers, and the estimated time length to complete the survey and the individual interview. This resulted in modifying the wording of two survey items (Q9 and Q10). The pilot reviewers also received the observation forms (see Appendix C for Classroom Observation Form and IEP Review Form) for further feedback on form comprehensiveness and accuracy. No changes were recommended for these forms.

Validity and Reliability

Data quality in research that uses both quantitative and qualitative methods is determined by the separate standards of quality for the individual research strands (quantitative and qualitative) (Teddlie & Tashakkori, 2009, p. 210). In quantitative research, validity and reliability of the data are ensured by building observable and recordable constructs (Teddlie & Tashakkori, 2009) while qualitative research focuses on strategies that facilitate the trustworthiness and understanding of the research findings (Gay et al., 2012).

Member checks. In order to optimize the descriptive and interpretive validity of the study, I offered to conduct member checks (Gay, Mills, & Airasian, 2012; Given, 2008) with all seven teachers whom I interviewed and observed. All seven teachers were able to review the classroom observation forms with data recorded (type and frequency of AT) at the time of the follow-up interviews. No concerns regarding the accuracy of the data were recorded. With regard to reviewing the interview data, they all declined the offer based on the fact that interviews were recorded to ensure accuracy of their statements. This research step was only used for the qualitative data before I started the analysis.

Exploration validity. Stebbins (2001) describes exploration validity as the process of using different methods to examine the same group or activity (known as triangulation) as well as finding recurrent evidence for each generalization. Subsequently, this study used classroom observation data and teacher interviews as well as IEP reviews with the purpose of establishing exploration validity. Triangulation of the data with other stakeholders in the research study was not conducted, as no other investigators were part of the research project.

Peer debriefing. Qualitative researchers use peer debriefing as a technique to enhance the trustworthiness and credibility of all research projects (Janesick, 2007; Spall, 1998; Spillett, 2003). During debriefing, a peer acted as an auditor by reviewing and assessing transcripts, emerging theories from those transcripts, and the final report (Janesick, 2007). For my research project, I enrolled the peer audit services of a former colleague who used to be a school administrator at the site where this research study was conducted and is currently completing a doctoral program out of state. The student-peer had professional background in the use of AT for instructional purposes and reviewed the coding categories from classroom observations and teacher interviews. There was 100% inter-coder agreement.

Audit trail. In order to develop a detailed audit trail, a researcher needs to maintain a log of all research activities and document all data collection and analysis procedures throughout the study (Creswell & Miller, 2000; Rice & Ezzy, 2000). Subsequently, I have maintained a folder with all the raw data collected (including the classroom observation and teacher interviews schedule), and the field notes.

Generalizability. "The goal of qualitative research is to understand *what is happening* and why" with less concern on the results generalizability (Gay et al., 2012, p. 395). However, despite a limited sample, in using multiple methods of data collection and analysis, I attempted to capture and report sufficient details to allow the readers "to see for themselves" (Gay et al., 2012, p. 395) the evidence that supported my research results. Finally, for any audience interested in transferring the results to their particular contexts, I provided a thorough description of the research context and the assumptions that were central to the research.

Confidentiality. Although the identities of those teachers who participated in the observations and interviews were known to me I did not reveal their names to the program's administrators. However, my presence in various classrooms might have indicated which teachers were being observed. Additionally, since the final analysis examined content area differences, the teachers received content area codes for their participation, but given the small size of the programs, it is possible for any other individual in the program to deduce who the observed teachers were. All these potential threats to confidentiality were shared at the time that participants were asked to consent to being observed and interviewed. None of the teachers observed expressed any concerns over them.

Data Analyses

I completed a two-stage data analysis process. First, I analyzed my data sources separately (survey, observations, interviews, IEPs review) as described in the following sections. Second, in order to integrate the separate findings and respond to the research questions, I merged the findings of the overall data according to the analytical plan as shown in Figure 4 below. During this second level of analysis, I used the data collected to determine how specific AT devices and the frequency of their use will correspond to the SAMR levels.

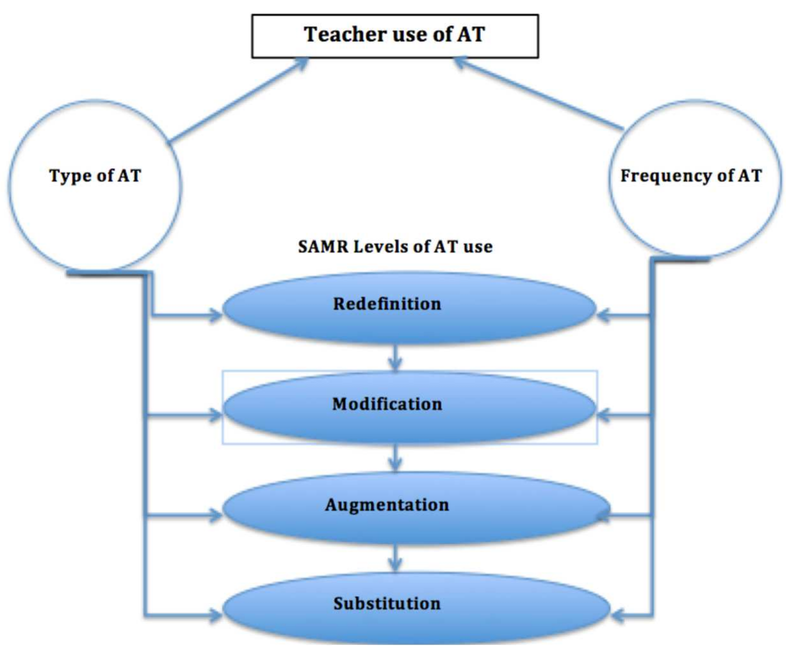


Figure 4. Analytical model

There were four major sources of data/information that were collected: online survey, teacher observations, teacher interviews, and IEP reviews. In the following sections I discuss how I analyzed each.

Survey. Data obtained from the online survey were presented in cross-tabulated formats and analyzed to directly inform all the research questions. I provided frequencies for all but three (Q14, Q32, Q34) survey items which were non-frequency items; for item Q14 (it required teachers to indicate an estimated percentage for using AT on each of the SAMR levels during the previous five instructional days), Q32 and Q34 (items required teachers to rank barriers to using AT and factors that influenced them positively to using AT), I reported means and standard deviations. All results were presented through the use of visual display of data.

Classroom observations and interviews. Data from both classroom observations and teachers interviews, including field notes, were transcribed and coded per the following *a priori* categories: type of AT, frequency of AT, the SAMR level of use, and reported first and second-order barriers. This process is consistent with Merriam (2009) who describes beginning the coding process, “by identifying segments in a data set that are responsive to the research questions” (p. 176). All category names were recorded in a master list, which I used to ensure consistency within my coding (intracoder reliability). Throughout the process of identifying analytical units, I also recorded reflective notes about what I learnt from the data, a process known as *memoing* (Given, 2008). Once coded, I checked the data further for *co-occurring codes* (segment data that may have more than one code attached to them, especially those data reflecting reported AT use as well as references to first- and second-order barriers) (Contreras, 2011). The codes were used to identify specific quotations or other narrative sections that were used in the results to exemplify a specific finding. I also converted the codes into frequency counts for additional interpretation.

IEPs review. The IEP review allowed me to provide frequency data in order to reflect the overall *expected* use of AT for the program for students with SLD.

Data interpretation. Following the individual data analyses, I integrated all findings within the framework of the SAMR model. The results were examined with the purpose of understanding how teachers make use of AT (as defined by *frequency* and *type*) at each individual SAMR level and whether certain levels of use were more likely to experience certain types and frequencies of AT. I anticipated that the patterns of AT use would vary between ELA, an instructional reading class, and other non-instructional reading content areas such as Math, Social Studies, Science, and Other. I further interpreted the newly merged data in the context of Brickner's first- and second-order barriers theoretical framework, specifically, whether certain barriers are more likely to be reported in connection to certain SAMR levels.

Summary

The procedures described in this chapter were undertaken to provide evidence specific to each of my research questions but also to complement each other. I attempted to connect all evidence for the ultimate purpose of understanding the weight of the second-order barriers on special education teachers. In the following chapter I present the results of my study and address each of my research questions.

Chapter 4: Results

This research study investigated the use of assistive technology (AT) by special education teachers in selected secondary content domains and the reported barriers to use. The research was guided by the following questions:

(1) Given the school's technology instructional inventory, which AT do middle and secondary content area teachers report using, for what purpose, and how frequently?

(2) Are there observed and reported differences in type of device and level of use between English Language Arts teachers who teach reading and other content area teachers who do not provide direct reading instruction?

(3) Which first and second-order barriers do teachers report as influencing their decisions to use or not use AT?

(4) How do the observed and reported AT use with students with SLD align with the types of AT and their use documented in the students' IEPs?

In this chapter, I will present the results obtained from the data collection process and I will describe the sample as well as procedures in detail. The sections below will introduce the results of each data collection component individually (IEPs review, teacher survey, classroom observation and teacher interviews – the order is chronological in order of data collection).

Sample

A total of 19 of the 21 teachers in the school participated in the teacher survey but the survey responses of two teachers had to be invalidated due to incomplete answers. Of the 17 teachers left, 47% (n = 8) were 35 years and younger, 29% (n = 5) were between 36-50 years, and 24% (n = 4) were between 50-65 years old. The majority (59%) of the teachers (n = 10) reported having more than seven years of experience of teaching students with learning disabilities, while 35% (n = 6) were beginning teachers (with less than three years), and one had been teaching for 4-7 years. More than three quarters (76%) had been teaching students with SLD for longer than three years.

Additionally, more than half of all teachers (n = 9, 53%) had primarily teaching experience in self-contained special education classes and special education resource rooms (n = 7), nine (53%) also reported having teaching experience in general education before joining the current program. With regard to the length of teaching in the current school, 53% of the teachers (n = 9) reported that they were teaching in the school less than three years while four (24%) of these teachers were in their very first year at the school. The remaining eight teachers (47%) had been teaching in the school for more than three years.

Among the 17 teachers, five were teaching Reading/English Language Arts, three Math, two Social Studies, two Science; the remaining five teachers represented other academic areas such as Arts, Physical Education, Careers/Transition, Music, and Media/Technology. All teachers had dual certification in content area and special education. A little more than half (59%, n = 10) reported having received AT professional development throughout the years since they began teaching; the remaining seven (41%) indicated they never received AT training.

Results of IEP Review

The purpose of the IEP review was to provide hypothetical boundaries for the *expected* use of AT with the students in the program. I reviewed the Instructional

Accommodations and Supplementary Aids sections of the IEPs of all the students (*n* = 60) in the program and recorded the technology recommended for instructional use. In order to facilitate the interpretation of the data, I organized the list of AT in categories of low, medium, and high AT. Table 2 indicates that a total of 17 different AT accommodations were recorded in the IEPs. Among these, the six categorized as low AT were most frequently noted in IEPs. These included: content graphic organizers (*n* = 60, 100%); organizational aids (*n* = 53, 88.3%); highlighters and pencil grips (*n* = 11, 18.3%), and content area manipulatives (*n* =10, 16.6%). One or more of the six of medium AT accommodations and supplementary aids were specified in 53 of the 60 IEPs. The most common were the math calculation devices (basic and advanced calculators, electronic rulers, protractors, etc.), which were found listed in 53 (88.3%) of the IEPs; spelling and grammar devices (*n* = 23; 38.3%); audio recordings (*n* =27; 45.0%); word processors (*n* = 11; 18.3%); and other audio materials (*n* = 4; 6.7%). The remaining category of the four high AT accommodations and supplementary aids, which includes complex computer-based technology, had the smallest frequency. Only 34 (56.6%) of the 60 IEPs listed one or more of these AT items. These included screen readers, which were noted in 31 (51.6%) of the IEPs, speech generating devices (*n* = 22; 36.6%), and any other computer-based technology such as specialized reading or math programs (*n* = 3, 5.0%). One student's IEP indicated the provision of an AT consult (an IEP provision that allows for the IEP to consult with an AT specialists regarding the student's AT needs).

Table 2

AT Accommodations and Supplementary Aids per IEP Review (n = 60)

	Type of AT	Frequency (n = 60)
Low AT	Highlighters, pencil grips	11
	Organizational aids (checklists, rubrics, notes/outlines)	51
	Content area non-computer manipulatives	10
	Graphic organizers	40
	Tactile graphics	1
	Visual cues/organizer	20
Medium AT	Math tools and calculation devices	53
	Spelling and grammar devices	23
	Audio recording	27
	Word Processors/Electronic note takers	11
	Audio materials	4
	Large print	1
High AT	Text to speech/Screen reader	31
	Scribe/ Speech Generating Devices (STT)	22
	Use of Technology/Computer Access Tools/Devices/Software	3
	AT consult*	1
Total		309

**AT consult is a service not a device; however, it was included due to its relation to the AT use.*

Results of the Teacher Survey

The purpose of the teacher survey was to collect information reflecting the *reported* use of AT. The survey items elicited answers on type of AT, frequency of AT, purpose of AT, as well as factors influencing the use of AT by teachers. Below are the data per each category. The response rate for the survey was 80.9% (two of the 19 surveys were never completed and could not be used). Table 3 below provides demographic information for the participants.

Table 3

Survey Teacher Participants Demographics (n = 17)

Content area	*N*	Gender (M/F)		Race*	Years of experience		
		F	M		0-3	4-7	7>
ELA/Reading	5	100%	-	80% WC 20% AA	80%	-	20%
Math	3	67%	33%	66.7% WC 33.3% AA	66.7%	-	33.3%
Social Studies	2	50%	50%	100% WC	50%	-	50%
Science	2	-	100%	100% WC	50%	-	50%
Other	5	40%	60%	80% WC 20% AA	-	20%	80%

*WC = White Caucasian, AA = African American

Type and frequency of AT use. The survey respondents had to select the type of AT they use and the frequency of use from a list of technologies available for them at the school (the list was built using information from the teacher and parent manual as well as the school's instructional inventories). The AT was presented in categories of low (1), medium (2), and high (3), each with specific examples from the actual program's technology inventory. Table 4 presents the frequency of AT use. Most of the teachers (*n* = 13, 76.4%) reported daily use of low AT, followed by 41.1% (*n* = 7) of daily use of medium AT, and 29.4% (*n* = 5) reported use of high AT. The majority of the respondents (*n* = 6, 35.2%) indicated that they never used high AT while 11.7% (*n* = 2) reported that they never used medium AT, and only 5.8% (*n* = 1) checked that they never used low AT.

Table 4

Overall Teacher Reported Use of AT by Type (n = 17)

	Daily use	2-3 times/wk	Never
Low AT	13	4	1
Medium AT	7	9	2
High AT	5	7	6
Total	25	20	9

Additionally, all teachers were asked to report AT use in their own content area. There were three items that included individualized lists of AT and teachers were asked to indicate which they used in their specific subject area instruction. (See Table 3 for number of participants in each content area). The five English Language Arts/Reading teachers mostly reported *daily* use of Lexia, a computer-based reading program, (n = 3) and highlighters (n = 2). *Occasional* use (2-3 times per week or more) was recorded for Kurzweil (n = 5), also a screen reader, various computer apps such as Evernote, iThoughts, Flashcards, and myHomework (n = 4), graphic organizers (n = 4), word processors (n = 5), and other reading and network-ready devices like tablets and smart phones (both n = 4). All five of the ELA/Reading teachers reported never using smart phones and the research-based special font, *Dyslexie*, that has been found to produce reading benefits for students with learning disabilities (University of Twente, Netherlands, 2010). Table 5 below outlines the overall distribution of frequency among ELA/Reading teachers.

Table 5

Reported Use of AT by ELA Teachers (n = 5)

Type of AT		Daily	Occasional (2-3x/wk)	Never	Total
Low	Highlighters	2	2	1	5
	Pencil grips	2	1	2	5
	Graphic organizers	1	4	0	5
Medium	Presentation software	1	3	1	5
	Online dictionary	0	3	2	5
	Word processors	0	5	0	5
	Audio books	0	2	3	5
High	BrightLink/Smartboard	1	0	4	5
	Screen reader (Kurzweil)	0	5	0	5
	Screen reader (TextAloud)	1	0	4	5
	Dragon Naturally Speaking/Dictation	0	2	3	5
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	0	4	1	5
	Lexia	3	2	0	5
	Moodle	1	4	0	5
	Tablets	0	4	1	5
	Special Font	0	0	5	5
	Smart phones	0	0	5	5
	Smart Pen	1	0	4	5
	Total	13	41	36	

Non-ELA teachers use of AT. All math teachers (*n* = 3) said they used the BrightLink/Smartboard, calculators, and Moodle on *daily*basis. Also, highlighters, videos and tutorials, and presentation software were each reported by one teacher each to be used daily. Computer math games were indicated as *occasional* use of 2-3 times per week. Screen readers were reported as *never used* by the math teachers. Table 6 below further details the AT use by the math teachers.

Table 6

Reported Use of AT by Math Teachers (n = 3)

Type of AT		Daily	Occasional (2-3x/wk)	Never	Total
Low	Highlighters	1	2	0	3
	Pencil grips	1	0	2	3
	Calculators	2	1	0	3
Medium	Electronic worksheets	0	1	2	3
	Presentation software (Prezi, Powerpoint, other)	2	0	1	3
	Math manipulatives (including virtual)	0	2	1	3
High	Smartboard	3	0	0	3
	Screen reader (Kurzweil, TextAloud, Other)	0	0	3	3
	Dragon Naturally/Dictation	0	1	2	3
	Smart Pen	1	0	2	3
	Smart Phone	0	1	2	3
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	0	2	1	3
	Moodle	2	0	1	3
	Tablets	0	2	1	3
	Math computer games	0	2	1	3
	Videos, tutorials	1	2	0	3
	Total	13	16	19	

The two social studies teachers indicated *daily* use of manipulatives (such as globes, atlases, puzzles, etc.), BrightLink/Smartboard, and Moodle. They reported *never* using any of the school's screen readers or online encyclopedias/atlases; however, one of the teachers reported using a different speech-to-text software, *YakiToMe*, which is an open-source free screen reader online. Table 7 below further details the responses of the social studies teachers.

Table 7

Reported Use of AT by Social Studies Teachers (n = 2)

		Daily	Occasional (2-3x/wk)	Never	Total
Low	Highlighters	1	1	0	2
	Graphic organizers	1	1	0	2
	Manipulatives	2	0	0	2
Medium	Presentation software	2	0	0	2
	Word processors	0	1	1	2
	Online dictionary	0	1	1	2
High	BrightLink/Smartboard	2	0	0	2
	Screen readers (Kurzweil, TextAloud)	0	0	2	2
	Other screen reader	1	1	0	2
	Dragon Naturally Speaking/Dictation	0	1	1	2
	Smart Pen	2	0	0	2
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	0	2	0	2
	Moodle	2	0	0	2
	Tablets	0	1	1	2
	Smart phones	0	1	1	2
	Interactive online tools (e.g., timelines)	1	1	0	2
	Videos (tutorials and instructional)	0	2	0	2
	Online encyclopedia, atlas	0	0	2	2
	Computer classrooms	1	1	0	2
	Total	15	14	9	

The two science teachers reported making *daily* use of the BrightLink/Smartboard and presentation software (such as Powerpoint and Prezi) while highlighters, videos and other media, and Internet online tools were used 2-3 times per week (*occasional*). These two science teachers indicated they *never* used online dictionaries, screen readers, graphic organizers, or electronic worksheets. Table 8 below further details the frequency of AT use as reported by the science teachers.

Table 8

Reported Use of AT by Science Teachers (n = 2)

		Daily	2-3x/week	Never	Total
Low	Highlighters	0	2	0	2
	Pencil grips	1	0	1	2
	Graphic organizers	0	0	2	2
	Manipulatives	1	1	0	2
Medium	Presentation software	2	0	0	2
	Online dictionary	0	0	2	2
	Word processor	0	1	1	2
	Electronic worksheets	0	0	2	2
	Calculators	0	1	1	2
High	BrightLink/Smartboard	2	0	0	2
	Screen readers (Kurzweil, TextAloud)	0	0	2	2
	Smart Pen	1	1	0	2
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	1	0	1	2
	Moodle	1	1	0	2
	Media, videos, tutorials	0	2	0	2
	Internet for online activities	0	2	0	2
	Total	9	11	12	

Of the five teachers in the Other content areas (e.g., Art, PE, Media/Technology, Music, and Careers/Transition), four indicated daily use of pencil grips, manipulatives, and word processors. They reported occasional use (2-3 times per week) of highlighters (n = 4), computers to access such things as online dictionaries (n = 3), videos and tutorials (n = 3), and Moodle (n = 3). Among AT that was reported as *never* used by any of the five teachers were: Dragon Naturally Speaking/Dictation (n = 5), and graphic organizers (n = 5). Table 9 below provides the entire set of answers provided by the teachers in Other content areas.

Table 9

Reported Use of AT by Teachers in Other Content Areas (n = 5)

		Daily	2-3x/week	Never	Total
Low	Highlighters	0	4	1	5
	Pencil grips	1	0	4	5
	Graphic organizers	0	0	5	5
Medium	Manipulatives	1	2	2	5
	Presentation software	0	1	4	5
	Word processors	1	2	2	5
	Online dictionary	0	3	2	5
	Electronic worksheets	0	2	3	5
High	BrightLink/Smartboard	0	1	4	5
	Screen readers (Kurzweil, TextAloud)	0	1	4	5
	Dragon Naturally Speaking/Dictation	0	1	4	5
	Smart Pen	0	1	4	5
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	0	3	2	5
	Moodle	0	3	2	5
	Tablets	0	1	4	5
	Audio books	0	2	4	5
	Special Font	0	0	4	5
	Smart phones	0	2	3	5
	Interactive online tools	0	1	4	5
	Videos, tutorials	0	3	2	5
	Totals	3	33	64	

Purpose of AT use across content areas. To respond to questions related to the purpose of AT, teachers were first (Q14) asked to estimate the frequency of use in instruction of each AT by SAMR level over the previous five full instructional days. For each SAMR level, teachers were able to access specific examples (Appendix F) of how AT could be used in order to correspond to a certain level. The response format used a sliding scale of 0-100% scale where 0% meant a certain AT was never used at specific SAMR level, and 100% corresponded to using a certain AT at a specific SAMR level 100% of the time. The item provided a brief explanation with a definition and examples for each SAMR level as well as a link for the respondents to access further optional resources on each section. Then, for each of the AT indicated as used in their content areas (this item was a follow-up to the individualized lists of AT per content areas), teachers were asked to indicate the primary purpose for using each specific AT. Table 10 below includes minimum and maximum percentages of time and average percentage of time for AT use by SAMR level. Overall, the purposes for use of AT were most often to Augment instruction (52.06%) followed by Modification (45.33%), Redefinition (37.78%), and Substitution (32.06%).

Table 10

Reported Percentage of Time by SAMR Purpose of AT Use in Instruction

SAMR level	Min Value (%)	Max Value (%)	Average Value (*SD*) (%)
Substitution	0.00	90.00	32.06 (26.69)
Augmentation	0.00	100.00	52.06 (34.18)
Modification	0.00	91.00	45.33 (33.44)
Redefinition	0.00	90.00	37.78 (30.51)

Purpose of AT use in ELA/Reading. The responses of the six teachers of ELA/Reading indicated that AT was used primarily for Modification (63.6%) and Augmentation (54.5%) of reading tasks. Within these levels, teachers indicated they mostly used highlighters (n = 4), learning apps (n = 3), Moodle (n = 3), screen readers (n = 4), and graphic organizers (n = 3). At the level of Redefinition, four teachers indicated using the following AT: word processors (n = 2), Dragon Naturally Speaking/Dictation (n = 1), and smart phones (n =1). The survey also provided respondents with the N/A option per each of the AT included in the list to allow them to indicate AT that did not apply to their content area. The highest values for this category included the special font (n = 5), smart pens (n = 5), BrightLink/SmartBoard (n = 4), audio books (n = 3), TextAloud (one of the program's screen readers) (*n* = 3), and online dictionaries (*n* = 2). Four ELA/Reading teachers also marked that Dragon Naturally Speaking/Dictation as N/A. Below is Table 11 with all the values reported in the teacher survey.

Table 11

Reported Purposes of AT Use by ELA Teachers (n = 5)

		SAMR level of AT use				
	Type of AT	S*	A*	M*	R*	N/A
Low	Highlighters	0	4	1	0	0
	Pencil grips	0	2	1	0	2
	Graphic organizers	0	1	3	0	1
Medium	Presentation software	1	3	0	0	1
	Word Processor	2	1	0	2	0
	Electronic worksheets	0	0	2	0	3
	Online dictionary	1	1	1	0	2
High	Smartboard	0	1	0	0	4
	Kurzweil	1	0	4	0	0
	TextAloud	1	0	1	0	3
	Dragon Naturally Speaking/Dictation	1	0	1	1	2
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	0	3	1	0	1
	Lexia	1	2	1	0	1
	Audio books	0	1	1	0	3
	Moodle	1	3	1	0	0
	Smart Pen	0	0	0	0	5
	Smart Phones	0	2	1	1	1
	Special font	0	0	0	0	5
	Total	9	24	19	5	62

**S = Substitution, A = Augmentation, M = Modification, R = Redefinition*

Purpose of AT use in non-ELA areas. The three math teachers who participated in the survey used AT mostly for the purpose of Augmentation (46.8%) of the instructional tasks followed by Modification (31.2%). Within these levels, the math teachers reported highest use for calculators (*n* = 2), videos and tutorials (*n* = 2), presentation software (*n* = 2), and Moodle (*n* = 2). Among the math teachers, the following AT were most frequently considered as N/A: the talking calculator (*n* = 3); online math games (*n* = 3); screen readers (*n* = 5), and the special font (*n* = 3). Table 12 provides further information on the reported purpose of AT use by the math teachers.

Table 12

Reported Purpose of AT Use by Math Teachers (n = 3)

		SAMR level of AT use				
	Type of AT	S*	A*	M*	R*	N/A
Low	Highlighters	0	2	1	0	0
	Pencil grips	0	1	0	0	2
	Math manipulatives	0	1	1	0	1
	Traditional calculator	0	2	1	0	0
Medium	Talking calculator	0	0	0	0	3
	Math virtual manipulatives	1	0	1	0	1
	Online math games	1	1	1	0	3
	Videos, tutorials	0	2	0	1	0
	Presentation software	0	2	0	0	1
	Electronic worksheets	0	0	1	0	2
High	BrightLink/Smartboard	1	1	1	0	0
	Computers for practice/drill activities	0	0	1	0	2
	Screen readers (Kurzweil, TextAloud)	0	0	0	0	3
	Dragon Naturally Speaking/Dictation	0	0	1	1	2
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	0	1	0	1	1
	Moodle	0	2	0	0	1
	Smart Pen	0	0	1	0	2
	Smart Phones	0	0	0	1	2
	Special fonts	0	0	0	0	3
	Total	3	15	10	4	29

**S = Substitution, A = Augmentation, M = Modification, R = Redefinition*

Two teachers of social studies responded to the survey items and indicated that they used AT mostly to Modify (37.9%) and Redefine (37.9%) instructional tasks (Table 12). Within these SAMR levels, the social studies teachers reported to using BrightLink/Smartboard (*n* = 2), online graphic organizers (*n* = 2), and interactive online tools (*n* = 2) such as virtual timelines and maps. Social studies teachers did not report using AT for Substitution purposes. The AT considered N/A for this content area included: online encyclopedias and atlases (*n* = 2); Smart Pens (*n* = 2) and the special font (*n* = 2). Table 13 below outlines the all the data under reported purpose of AT use by the social studies teacher.

Table 13

Reported Purpose of AT Use by Social Studies Teachers (n = 2)

		SAMR level of AT use				
	Type of AT	S*	A*	M*	R*	N/A
Low	Highlighters	0	1	1	0	0
	Graphic organizers	0	1	0	1	0
	Manipulatives	0	1	0	1	0
Medium	Online dictionary	0	1	0	0	1
	Online encyclopedias and Atlas	0	0	0	0	2
	Smartboard	0	0	0	2	0
High	Screen readers*	0	0	2	0	0
	Dragon Naturally Speaking/Dictation	0	2	0	0	0
	Apps (Evernote, iThoughts, Flashcards, myHomework, and other)	0	0	1	1	0
	Interactive online tools (Virtual timelines and maps)	0	0	2	2	0
	Moodle	0	1	0	1	0
	Smart Pen	0	0	0	2	2
	Smart Phones	0	0	1	0	1
	Tablets	0	0	1	0	1
	Internet/online activities	0	0	1	1	0
	Special fonts	0	0	0	0	2
	Inspiration software	0	0	2	0	0
	Total	0	7	11	11	9

**S = Substitution, A = Augmentation, M = Modification, R = Redefinition*

Based on the answers of two teachers of science, AT was predominantly used for Augmentation purposes (83.3%) (Table 14). Within this level, the science teachers reported the use of highlighters (*n* = 2), manipulatives (*n* = 2), videos and online tutorials (*n* = 2), presentation software (*n* = 2), and the BrightLink/Smartboard (*n* = 2). The following AT was considered to be N/A for this content area: graphic organizers (*n* = 2); electronic worksheets (*n* = 2); screen readers (*n* = 2); apps (*n* = 2); online dictionaries (*n* = 2) and special fonts (*n* = 2).

Table 14

Reported Purpose of AT Use by Science Teachers (n = 2)

		SAMR level of AT use				N/A
	Type of AT	S*	A*	M*	R*	
Low	Highlighters	0	2	0	0	0
	Pencil grips	1	0	0	0	1
	Science manipulatives	0	2	0	0	0
Medium	Calculator	0	1	0	0	1
	Presentation software	0	2	0	0	0
	Online dictionary	0	0	0	0	2
	Word Processor	0	1	0	0	1
	Electronic worksheets	0	0	0	0	2
	Graphic organizers	0	0	0	0	2
High	Videos, tutorials, media	0	2	0	0	0
	BrightLink/Smartboard	0	2	0	0	0
	Screen readers (Kurzweil, TextAloud)	0	0	0	0	2
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	0	0	0	0	2
	Interactive online tools	0	1	1	0	0
	Moodle	0	2	0	0	0
	Smart Pen	0	1	0	0	1
	Smart Phones	0	2	1	1	2
	Special font	0	0	0	0	2
	Total	1	18	2	1	18

**S = Substitution, A = Augmentation, M = Modification, R = Redefinition*

The five teachers from the Other content areas indicated that they most frequently used AT for the purpose of Substitution (40.4%). Within this SAMR levels, the teachers made most frequent use of online dictionaries (*n* = 2), manipulatives (*n* = 2), electronic worksheets (*n* = 2), tablets (*n* = 2), Moodle (*n* = 2), and Dragon Naturally Speaking/Dictation (*n* = 2). The N/A option revealed that the following AT was considered to not apply to one or more of these other content areas: highlighters (*n* = 5), the special font (*n* =5), and graphic organizers (*n* = 4). See Table 15.

Table 15

Reported Purpose of AT Use by Other Content Area Teachers (n = 5)

		SAMR level of AT use				
	Type of AT	S*	A*	M*	R*	N/A
Low	Highlighters	1	3	1	0	5
	Pencil grips	1	1	0	0	3
	Manipulatives	0	2	0	1	2
Medium	Graphic organizers	1	0	0	0	4
	Virtual manipulatives	2	0	0	0	3
	Word Processor	1	2	0	0	2
	Online dictionary	2	1	0	0	2
	Electronic worksheets	2	1	0	0	2
High	BrightLink/Smartboard	1	0	0	1	3
	Screen readers (Kurzweil, TextAloud)	1	1	1	0	3
	Dragon Naturally Speaking/Dictation	2	0	0	0	3
	Apps (Evernote, iThoughts, Flashcards, myHomework, other)	1	0	1	1	2
	Videos, tutorials	1	1	1	0	2
	Moodle	2	0	1	1	1
	Smart Pen	1	0	0	1	3
	Smart Phones	0	1	0	1	3
	Internet/online activities	0	2	0	2	1
	Special font	0	0	0	0	5
	Total	19	15	5	8	49

**S = Substitution, A = Augmentation, M = Modification, R = Redefinition*

Reported barriers to use of AT. The survey asked teachers to rank in the order of importance (1 being least important to 5 being the most important) the factors that influence their decision to not use AT for the instruction of students with SLD. Of the 17 teachers, 35.2% (*n* = 6) claimed that limited or no access to desired AT was the most important barrier to using AT followed by 23.5% (*n* = 4) who reported that students' refusal to use AT was the most important barrier that prevented the use of AT, and 17.6% (*n* = 3) cited that limited training on using AT as the most important barrier. Among the remaining three teachers, two indicated that the reasons they did not implement AT was because their did not believe it was helpful in the learning process and one reported that that AT disrupts the learning environment due to insufficient time and technology constraints.

Overall, the highest-ranked factors reported to influence the teachers' decisions to not use AT were: limited access to certain technologies (*M* = 3.69, *SD* = 1.35); students' refusal to use AT accommodations (M=3.19, SD=1.56); the disruption AT causes in instruction due to time and non-functional technology (*M* = 3.06, *SD* = 1.12) and limited AT training (*M* = 3.00, *SD* = 1.21). The least important factor was reported to be teachers' belief that AT was not as helpful in the learning process (*M* = 1.81, *SD* = 1.38). Table 16 below provides further the complete data for this item.

Table 16

Mean Reported Barriers to AT Use (5-point Likert scale)

Barrier	Mean (*SD*)*
I have limited or no access to AT I would like or need to use.	3.69 (1.35)
I have limited or no training in how to use AT	3.00 (1.21)
I do not believe AT is helpful in the learning process	1.81 (1.38)
The use of AT disrupts the instruction due to issues such as time and technology constraints or other	3.06 (1.12)
Students often refuse to use AT	3.19 (1.56)

Classroom Observations

The purpose of the classroom observations was to identify the type and frequency of AT during instruction as well as the purpose observed teachers used AT for. These parameters defined the boundaries of *observed* use of AT. The classroom observations collected data on the type of AT, the frequency of AT as well as the SAMR level of AT used by the observed teachers. Table 16 lists each individual type of AT recorded during the total observations by teacher along with frequency and SAMR level. Observations were made using a standardized protocol that captured the type and the frequency of AT per each instructional period as well as the purpose for each AT (SAMR level). For example, throughout one instructional day, a teacher used student computer stations once in each period but for different purposes (such as one period was used for word processing, another period was used for live editing of student work via Google Docs, etc.). Subsequently, I recorded every instance of AT used along with the type of AT and field notes regarding the purpose for which was used.

Type and frequency of AT. Based on classroom observations, the teachers (n = 7) made frequent use of the classroom computers (*daily*) for teacher tasks or projection of course materials, followed by organizational aids such as student plan books (*daily* in the beginning of each instructional period), checklists, graphic organizers, color-coding tools, and highlighters (2-3 times per week). Additionally, all but one (ELA) of the observed teachers utilized Moodle, the school's online learning platform, at least once per day; the ELA teacher did not use Moodle for her instructional needs. Also, five of the seven teachers utilized the BrightLink projectors for their Smartboard capabilities, which allow students to interact with the projected content. The classroom observations also recorded occasional use (2-3 times per week) of tablets, instructional videos, and screen readers; Dragon Naturally Speaking/Dictation was not observed at all.

Purpose of AT use. Across 14 days (84 instructional periods) of classroom observations, I observed three ELA/Reading teachers (36 instructional periods), one Math teacher (12 instructional periods), one Social Studies teacher (12 instructional periods), one Science teacher (12 instructional periods), and one Other/Careers teacher (12 instructional periods). Based on all these observations, the most frequent purpose for using AT was Augmentation (72%), followed by Modification (22%), Redefinition (4%), and Substitution (2%) (Table 17). Only one instance of Substitution was observed during Careers/Transition and involved the use of student computer stations to complete online college applications (these were available as hard copies as well). Two Redefinitions of instruction tasks were observed: the use of Moodle in Social Studies to create an interactive lesson on Ancient Egypt, and the use of Google Docs to facilitate sharing of written work while also receiving live feedback through the chat function from the teacher. For Augmentation purposes, all teachers made daily use of their personal classroom computers, the BrightLink/Smartboard projectors, organizational aids, Moodle, and content area manipulatives. The instances of Modifications involved the use the screen readers as editing tools rather than just digital text readers (students are asked to run their own written essays through a screen reader in order to have their work read back to them and identify errors), the occasional use of iPads (particularly in math and ELA classes), graphic organizers, and interactive media activities (particularly the use of online maps in social studies). Certain AT such as Moodle, classroom computers and the BrightLink/Smartboard projectors, while used across content area classes, varied in their purpose of use as some teachers utilized the AT for purposes other than their basic functions. For example, Moodle was used mostly for online storage of class instructional materials to provide remote access by teachers and students, which was categorized as Augmentation. Other teachers, such as in math, used the learning platform of Moodle to administer quizzes, provide opportunities for free online practice of math exercises, and upload homework for remote access. These uses correspond to the Modification level.

Observed barriers to use of AT. There were two instances of non-functional computers and network connections recorded across 14 days of observation. Additionally, three students refused to use the AT that was offered to them (a screen reader and scribe software) during one of the observed classroom sessions. Also, in three of the observed classrooms, the teachers did not have a BrightLink projector (one ELA/Reading and one Other/Careers), which prevented them from using Smartboard functions in their instruction while one of the math classrooms did not have student computer stations (the teacher allowed the students to use her three personal mini iPads when needed). No other barriers were recorded during classroom observations.

Table 17

Frequency and Purpose of AT Use by Content Area over Two-Day Observations (36 periods) (n = 3)

Content area	# periods		Type of AT	Frequency	SAMR level
ELA	36	Low	Organizational Aid (checklists, agenda books, color coding tools, highlighters)	72	A
			Graphic organizers	18	A
			Reading trackers	7	A
			Total Low AT	97	3A
		Medium	Classroom computers	54	A
			Headphones	5	A
			Total Medium AT	59	2A
		High	Bright Links Projector/Smartboard	24	A
			Screen readers/Text-to-speech	6	M
			Scribe/Speech-to-text	2	M
			iPads	2	A
			Moodle (online learning platform)	18	A
			Google Docs	2	R
			Smart phones	3	A
			Media/Videos	1	A
			Email	1	A
			Reading programs (Lexia, NewsELA)	4	A
			Total High AT	63	7A, 2M, 1R
Total ELA			-	219	12A, 2M, 1R

**S = Substitution, A = Augmentation, M = Modification, R = Redefinition*

Table 18

Frequency and Purpose of AT Use by Non-ELA content areas over Two-Day Observations (48 periods) (n = 4)

Content area	# periods		Type of AT	Frequency	SAMR level
			Organizational Aids		
Non-ELA	48	Low	(checklists, agenda books, color coding tools, highlighters)	84	A
			Pencil grips	4	A
			Manipulatives	24	A
			Seat cushion	2	A
			Graphic organizers	24	M
			Total Low AT	138	4A, 1M
		Medium	Calculators	12	A
			Headphones	18	A
			Word processor	12	S
			Classroom computers	24	A
			Total Medium AT	66	1S, 3A
		High	BrightLink/Smartboard*	24	A
				12	R
			iPads, Tablets	30	M
			Moodle (online platform)*	24	M
				24	A
			Stylus	12	A
			Screen readers	12	M
				3	A
			Interactive maps	12	M
			Interactive binders	12	M
			Virtual magnifier	12	A
			Smart phones	2	A
			Total High AT	476	6A, 5M, 1R
Total Non-ELA				680	1S, 10A, 6M, 1R

**S = Substitution, A = Augmentation, M = Modification, R = Redefinition*

Teacher Interviews

The purpose of the teacher interviews was to further probe into teachers' use of AT and to better understand the observed use of AT in the classroom. The interviews occurred at the end of each of the 2-day classroom observations and used both pre-set questions as well as additional inquiries as the conversation dictated. A list of the interview pre-set questions is available in Appendix B.

Type and frequency of AT. All seven teachers who were interviewed identified organizational aids such as highlighters, student plan books, graphic organizers, checklists, and color-coding as AT that they used daily. The school's online learning platform Moodle and the screen readers were also frequently mentioned by six of the seven teachers as being used at least 2-3 times per week. However, not all teachers used this type of AT in the same way. For example, the screen readers were used by some teachers for their basic reading-assistance and offered them as supports to students who struggled with decoding while other teachers allowed and encouraged students who were working on writing compositions to use screen readers as their personal reading and editing assistants (the software would read the students' essays to allow them to pick up on written expression errors). Table 18 below presents the reported frequency of use of specific AT by teacher.

Teacher-reported purposes of AT use. In response to the interview questions inquiring about the purpose of AT use, all seven teachers connected their answers to their own understanding of how students learn. They all expressed their beliefs that AT is an extension of learning and a way to access general education curriculum for students with learning disabilities. Therefore, they claimed AT as essential in the learning process and further commented that they use it “as needed”. One of the ELA/Reading teachers noted that, “AT bridges a gap in learning which is essential for our students”, while another (ELA/Reading) commented that, “I don’t think it would be feasible to teach without AT for this (student) population and the content area that I am teaching because I don’t think the students would have access to content or achieve as much independence in learning”. On a similar note, the Careers teacher stated that, “to my mind AT is anything that is going to help students work near to their grade level.”

None of the teachers used the SAMR terminology when discussing the purpose of their AT use. However, one of the ELA teachers specifically mentioned that the purpose of AT used in her classroom is to assist with “visual organization” and “to take students to the higher level of thinking needed to access middle and high school curriculum content”. She explained that,

> If a student is reading on a 4th grade level but they are expected to access 10th grade level (based on their age), I can’t say ‘just muscle your way through it’, that would be ridiculous because they wouldn’t have the time and energy to get to the meat of that text. It would be like me trying to take all my classes in Hindi.

According to the SAMR model, this might correspond to the Augmentation, Modification and/or Redefinition levels as using AT for such instructional tasks goes beyond substituting a teacher function (such as reading the text for the student or inquiring the student about elements of the text). Instead, the use of graphic organizers, for instance, have been documented in the literature (Scruggs, Mastropieri & Okolo, 2008a) to assist students with SLD by providing a visual representation of the organization and structure of the concepts as well as the relationships between the concepts therefore preventing a student from having to process as much as semantic information to understand the text. Moreover, the use of AT such as Google Docs (as used by the above-referenced teacher) in a way that allows the student to share his/her written work in progress and permits the teacher to provide the student with live feedback, is an example of a scenario in which multiple students can immediately incorporate teacher feedback. This can prevent extended wait times for students while the teacher takes turns in attending everybody.

Another ELA teacher saw AT as, "needed in the classroom to foster some of the skills that students need to access curriculum in a different way that they might not be able to do on their own". This perception was shared by the social studies and science teacher who added that, "AT provides a more clear cut way to present material". These appear to correspond to the Augmentation level under SAMR as the presentation of materials through AT such as Smartboard projecting can enhance the task by embedding multiple means of content representations (audio and video) and, where appropriate, improving student engagement through interaction with projected content. The math and careers content area teachers agreed that the purpose of AT is to allow students to engage with the curriculum by receiving help with understanding and retaining information. "For me, AT is any sort of program or software that is going to help the student engage and grasp the curriculum", noted the Careers teacher who also reflected on some of his students' AT needs when filling out college applications:

> It's just a wall of words coming at the students and, so, AT such as a screen reader helps them go through and pick up on information since they can't fully get it. They need some of that independence.

These comments suggest that the teachers perceive the use of AT in the top three levels of SAMR given the AT capabilities to assist with specific learning deficits encountered in the profile of a student with SLD such as reading disorders, the need for frequent and immediate feedback as well as the need for multisensorial representation of instructional content.

The reported use of the school's online learning platform, Moodle, revealed consistent but varied usage. Whereas most teachers maintained a basic Moodle site to store course materials online, which corresponds to the Substitution level, one ELA teacher, the social studies and the math teachers appeared to utilize this resource for higher SAMR purposes. All three of these teachers used the program to construct and administer quizzes and provide additional interactive online resources for the students in the after-school hours and for remote access. For example, the social studies teacher reported that she had embedded a free-source screen reader, *YackItToMe*, with the print materials she had uploaded for her students to automatically assist with the reading of the text. Also, she had linked an online graphic organizer builder to allow students to build their own visual aids. Similarly, the math teacher, who maintained her own non-school math website that was linked to Moodle, included math tutorials and videos, free practice items online, interactive homework, teacher notes, and other class materials for remote student access. She also used Moodle reports to verify whether student work was completed timely, which allowed her to prompt the student with additional reminders as needed. Finally, one of the ELA teachers also provided multiple learning online opportunities for her students via Moodle (audio books, quiz and homework reminders via Twitter-style function as well as interactive reading activities online with audio files).

As a former student with a learning disability, this ELA teacher justified her use of Moodle as above-mentioned by commenting that,

> I have had an experience with my own education where there was a lot of trial-and-error about curricula that didn't work and it was so frustrating. Now that I have more knowledge about how the brain of a person with a learning disability works, I try to push and adapt because there are students who cannot verbalize these needs. I am motivated to do so because I want them to see how far they can go with it.

Although the interview questions about the purpose of AT use did not mention the issue of compliance with the IEP, all teachers brought this into discussion at the time. They further commented that, in the absence of specific requirements in an IEP about how to use the AT, the implementation in the classroom is, ultimately, dictated by student needs and trial-and-error. The math teacher, for instance, indicated that, "most of my kids have supplementary aids in their IEP and I take that into consideration; I'll accommodate everyone to a degree and then modify it if I need to, but, in the end, I give everyone the overall AT." Also, the Careers teacher mentioned that, "most of it (implementation of AT) is IEP-driven but, like I said, if there are a number of students using a certain AT and there are some who don't have it in their IEP, I'm going to try it on them anyway and see what happens." Another teacher (science) noted that, "I look in the IEPs because that is what you are supposed to do (I am new at this) and I look for accommodations in the IEP that I can use and, as long as they are not ridiculous, I use them."

The similarities in the types of AT specified across student IEPs were also touched on by teachers. One content area teacher, in particular, stated that,

> I check the IEPs but I discovered that the vast majority of the students in the program have the same accommodations such as teacher notes (which I make mine available online anyway) so I only look for what is different. For example, I do have AT across the board that they all have in their IEPs such as audio for text but, with the older students, I make it more of their own choice whereas with the middle division students I end up practicing it and them how to use it step by step.

The Careers/Transition teacher who is responsible for preparing students to take the SAT or ACT indicated that he, "would comb through the IEPs in the beginning of the year" to identify specific testing accommodations that students will need later on." However, for classroom instruction, he acknowledged that, "if three out of five students in a class have an IEP [specifying some AT] that would make using something applicable, then we will use it for the entire class in the same way regardless…it's not going to do anything but help."

Reported barriers to use of AT. Barriers to using AT were reported by all seven teachers although they were all in agreement that they were highly encouraged and partially supported to implement AT for instruction. Teachers mostly reported six specific barriers: lack of time (including planning time issues); computer equipment quality and connectivity problems; insufficient financial resources; professional development; teaching experience, and individual comfort level with technology. Of these, the first four are considered first-order barriers and the last is a second-order barrier.

Time. Throughout all seven interviews, the lack of time to plan and implement AT was mentioned as a barrier. It was consistently the first barrier to be noted by a teacher when asked the question, “What first-order barriers do you identify as influencing your use of AT in the classroom?” It also came up across all teachers’ discourse when the issue of having to take print curriculum and make it available and interactive to students via medium and high-tech devices such as Smartboard, presentation software, screen readers, and other computer-based supports was discussed. One of the ELA/Reading teachers said, “I think obviously time is a huge factor because if things that are adapted text are not readily available or cheap, then you are going to have to make something and it just take a whole time to scan it to *pdf*, then put it into Kurzweil or another screen reader, then upload it on your page and so on. A lot of steps” while an ELA/Reading colleague stated, “When you are entering a new program and you are learning all the platforms and the programs and all of the new nuances of that program, you are very limited in your time.”

Currently, according to the school’s schedule, each teacher has one 45-minute planning period from Monday through Thursday, and 30 minutes of planning on Fridays when students are dismissed early. For example, the social studies teacher who is a daily user of Moodle, shared that, “I would hope to construct projects for my students that would allow them to interact with each other via table-top projecting of maps and timelines but such a project takes hours to plan and requires trial lessons”. Similarly, one of the ELA teachers mentioned that she uses much of her own time to prepare for teaching tasks with AT which are “not necessarily difficult but time-consuming and including multiple steps to complete”. Another ELA teacher commented that, “I feel it would be overwhelming to implement various AT as much as I would like to given my overall challenges as well as a first-year year teacher.” Three of the teachers acknowledged that, although insufficient time is always an issue, planning to teach with AT does not always require additional time specifically as one becomes familiar and comfortable with how the AT is used. The math teacher explained that, "Once AT becomes part of your routine, like another tool under your belt, additional planning will not be required". However, "if it was something new, it would likely require research on my side and that takes time". Another teacher stated, "When I first started working here, I didn't consciously plan to teach with AT but, after a while, it became second nature and planning with it takes less time now."

Technology quality and connectivity. Six out of seven teachers reported technology trouble-shooting as a second biggest barrier to their use of AT. While agreeing across the board that technology support was readily available at the school, most teachers cited the slow speed and/or quality of their in-network computers as well as connectivity issues as affecting their teaching. For example, when describing his planning process for a particular project, one of the teachers said, "I tried to embed audio support for print text or video onto the Moodle page, but the computer was very slow and it was very frustrating". Ultimately, he ended up uploading the print materials without the audio support and made the videos available via Internet links for students to complete the project preparation but the time spent on trouble shooting used up his planning period. Similarly, an ELA teacher stated that, "Access to technology is a barrier in that, even though we are wanting to utilize it, if it's not functioning properly, then everything goes out the window with the lesson and that makes it very tough".

Financial resources. The issue of school funding was mentioned by all seven teachers, yet approached from different perspectives. While all seven were in agreement that the school's policy encourages trial use of AT and will follow-up on requests to purchase, all of these teachers directly or indirectly noted the program's limited financial resources as a barrier to their implementation of AT. For example, an ELA teacher opined that, "We are very limited with our monetary situation and that makes it difficult to have a pool of those higher AT components like iPads or individualized laptops per classroom or a classroom set". Another ELA teacher mentioned that, although sometimes the amounts she personally pays for the AT supports she needs are small, she would rather make purchases with her own funds to avoid the "paperwork" and wait time on getting the requests approved. Also, five of the seven teachers expressed hope that their department budgets would be increased as they described projects they would like to create for their students if they had access to additional AT. For example, the social studies teacher mentioned she would welcome tablets in the classroom so that "students can independently listen to different sections of curriculum text and to communicate with each other with device support". Finally, two of the teachers (both ELA/Reading) noted they did not have access to a Smartboard/BrightLink system in their classroom although they believed it would greatly improve their instruction.

Professional Development. The school develops a yearly professional development (PD) plan, which includes around 20 professional development sessions provided on-site throughout the school year to address PD needs for the teaching staff. The topics are decided based on end-of-year in-school teacher surveys (the previous year's teacher feedback through survey decides the following year's topics) as well as suggestions from the school administrators based on observations completed of teachers as part of the teacher evaluation process. In the past, implementation of AT for instructional purposes was consistently included in the PD offerings. In the current academic year, the school selected the theme of executive functioning of students with SLD for its PD. This choice was made by the school's leadership team in order to foster understanding of the implications of this area of cognition and learning and their application to working with students with diverse profiles. In addition, at the beginning of each school year, the school provides teachers with one-week of two- three hour individual professional development workshops referred to as the Teacher Institute. During this week, each teacher can select up to three workshops to address their PD needs for that year. The workshops always include AT training on available learning tools such as Powerschool (online grading book), Moodle (online learning platform), OnCourse (online lesson plan builder/database), and Kurzweil (screen reader).

All seven teachers acknowledge having attended the school's professional development workshops on AT during the current school year. However, the teachers noted a few barriers related to this professional development. One ELA teacher, a beginning teacher with less than three years of experience, explained that the Teacher Institute had overlapping sessions on different topics. Teachers had to choose which sessions to attend. According to this teacher, her choices were driven by her priorities as a beginning teacher, which included the technology tools primarily needed for compliance with the school's policies (e.g., Powerschool for grading, the school's OnCourse lesson planning platform, and the schools' website which students use to login to their online accounts of various software including Kurzweil, screen reader, and Lexia, reading program, and Moodle course pages). This teacher stated that for upcoming school year, "Moodle will be the one [session] that I go to because this year I have used

Moodle on and off… it hasn’t been my priority as a first-year teacher”. Another ELA teacher discussed her desire for more professional development due to her lack of confidence in integrating AT in her teaching. “I plan to use the technology available sometimes but, when I try to put it into action, if it doesn't go the way I want to, I find myself looking for a plan B (i.e., teaching without AT). AT training is important but I don't use much AT because I don’t have the confidence to implement it.”

Other teachers interviewed preferred self-training and seeking out training opportunities outside of school. She voiced concerns that, “Although training is available at the school throughout the year, sometimes it’s not convenient enough since one person may be trying to train all the staff at once or training would be offered as come-by-as-needed which, due to scheduling conflicts, it often ends up not happening.”

Teaching experience. Five of the seven teachers who participated in the classroom observations and interviews were beginning teachers with less than three years of teaching. Of these, three were in their first year teaching at this school. These five teachers all acknowledged the work overload of a beginning teacher as one of their primary barriers to implementing AT. For instance, when discussing the use of Moodle, one of the teachers stated that, “As a first-year teacher – with everything else that I’m learning and trying to get under my belt and be comfortable with – I don't think that I would have the mental capacity or time to be able to do anything else above and beyond what I am doing now.” Another new teacher indicated that she was interested in longer-term AT supports for her students, such as recording and/or uploading digital materials which required scanning and reformatting, but stated, “it is daunting and overwhelming because being a first-year teacher mandates so many other tasks and responsibilities for which there is not enough time to complete." A teacher who was in her third year at the school recalled her first year of teaching, " I literally started my first year of teaching here two days before the school started so I was thrown in. It was very stressful the first year; then we also lost someone (another teacher) in October and my schedule changed again. I had to pick up another class and switch my schedule around. I also had to change the curriculum path for the school because they were allowing students to switch to Calculus without trigonometry. It was very stressful." The other beginning teachers agreed to the barriers posed by having to juggle first-year teaching responsibilities.

The remaining two of the seven teachers who had more than seven years of teaching experience expressed that their years of teaching made the integration of AT easier. They also both discussed their teaching philosophies, which aligned to the constructivist paradigm. They noted that experience had transformed how they used AT for instruction. For instance, the social studies teacher commented that after years of teaching, "planning to teach with AT became a second nature". "I live by word processors, I breathe BrightLink – the actual software for it is EasyInteractive – where they can highlight and build graphic organizers which I put up on Moodle. Based on my teaching philosophy, without AT, education would not be equitable for our students, it wouldn't exist because you can't afford a 1:1 (dedicated aide) for all the students who need this level of individualized instruction. Similarly, the other more experienced Careers/Transition teacher confirmed that having more years of teaching builds the knowledge about how to individualize instruction with AT. For instance, when referring to the use of graphic organizers as an essential AT support, he explained that, "the fact of the matter is that, for a student, a graphic organizer or any use of AT is going to become an extra step that they might not wish to do on their own but working towards having students internalize such supports and seeing them having been successful and getting something out of these AT, keeps me going."

Comfort level with AT. All seven teachers reported that their own comfort level with technology was a factor influencing their motivation to implement AT in the classroom. One of the ELA teachers who stated she was not a "tech-savvy person" claimed comfort level as one of the largest barriers she encountered when considering AT for instruction. She noted that at times she chose not to use certain AT because of her lack of knowledge, "There are times that I know of programs that could be used but really figuring out how to incorporate an extra layer into everything else that's already being done…it sometimes makes it brain wrecking."

Another ELA teacher agreed that, "using a lot of time of [her] own and motivation" makes a difference in finding out new ways to teach with AT. She stated that she has come to [a] level of comfort with technology through her personal experiences as a former student with an educational disability. Similarly, the math teacher confirmed that, "being a tech person definitely helps out in the classroom". This teacher also mentioned that, "I am always willing to try [new AT] it. If I know what it is, I will research it and try it but overall my barrier would be black of knowledge of what I could try. Knowing what are all the options, that is my biggest barrier, not whether I am willing to try it." The social studies teacher also revealed that her comfort level and preparedness to teach with AT are important factors in implementing technological supports in the classroom. She believed that she is faced more with second-order barriers such as her comfort level with using certain AT rather than first-order barriers such as training, access to new AT, or planning time. Finally, the science teacher noted that, "I was never into getting into technology…it does affect my teaching, I think. I am just sticking to what I am good at."

Addressing the Research Questions

To address the research questions that I posed, I needed to consider together the findings of the individual components of the study. As noted in Chapter 3, I used data from specific components to inform each question. In the following sections I integrate the findings presented in the earlier section of this chapter to inform each of the research questions.

Research question 1. *Given the school's technology instructional inventory, which AT do middle and secondary content area teachers* <u>*report*</u> *using, for what purpose, and how frequently?*

For this research question, I collected data using items from the web-based teacher surveys that required all teachers to report the type, frequency, and purpose of AT they use for instructional purposes (Q12, 13, 15-19) as well as from the teacher interviews (TIQ#2, 4, 5, 9, 10) for which I constructed three corresponding codes for the frequency, type, and purpose of AT in order to analyze the teachers' discourses. Table 19 outlines the type of AT, corresponding frequencies based on *daily* vs. *occasional* use (2-3 times/week) as well as the reported SAMR level. Accordingly, the AT most often reported for *daily* use by the participants included presentation software (39%), the school's online learning platform, Moodle (33%), and content-area manipulatives (including virtual manipulatives) (33%). Overall, low and medium AT were the categories mostly reported under *daily* use for the purposes of Substitution and

Augmentation. For *occasional* use (2-3 times/week), teachers reported predominantly low and high AT such as highlighters (61%), computer apps (61%), mobile devices (tablets, cell phones) (55%), and interactive online tools such as games and drill exercises (44%). The AT used *occasionally* was primarily reported under the purpose of Augmentation.

The interviews with the seven teachers revealed additional reports of AT use. The type of AT that teachers most frequently mentioned during interviews when asked, "Which are the top three ATs that you use consistently (daily or 2-3 times/week)?" were the classroom computers for projecting content on Smartboard, organizational aids as a group (in the form of student plan books used daily at the beginning of each instructional period, checklists, graphic organizers, color-coding tools, and highlighters), and Moodle which was used by all but one ELA teacher. Teachers' responses to the interview questions, while not necessarily making direct references to the SAMR levels, allowed for inferences about the purposes for which they used AT. Based on the interviews (coding), AT was used most often for Augmentation followed by Modification. Teacher reports of AT use for the purpose of Redefinition or Substitution were very limited.

Table 19

Overall Reported Use of AT by Type, Frequency and SAMR Level (n = 17)

	Type of AT	Frequency of use (% of teachers across content areas) Daily	(2-3x/wk)	SAMR* level mostly reported per AT S	A	M	R
Low	Highlighters	28%	61%	-	x	-	-
	Pencil grips	28%	5%	-	x	-	-
	Manipulatives	33%	33%	-	x	-	-
	Graphic organizers	11%	28%	-	-	x	-
Medium	Presentation software	39%	22%	-	x	-	-
	Online dictionaries	0%	39%	x	-	-	-
	Word processor	5%	50%	x	-	-	-
	Electronic worksheets	0%	11%	x	-	-	-
	Audio books	0%	22%	-	x	-	-
High	Smartboard/BrightLink	28%	5%	-	-	-	x
	Screen readers	11%	39%	-	-	x	-
	Dragon Naturally	0%	28%	x	-	-	-
	Smart Pen	28%	11%	-	-	-	x
	Apps	5%	61%	-	x	-	-
	Moodle	33%	44%	-	x	-	-
	Tablets/Smart phones	0%	55%	-	x	-	-
	Special fonts	0%	0%	-	-	-	-
	Interactive online tools	22%	44%	x	-	-	-
	Videos, tutorials	5%	50%	-	x	-	-

**S = Substitution, A = Augmentation, M = Modification, R = Redefinition*

Research question 2. *Are there observed and reported differences in type of device and level of use between English Language Arts teachers who teach reading and other content area teachers who do not provide direct reading instruction?*

To answer this research question, the data from the teacher survey (Q#12, 13, 15-19), classroom observations, and teacher interviews (TIQ7) were used. Table 20 below presents the alignment between the observed and reported use of AT across ELA teachers versus non-ELA teachers (math, social studies, science, and other combined). The data reflected percentage (non-statistical) differences between observed and reported AT use. In most cases, both ELA and non-ELA teachers appeared to report similar types of AT to the ones observed. However, the frequency of use revealed considerable discrepancies between teacher reports and classroom observations. For instance, ELA teachers only reported *daily* use of medium AT for 7.7% of the time while classroom observations revealed that medium AT was used on *daily* basis 50% of the time. Similarly, non-ELA teachers reported using medium AT *daily* almost a third of the time (27.2%) while observations did not reflect *daily* use but rather *occasional* use of medium AT.

In several individual cases, the teachers also reported using certain AT (such as the screen reader, videos and tutorials in math or manipulatives, and online student activities in social studies), but these were not observed consistently across all classroom observations. Likewise, certain ATs were used during classroom observations such as tablets, word processors, audio books in ELA/Reading or manipulatives in Science instruction, but theses AT were not reported by teachers to be used.

With regard to the purpose of AT use, the differences between reported and observed remain. With very few exceptions, the percentages reported by both ELA and non-ELA teachers regarding all SAMR levels are visibly higher on all types of AT than actually observed. Subsequently, the survey reports by ELA teachers indicated that they used AT in their instruction primarily for the purposes of Augmentation and Modification. During classroom observations in ELA, this was confirmed. Similarly, the non-ELA teachers reported use of low and medium and AT also for Augmentation and Modification and they were, also, observed to do so. The only major difference between ELA and all other content areas (math, social studies, science, Other/Careers) was revealed by the survey responses and observations which found that the ELA teachers demonstrated higher and more consistent use of a variety of AT (e.g. graphic organizers, organizational aids, computer-based programs, screen readers, specific reading software and supports such as Lexia, reading program, NewsELA, and reading trackers) whereas, in the other content areas, teachers rarely used high AT and focused on low and medium AT instead (e.g., organizational aids, BrightLink/ Smartboard, content-area manipulatives and Moodle). However, these differences in use did not appear to be dictated by the nature of the content areas, but rather by teachers' level of experience, knowledge about the tool's capabilities, and the lack of sufficient planning time, as reported in the interviews. Finally, the ELA classes also received a boost in their use of AT by employing specific reading programs such as Lexia on daily basis.

Table 20

Observed and reported differences in AT use by ELA vs. Non-ELA teachers***

			ELA		Non-ELA teachers	
			Reported	Observed	Reported	Observed
Type of AT						
		Low	17.7%	13.3%	17.3%	30.2%
		Medium	23.5%	20.0%	27.7%	24.8%
		High	58.8%	66.7%	55.0%	45.0%
Frequency of AT						
	Daily	Low AT	38.5%	33.3%	30.5%	20.0%
		Medium AT	7.7%	50.0%	27.2%	0%
		High AT	53.8%	0%	42.3%	0%
	Occasional (2-3x/week)	Low AT	17.1%	66.7%	17.3%	80.0%
		Medium AM	31.7%	50.0%	22.7%	100%
		High AT	51.2%	100%	60%	100%
SAMR level						
	Substitution	Low AT	0%	0%	36.8%	0%
		Medium AT	44.4%	6.67%	25.2%	2.8%
		High AT	55.6%	0%	38%	0%
	Augmentation	Low AT	29.2%	13.3%	24.9%	25.7%
		Medium AT	25%	20%	30.4%	17.2%
		High AT	45.8%	40%	44.6%	25.7%
	Modification	Low AT	26.3%	0%	12.27%	2.85%
		Medium AT	21%	0%	7.5%	5.71%
		High AT	52.6%	13.3%	80.2%	17.2%
	Redesign	Low AT	0%	0%	2.27%	0%
		Medium AT	50%	0%	2.27%	0%
		High AT	50%	6.67%	92.3%	2.8%

**Reported ELA (n = 5); Observed ELA (n = 3); **Reported non-ELA (n = 12); Observed non-ELA (n = 4)*

Research question 3. *Which first and second-order barriers do teachers* *report* *as influencing their decisions to use or not use AT?*

This research question drew from teacher reports in the survey (Q#23, 25) and interviews (TIQ6-9, Q11-19). The survey identified four main barriers to using AT, all first-order. These included: limited access to certain technologies, students' refusal to use AT accommodations, the disruption AT brings when used for instruction (such as time and tech quality or trouble shooting restraints), and limited AT training. However, during the interviews, although the teachers continued to note the insufficient professional development, more connectivity and poor quality or lack of computer equipment (e.g. two of the observed teachers did not actually have student computer stations in their classroom therefore the use of many of the computer-based programs available at the school could not be observed) as well as the lack of financial resources, another barrier emerged from their reports: the lack of time to prepare digital materials or otherwise integrate AT into their instruction. For five of the interviewed teachers, the time barrier was triggered by challenges of being new to teaching, which required juggling multiple tasks and expectations.

Of the second-order barriers, the teachers' comfort level with technology was most often cited by teachers during interviews. While the interviewed teachers all acknowledged working in an environment where the use of technology for instructional purposes is encouraged, they did not evidence the frequent use of a variety of AT. For most of those interviewed this was due to insufficient knowledge. Also, some of the teachers commented during their interviews that they preferred obtaining professional development related to AT on their own time and in their own way as opposed to the professional development offered by the school "since the on-site workshops are usually group trainings and one person is trying to train all the staff at once which makes it less convenient." Yet, it is not clear whether they actually participated in any of the professional development, either provided by the school or outside the school.

Research question 4. *How do the observed and reported AT use with students with SLD align with the types of AT and their use documented in the students' IEPs?*

I have used all four data collection venues (teacher survey, classroom observations, teacher interviews, and the IEP review) to answer this research question. Without exceptions, teachers noted that they made it a priority in the beginning of the school year or upon enrolling a new student to review the Instructional Accommodations and Supplementary Aids sections in their students' IEPs. Given the similar types of AT noted across all of the IEPs, which was mostly low and medium AT, the teacher observed and reported use of AT was aligned. According to the IEP review, students were expected to be provided with highlighters, organizational aids, graphic organizers, content-area manipulatives (low AT) as well as spelling and grammar devices, word processors, and audio materials (medium AT). Survey results and observations found all of these to be used in the classrooms.

With respect to the use of high AT, a smaller percentage (27%) of the IEPs included high AT (such as speech-to-text and text-to-speech software). This was reflected in the classroom observations where the only teachers who were observed to use a screen reader for instructional purposes were the social studies teacher and one of the ELA teachers. However, in both cases, these teachers used software that was not provided by the school but were open-source programs. Another ELA teacher offered her students the use of Kurzweil, the screen reader that the school provided, in order to assist them with editing their written work, but the students declined to use it.

Summary

This chapter has reported the results of the individual components of the research study and combined those results in an attempt to address the four research questions. In summary, the results suggest that AT used in this research site was predominantly low and medium technology for purposes such as Augmentation (mostly) and Modification. Teachers reported barriers to AT use that were consistent with first-order barriers identified by previous literature (Brickner, 1995) such as lack of financial resources, and professional development. Less experienced teachers also frequently reported insufficient time given all of the demands associated with beginning teaching.

The IEP review also revealed that AT accommodations and supports continue to focus on low and medium AT even in a school that provides access to an array of high technology.

Chapter 5: Discussions and Limitations

The purpose of this study was to build on previous literature regarding teacher use of AT as the benefits of integrating technology in the education of students with disabilities have long been documented. This research project intended to further the understanding how special education teachers make use of the *entire* AT continuum in special education (low to high), including the type, the frequency, and the purpose of AT use. Additionally, building on Brickner's (1995) work on the barriers to use of technology, I have sought to identify the first- and second-order barriers that special education teachers report when implementing AT.

Special Education Teachers and the Use of AT

The findings of this research study revealed a few patterns. Although there were some differences recorded across the teacher use of AT based on resources, training, experience, and comfort level, overall the participants in this study demonstrated alignment between the expected use of AT (per the IEP provisions), their self-reports of AT use, and the findings of the observations of their classrooms.

Type and frequency of AT. Overall the type and frequency of AT was consistent across teacher reports in that most participants (ELA and non-ELA) reported to using low and medium AT such as organizational aids, graphic organizers, and content-area manipulatives on *daily* basis. Higher AT was mostly reported and observed for *occasional* use of at least 2-3 times per week. However, research question #2 (Table 20) did reflect a few findings worth noting for both ELA and non-ELA teachers. In the case of ELA teachers, they reported using low and medium AT more than they were observed to do so while high AT was recorded being used during classroom observations more than teachers reported using it. This could have been facilitated by the fact that classroom observations were announced, therefore teachers could have potentially restructured their lesson plans to reflect increased use of high AT which, according to the follow-up interviews, teachers thought were expected to implement. In turn, the non-ELA teachers believed to be using more medium and high AT than low AT although their observations revealed the opposite. In fact, during classroom observations, only *occasional* use of medium and high AT was recorded.

However, the explanation behind these results can also lie in variations among teachers and their understanding of the low/medium/high AT classification. Also, the apparent uniformity in type and frequency of AT use across teachers could reflect both compliance with the IEPs (which was fully established) but also teaching practices aligned with the learning profile of students with learning disabilities.

Purpose of AT use. While SAMR was a new concept to the teacher participants in this research study, which, undoubtedly, would need additional application and reflection to see its direct connection to the classroom environment, teacher reports and classroom observations appeared to be in sync and depict a similar picture with regard to the purpose of AT use. The findings of the teacher survey revealed that teachers mostly used AT for Augmentation and Modification of instructional tasks and only occasionally they engaged in using technology for either Substitution or Redefinition. Catering to these middle levels might be an indication of the connection made by the teachers between the functions of low and medium AT but to establish an actual significant relationship would require additional investigation. Throughout the teacher interviews, only two instances have been recorded of teachers alluding to high AT potentially needed in Redefinition of task is to be attempted. The use of AT for Redefinition purposes was only observed twice in 14 days of classroom observations which, again, could be an indication that, since high AT was the least used, then maybe the connect exists but this research study has insufficient data to prove that. The two teachers who were observed to use AT to redesign their instructional tasks included a senior and a beginning teacher. Despite their difference in years' experience, both of these teachers indicated that frequently used a variety of technologies in their daily life as well as well as in their classrooms. This might indicate an increased comfort-level as well as ability to use technology in various ways that could relate to AT use at more advanced SAMR levels.

First-order Barriers

Even in a school that has attempted to remove or reduce the first-order barriers such as ensuring availability of AT from the entire continuum (low, medium, and high, even though unevenly distributed), making efforts to provide professional development opportunities on the AT available at the school (even though limited or suffering from time constraints), teachers continued to identify first-order barriers as their pre-eminent roadblocks in making use of AT. The teacher survey and interviews revealed different first order barriers. Whereas the survey responses revealed the top three barriers to be access to AT, student refusal to use AT, and the disruption caused by the use of AT during instruction, during the interviews teachers noted lack of time to plan and prepare to teach with AT, technical support issues and limited AT knowledge. These differences might be explained by insufficient teacher representation across classroom observations compared to the survey participation (7 vs. 17). However, 5 of the 7 teachers that were observed had the characteristics of the typical teacher in this school in that they had been teaching for less than three years and were younger than 35 years old (47% of teachers in the program had the same characteristics). Another possible explanation could be that the survey asked the teachers to rank AT barriers from a set of choices established by the literature in the field (which, as stated in Chapter 2, did not focus on special education or second-order barriers) such as limited access to technology, limited training on how to use technology, and the quality of available technology rather than allowing them to identify these on their own. This was attempted through post-observation interviews with the teachers when they were specifically asked to indicate what, why, and how often they used AT which not only addressed their observed practice directly but encouraged them to reflect on it as well. Finally, a third potential explanation could be that a large number (5 of 7) of teachers who agreed to participate in the second phase of the study were not only beginning teachers but experiencing their first year in this school which appeared in to influence their perceptions of the barriers.

Second-order Barriers

According to Brickner (1995), second order barriers include those things that are more difficult to measure such as underlying beliefs about teaching. However, the rationale for selecting the school as the research site was driven by the fact that the school provided an array of AT to teachers, encouraged its use, and provided professional development. As noted by Brickner (1995), second-barriers are often not easily known or acknowledged by the teachers due to their intrinsic nature and, especially in such circumstances when teachers are given the freedom to make instructional decision about how to implement AT for students with disabilities, the presence of teacher-specific factors can greatly impact the individualization of instruction with AT.

I found Brickner's statement to be true with respect to the current study. The only teacher specific factors that appeared to impact the use of AT were experience and, for two of the teachers who were interviewed, personal opinions about the efficacy of AT as compared to their traditional teaching practices. According to teacher reports during interviews, the teacher's comfort level with technology was most frequently noted as a factor influencing the implementation of AT. Interestingly, this lack of comfort was attributed to such things as lack of knowledge, concerns about spending too much planning time to deal with technology maintenance issues network connections to the detriment of not being fully prepared for instruction, and not always having enough time and resources to explore other, more complex, uses of AT. These attributions appear to circle back to first-order barriers which could be a potential indication of a relationship with the first-order barriers.

Limitations

This research study used a very small sample for the teacher survey and even smaller for the classroom observations and subsequent interviews. Therefore, the ability to generalize these findings is not possible.. A second important limitation is related to the novelty of the SAMR framework, which was not familiar to any of the participants at the time they responded to the survey and even during the interviews. Although descriptions of the SAMR levels as well as examples were provided for the teachers, the taxonomy builds on constructs that overlap and may be confusing, thus threatening the validity of the findings.

Another limitation was not focusing the use of AT with specific students.

Notwithstanding, the exclusion of students as an important variable that influences the teachers' ways of implementing AT, most teachers seemed to report using AT rather globally, based on instructional needs and not specifically based on an IEP. A final limitation is the prior knowledge of the school that I, as the researcher, had. This knowledge was a two-edged sword. While it informed the questions I asked during the teacher interviews and in the survey, I believe it might have influenced who was willing to participate in the classroom observations and interviews as some of the senior teachers were aware of my knowing all the current school's administrators.

Potential Implications

Research implications. There are many areas of further research interest that have emerged from this research study.

Also, while the classification AT as low, medium, and high has generally been used in the field of special education, the introduction of the concept of purpose of use of AT such as defined by SAMR has the potential to expand teachers' understandings of AT and the role of technology in the instruction of students with disabilities. This study suggests a need to increase awareness among teachers about the different ways in which students can use AT supports beyond just Substitution and Augmentation of tasks.

Also, delving deeper into the teacher-specific barriers, it would be valuable to further research on second-order barriers such as an individual's resistance to re-aligning their teaching philosophy to accommodate a new generation of learners who now has easy access to various technologies. Finally, the brief glimpse of the potential relationships between first-order and second-order barriers for both experienced and inexperienced teachers that this research study has provided might warrant further attention in the research if we are to fully understand the set of roadblocks educators experience when they have to implement technology in instruction.

Practice implications. The discussion surrounding the use of AT as defined by type and purpose should find a place in all teacher preparation programs. Through a modest attempt to unpack multiple layers on the use of AT, this research study shed light on how limited even more experienced special education teachers were in their AT implementation. The lack of teacher knowledge and preparation regarding how to use the less "popular" AT (such as high AT which brings more complexity to the task of using it) can be an indication that a school's professional development opportunities may not be enough to build a healthy foundation for preparing teachers how to use AT supports for students with disabilities. Given various constraints of time and resources, it seems important that teachers be able to enter their first classroom with sound knowledge about and comfort in using a variety of AT. Also, for teachers who are already in the classroom, there appears to be a clear need of additional planning time when they may work with others to explore the use of AT as well as plan for its use. This is more than initial professional development; teachers need time to implement the extra steps required to prepare digital materials. As such, administrators should consider re-evaluating the school's schedules in order to identify blocks of planning time for teachers to engage in these types of activities during the school day.

Finally, there appears to be a need for a framework or link between a student's IEP and classroom implementation of technological supports. While AT is required to be considered and listed in student IEPs, the ways in which a particular device could be used is left up to teachers and their own time, knowledge, and judgments. As shown in this study, for beginning teachers this can be a challenging task.

Policy implications. Increasing teacher planning time is both a practice and a policy implication. If the expectation is that special education teachers are to use an increasing variety of AT devices and supports, then their heavy paperwork and other unique workloads must be adjusted. The level of individualization of instruction that students with learning disabilities require cannot be supported along with record keeping and other special education teacher-specific tasks (such as, for instance, participation in IEP meeting which usually occur during school hours or individualizing curriculum content) without changes in the special education teachers' schedules.

Conclusion

The findings of this research study indicated that even in an environment where the implementation of technology is dictated by the program's instructional philosophy and is perceived as a core competency for the students, teachers continue to run into a variety of barriers when using AT. First, the type and frequency of AT use revealed that, although aligned to the IEP expectations, it didn't demonstrate individualized AT use per student but rather per the overall student profile of the program. Also, the teachers' use of AT fluctuated between low and medium AT and only occasionally included high AT which brings about improved capabilities of instruction; in fact, the overall use seemed to focus on medium AT. Second, the purpose of AT showed that, although teachers did not dwell on using AT for pure Substitution in tasks traditionally completed by teachers (such as hand-editing written work, for example), they are yet to show evidence that AT can be used to Redefine instruction for students with disabilities. In fact, a revisit of the SAMR model's connection to Bloom's taxonomy, might raise further questions as to whether teachers see the connections between various AT capabilities and cognitive tasks. This connection would, undoubtedly, warrant further research inquiries while, at the same time, would bring focus on teachers' pedagogy, which relates to planning for certain intellectual behaviors during learning, especially for students with learning disabilities.

Appendix A

Teacher Survey (Qualtrics)

QI. This study attempts to collect information about the use of assistive technology (AT) by special education teachers in secondary content areas and the reported barriers to use. Your participation in the Teacher Survey would include a 30-minute web-based questionnaire including items about the use of AT such as the type, the frequency, and the level of use. The survey will also record unidentifiable data regarding your professional background (age, training level, certification type, and content area that you teach).

Risks/Discomforts. There are no more than minimal risks known to participants. In order to prevent breach of confidentiality, your responses will be anonymous

Benefits. There are no direct benefits from participating in this research. However, the findings of this research project may inform the field of special education about potential factors both extrinsic and intrinsic to teachers that influence the implementation of AT for students with learning disabilities and indicate potential areas of need for teacher professional development in the school.

Confidentiality. All data obtained from participants will be anonymous and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). All questionnaires will be concealed, and no one other than then primary investigator listed below will have access to them. The data collected will be stored in the HIPPA-compliant, Qualtrics-secure database until it has been deleted by the primary investigator

Participation. Participation in this research study is completely voluntary. You have the right to withdraw at anytime or refuse to participate entirely without jeopardy to your employment status with the school. If you desire to withdraw, please close your internet browser and notify the principal investigator at this email: cconsta1@umd.edu. Your decision will not be shared with any of the school administrators or other staff members.

QII. I have read, understood, and printed a copy of, the above consent form and desire of my own free will to participate in this survey.
- ❍ Yes
- ❍ No

Q1. Which of the following best describes your age:
- ❍ 35 and younger
- ❍ 36 - 50
- ❍ 50 - 65

Q2. Counting this school year, how many years of special education teaching experience do you have?
- ❍ 0 - 3
- ❍ 4 -7
- ❍ More than 7

Q3. Counting this school year, how many years have you taught students with Specific Learning Disabilities? (This may have been in any capacity including general education teacher, co-teacher, separate resource room or special program).
- ❍ Less than 1
- ❍ 1 - 3
- ❍ More than 3 years

Q4. Counting this school year, how many years have you been teaching in this school?
❍ Less than 1
❍ 1 - 3
❍ More than 3

Q5. Of your total years of teaching experience with children with specific learning disabilities (SLD), how many did you spend in each of the following settings (including the current school year)?

	Never taught	0-3 years	4-7 years	More than 7 years
General education teacher	❍	❍	❍	❍
Self-contained classrooms or programs	❍	❍	❍	❍
Resource Room	❍	❍	❍	❍
Other (residential, hospital)	❍	❍	❍	❍

Q6. What subject/s do you currently teach? Check all that apply.
❑ English Language Arts
❑ Mathematics
❑ Social Studies
❑ Science
❑ Other

Q7. What content areas are you certified to teach? Check all that apply.
❑ English Language Arts
❑ Mathematics
❑ Social Studies
❑ Science
❑ Other

Q8. Have you ever received any training (any formal preparation, tutorial) in the use of assistive technology (AT) with students with SLD?
❍ Yes
❍ No

Q9. Where did you receive the AT training? Check all that apply.
❑ I received training during my undergraduate and/or graduate coursework
❑ I received professional development (individual coaching, workshops, conferences etc. while in my present or a prior another position)
❑ I have received training during opportunities I sought out on my own.

Q10. Which of the statements below best characterizes your familiarity with AT? For the purpose of this question, theoretical knowledge refers to knowing, in theory, how the AT can be used and for which purposes; the practical use refers to your actual use and level of comfort when using the AT as it is intended or for any other instructional uses. Please select only one.

- ❍ Very familiar (comfortable with both theoretical knowledge AND practical use)
- ❍ Somewhat familiar 1 (comfortable with theoretical knowledge BUT not as much with practical use)
- ❍ Somewhat familiar 2 (comfortable with practical use BUT not as much with theoretical knowledge)
- ❍ Not at all familiar (NOT comfortable with either theoretical knowledge or practical use)

Q11. Which of the statements below about AT best represents your understanding of the concept of assistive technology?

- ❍ AT only refers to non-computer technology (such as highlighters, paper-based graphic organizers, magnifiers, pencil grips so on)
- ❍ AT only refers to software used to assist students with disabilities
- ❍ AT only refers to hardware (low to high-tech equipment) used to assist students with disabilities
- ❍ AT refers to all low to high technology (including non-computer tools) devices and software

Q12. Given the past 5 full school instructional days, which of the following AT did you use and how frequently did you use it? If you are completing this survey prior to the end of the school day, please do not count the current day

	Frequency of use		
	Daily	2-3 times/ wk	Never
Low AT (non-computer technology such as highlighters, graphic organizers, concept maps, pencil grips, calculators, non-electronic manipulatives)	❍	❍	❍
Medium AT (computer-based tech such as online dictionaries, electronic worksheets, online content-area practice/drill programs, Moodle for course materials storage and display, Smartboard for material display to whole group only)	❍	❍	❍
High AT (computer-based tech such as Smartboard for interactive purposes, Moodle for interaction with course materials, SmartPens, Smart Tablets, Lexia, Kurzweil, TextAloud, ReadPlease, WriteType, Dragon Naturally Speaking, Special Fonts (OpenDyslexic, Lexia Readable, Tiresias Infofont), My Homework App, Everstudent/Evernote, Mahara, Voice-Dream, iThoughts, Dragon Dictation)	❍	❍	❍

Q13. In the past 5 full instructional days, for which of the purposes below did you use AT? Response scale uses percentage estimates (0-100%) across 5 days. Please slide the cursor across the middle bar to select desired percentage. If you are completing this survey prior to the end of the school day, please do not count the current day. Additional examples for each level of use are available
______ I use AT as a SUBSTITUTE for other, more traditional tasks (involves the use of technology for tasks that used to be and still could be easily completed without it; for example, reading certain text online versus its print version [without the use of text-to-speech function - Substitution Examples)
______ I use AT to AUGMENT curriculum (involves the use of AT for functional improvement but is still a direct tool for substitute; for example, accessing online resources for text such as dictionaries, additional/optional content links, study guides and so on - Augmentation Examples)
______ I use AT to MODIFY the learning process (involves different kinds of assignment; for example, adding audio and video to text for the purpose of enhancing the message of a given text or improve the reading experience -Modification Examples)
______ I use AT to REDEFINE the learning process (involves tasks that cannot be completed without AT; for example, students using learning platforms [such as Moodle, Blackboard] to share products with larger audience who can, in turn, provide specialized feedback) - Redefinition Examples).

Q14. The next two questions will focus on how often you use certain AT and for which purpose given the specific content area/s that you teach. Please, select your content area/s below.
- ❍ Reading/English Language Arts
- ❍ Math only
- ❍ Math and Science
- ❍ Social Studies
- ❍ Science only
- ❍ Other

Q15. [Reading/ELA] How frequently do you use the AT listed below and for which purpose?

	Frequency of use			Purpose of use				
	Daily	2-3 times/wk	Never	Substitute	Augment	Modify	Redesign	N/A
Highlighters	❍	❍	❍	❍	❍	❍	❍	❍
Pencil grips	❍	❍	❍	❍	❍	❍	❍	❍
Graphic organizers	❍	❍	❍	❍	❍	❍	❍	❍
Electronic worksheets	❍	❍	❍	❍	❍	❍	❍	❍
Smartboard	❍	❍	❍	❍	❍	❍	❍	❍
Kurzweil	❍	❍	❍	❍	❍	❍	❍	❍
Talk-Aloud	❍	❍	❍	❍	❍	❍	❍	❍
WriteType	❍	❍	❍	❍	❍	❍	❍	❍
Dragon Naturally Speaking	❍	❍	❍	❍	❍	❍	❍	❍
Dragon Dictation	❍	❍	❍	❍	❍	❍	❍	❍
Smart Pen	❍	❍	❍	❍	❍	❍	❍	❍
Apps (Evernote, iThoughts, Flashcards, myHomework, other)	❍	❍	❍	❍	❍	❍	❍	❍
Lexia	❍	❍	❍	❍	❍	❍	❍	❍
Moodle	❍	❍	❍	❍	❍	❍	❍	❍
Online dictionary	❍	❍	❍	❍	❍	❍	❍	❍
Tablets	❍	❍	❍	❍	❍	❍	❍	❍
Word processor	❍	❍	❍	❍	❍	❍	❍	❍
Audio books	❍	❍	❍	❍	❍	❍	❍	❍
ReadPlease	❍	❍	❍	❍	❍	❍	❍	❍
Special Fonts	❍	❍	❍	❍	❍	❍	❍	❍
Smart phones	❍	❍	❍	❍	❍	❍	❍	❍
Presentation software (Powerpoint, Prezi, other)	❍	❍	❍	❍	❍	❍	❍	❍

Q15a. You will now skip to question 20. Please, select Yes only if you have finished answering all items on this page.

❍ Yes

Q16 [Math] How frequently do you use the AT listed below and for which purpose?

	Frequency of use			Purpose of use				
	Daily	2-3 times/wk	Never	Substitute	Augment	Modify	Redesign	N/A
Traditional calculator	❍	❍	❍	❍	❍	❍	❍	❍
Talking calculator	❍	❍	❍	❍	❍	❍	❍	❍
Highlighters	❍	❍	❍	❍	❍	❍	❍	❍
Math manipulatives	❍	❍	❍	❍	❍	❍	❍	❍
Virtual (online or computer-based) math manipulatives	❍	❍	❍	❍	❍	❍	❍	❍
Math Games (computer-based)	❍	❍	❍	❍	❍	❍	❍	❍
Videos, tutorials	❍	❍	❍	❍	❍	❍	❍	❍
Electronic worksheets	❍	❍	❍	❍	❍	❍	❍	❍
Smartboard	❍	❍	❍	❍	❍	❍	❍	❍
Computer for practice/drill activities	❍	❍	❍	❍	❍	❍	❍	❍
Kurzweil	❍	❍	❍	❍	❍	❍	❍	❍
TextAloud	❍	❍	❍	❍	❍	❍	❍	❍
SmartPen	❍	❍	❍	❍	❍	❍	❍	❍
Pencil Grips	❍	❍	❍	❍	❍	❍	❍	❍
Dragon Naturally Speaking/Dictation	❍	❍	❍	❍	❍	❍	❍	❍
Tablets	❍	❍	❍	❍	❍	❍	❍	❍
Smart phones	❍	❍	❍	❍	❍	❍	❍	❍
Presentation software (Powerpoint, Prezi, other)	❍	❍	❍	❍	❍	❍	❍	❍
Apps (Evernote, iThoughts, Flashcards, myHomework, other)	❍	❍	❍	❍	❍	❍	❍	❍
Moodle	❍	❍	❍	❍	❍	❍	❍	❍

Q17. [Science] How frequently do you use the AT listed below and for which purpose?

	Frequency of use			Purpose of use				
	Daily	2-3 times/wk	Never	Substitute	Augment	Modify	Redesign	N/A
Highlighters	❍	❍	❍	❍	❍	❍	❍	❍
Pencil grips	❍	❍	❍	❍	❍	❍	❍	❍
Manipulatives	❍	❍	❍	❍	❍	❍	❍	❍
Virtual manipulatives	❍	❍	❍	❍	❍	❍	❍	❍
Media, videos, online tutorials	❍	❍	❍	❍	❍	❍	❍	❍
Online dictionary	❍	❍	❍	❍	❍	❍	❍	❍
Kurzweil	❍	❍	❍	❍	❍	❍	❍	❍
Text Aloud	❍	❍	❍	❍	❍	❍	❍	❍
Other screen reader	❍	❍	❍	❍	❍	❍	❍	❍
Browser/Internet for science activities	❍	❍	❍	❍	❍	❍	❍	❍
Calculators	❍	❍	❍	❍	❍	❍	❍	❍
Talking calculators	❍	❍	❍	❍	❍	❍	❍	❍
Inspiration (electronic graphic organizers	❍	❍	❍	❍	❍	❍	❍	❍
Word processor	❍	❍	❍	❍	❍	❍	❍	❍
Computers for offline class activities	❍	❍	❍	❍	❍	❍	❍	❍
Headphones	❍	❍	❍	❍	❍	❍	❍	❍
Presentation software (Powerpoint, Prezi, other)	❍	❍	❍	❍	❍	❍	❍	❍
SmartBoard	❍	❍	❍	❍	❍	❍	❍	❍
Smart Pen	❍	❍	❍	❍	❍	❍	❍	❍
Electronic worksheets	❍	❍	❍	❍	❍	❍	❍	❍
Moodle	❍	❍	❍	❍	❍	❍	❍	❍
Interactive online tools	❍	❍	❍	❍	❍	❍	❍	❍
Apps (Evernote, iThoughts, Flashcards, myHomework, other)	❍	❍	❍	❍	❍	❍	❍	❍

Q17a. You will now skip to question 20. Please, select Yes only if you have finished answering all items on this page.
❍ Yes

Q18. [Social Studies] How frequently do you use the AT listed below and for which purpose?

	Frequency of use			Purpose of use				
	Daily	2-3 times/wk	Never	Substitute	Augment	Modify	Redesign	N/A
Highlighters	❍	❍	❍	❍	❍	❍	❍	❍
Apps (Evernote, iThoughts, Flashcards, myHomework, other)	❍	❍	❍	❍	❍	❍	❍	❍
Manipulatives	❍	❍	❍	❍	❍	❍	❍	❍
Browser/Internet for student use	❍	❍	❍	❍	❍	❍	❍	❍
SmartBoard	❍	❍	❍	❍	❍	❍	❍	❍
SmartPen	❍	❍	❍	❍	❍	❍	❍	❍
Virtual maps and timelines	❍	❍	❍	❍	❍	❍	❍	❍
Kurzweil	❍	❍	❍	❍	❍	❍	❍	❍
Text Aloud	❍	❍	❍	❍	❍	❍	❍	❍
Other screen reader	❍	❍	❍	❍	❍	❍	❍	❍
Inspiration software	❍	❍	❍	❍	❍	❍	❍	❍
Graphic organizers	❍	❍	❍	❍	❍	❍	❍	❍
Media, videos	❍	❍	❍	❍	❍	❍	❍	❍
Online dictionary	❍	❍	❍	❍	❍	❍	❍	❍
Browser/Internet for teacher use	❍	❍	❍	❍	❍	❍	❍	❍
Computer use for offline classroom activities	❍	❍	❍	❍	❍	❍	❍	❍
Online encyclopedias, Atlas	❍	❍	❍	❍	❍	❍	❍	❍
Interactive online tools	❍	❍	❍	❍	❍	❍	❍	❍
Tablets	❍	❍	❍	❍	❍	❍	❍	❍
Smart phones	❍	❍	❍	❍	❍	❍	❍	❍
Moodle	❍	❍	❍	❍	❍	❍	❍	❍

Q18a. You will now skip to question 20. Please, select Yes only if you have finished answering all items on this page.
❍ Yes

Q19. [Other] How frequently do you use the AT listed below and for which purpose?

	Frequency of use			Purpose of use				
	Daily	2-3 times/wk	Never	Substitute	Augment	Modify	Redesign	N/A
Highlighters	❍	❍	❍	❍	❍	❍	❍	❍
Pencil grips	❍	❍	❍	❍	❍	❍	❍	❍
Word Processor	❍	❍	❍	❍	❍	❍	❍	❍
Browser/Internet for classroom activities	❍	❍	❍	❍	❍	❍	❍	❍
Online dictionaries	❍	❍	❍	❍	❍	❍	❍	❍
Interactive online tools (virtual manipulatives, programs)	❍	❍	❍	❍	❍	❍	❍	❍
Electronic worksheets	❍	❍	❍	❍	❍	❍	❍	❍
Videos, tutorials	❍	❍	❍	❍	❍	❍	❍	❍
Content-specific classroom/offline manipulatives	❍	❍	❍	❍	❍	❍	❍	❍
Tablets	❍	❍	❍	❍	❍	❍	❍	❍
Smart phones	❍	❍	❍	❍	❍	❍	❍	❍
Kurzweil	❍	❍	❍	❍	❍	❍	❍	❍
Text Aloud	❍	❍	❍	❍	❍	❍	❍	❍
Dragon Naturally Speaking	❍	❍	❍	❍	❍	❍	❍	❍
Dragon Dictation	❍	❍	❍	❍	❍	❍	❍	❍
Read Please	❍	❍	❍	❍	❍	❍	❍	❍
Inspiration (electronic graphic organizers)	❍	❍	❍	❍	❍	❍	❍	❍
Smart Board	❍	❍	❍	❍	❍	❍	❍	❍
Smart Pen	❍	❍	❍	❍	❍	❍	❍	❍
Moodle	❍	❍	❍	❍	❍	❍	❍	❍
Apps (Evernote, iThoughts, Flashcards, myHomework, other)	❍	❍	❍	❍	❍	❍	❍	❍

Q20. Do you think the use of AT can benefit certain content areas more than others?
❍ Yes
❍ No

Q21. Which content area/s do you think benefit/s more from use of AT? Please select only one.
❍ Reading
❍ English Language Arts
❍ Math
❍ Content areas (Social Studies, Science)
❍ All content areas benefit from use of AT equally
❍ Other

Q22. If you selected Other, please explain.

Q23. Please, rank in the order of importance 1 being the least important and 5 being the most important, the factors that influence your decision to NOT use AT in your instruction.
______ I have limited or no access to AT that I would like or need to use
______ I have limited or no training in how to use AT
______ I do not believe AT is helpful in the learning process
______ The use of AT disrupts the instruction due to issues such as time and tech constraints or other
______ Students often refuse to use AT

Q24. Please, indicate if there are any other factors influencing your decision to NOT use AT and if you would like to include any related comments.

Q25. Please, rank in the order of importance 1 being the least important and 5 being the most important the factors that have influence your decision to MAKE USE of AT in your instruction.
______ AT is needed to compensate for needs associated with my students' learning disabilities
______ AT allows me to engage my students in more advanced learning tasks that I couldn't conduct otherwise
______ I am required to use AT per student IEPs, it is a compliance issue
______ My students request the use of AT
______ Use of AT is part of my teacher evaluation

Q26. Please, indicate if there are any other factors influence your decision to use AT or include any other related comments as needed.

Q27. Please, include any additional comments you would like to make regarding your use of AT in your teaching of students with learning disabilities such as: you may include additional AT that was not listed for your content area, you may provide clarifications for certain answers and so on. Please, include N/A if you don't wish to make any additional comments. Thank you!

Appendix B

Teacher Interview Questions (TIQ#)

Use of AT

1. What is your definition of AT (what it is used for and how)?
2. How do you decide to use AT in your instruction?
3. Do you use a student's IEP to guide you in your use of AT during instruction and lesson planning?
4. Are there any other reasons why you use AT aside from the IEP?
5. Are you more likely to use AT with select students or in select lessons? If so, why?
6. Do you have preferences for certain AT? Why or why not?
7. Does the content area that you teach influence your use of AT? Why or why not?
8. When you recommend AT for a student's IEP, do you base that recommendation on certain factors such as student individual needs, access, training, personal comfort level, or do you use the disability category to guide you? If yes, could you give an example?
9. Are there are any others reasons you would use to recommend AT?
10. How do you think AT supports your lesson planning and instruction for all as well as individual students?
11. Do you feel prepared to teach with AT? If not, how did you learn to use AT available at your school?

12. Did you have any preparation to use AT for instructional purposes? If yes, where or which type (workshop, college coursework, professional development, and so on)?

Factors influencing the use of AT

13. What factors influence your use of AT during planning and instruction?
14. What kind of barriers do you run into when considering the use and/or implementing AT?
15. Are there any barriers to using AT in your practice that, if removed, would significantly improve your use of it?

Teaching style and philosophy

16. What is your teaching philosophy about how students learn?
17. How and where do you think AT fits into your teaching philosophy?
18. Are there any specific factors that could influence your teaching beliefs about using AT during instruction?
19. How confident do you feel in using AT effectively?

Classroom observation questions

I noticed that you _______________. Follow up questions.

Appendix C

Observation and Review Forms

Table C1

AT constructs to be used during observations and IEP review

Type of AT used			AT level of use*			
Low (AT-L)	Medium (AT-M)	High (AT-H)	Substitute (AT-S)	Augment (AT-A)	Modify (AT-M)	Redesign (AT-R)
No electronics. Easy to use.	Simple electronics. Relatively complicated mechanical devices.	Complex electronic devices.	Technology used only to provide a substitute for other learning activities without functional change.	Technology use for its added functionalities but still without functional change.	Technology used for significant task redesign	Technology used for higher order thinking skills such as synthesis and evaluation of a task.
Examples: pencil grips, specialty paper, planners, highlighting pens or tape, dry erase board.	*Examples:* tape recorder, calculator, timer, voice output communication aids, online dictionaries, outlining/presentation software,	*Examples:* specialized software (TTS, SST), talking calculator, portable keyboards, electronic spell checkers, mind mapping, SMART technology	*Examples:* Google Docs used only for its word processor abilities.	*Examples:* Google Docs used for storing and sharing files online.	*Examples:* Google Docs used for collaboration on a project.	*Examples:* Google Docs would be used to engage in discussions and reflections about differences and similarities of a given task while targeting innovative solutions to current affairs and contexts.

*The AT level of use has been defined based on the SAMR model (Puentendura, 2006)

Teacher code _________

Date ___________________

Day _____ Period ______

Table C2

Classroom Observation Form

Type of AT	Frequency	
	Single	Multiple (#)
Type #1		

SAMR level	Check	Comments/Description
Substitute		
Augment		
Modify		
Redefine		

Type of AT	Frequency	
	Single	Multiple (#)
Type #*n*		

SAMR level	Check	Comments/Description
Substitute		
Augment		
Modify		
Redefine		

Table C3

IEP Record Review – Data Collection Sheet

IEP	**AT devices (list by type/name)**		**Frequency**	**Level of use (if available)**
IEP #1	AT-L			
	AT-M			
	AT-H			
IEP #*n*	AT-L			
	AT-M			
	AT-H			

Appendix D

Table D1

Summary of Samples in the Reviewed Literature

Study	*N*	Gender M	Gender F	Race*	School Level/ Teaching area	Education level	Experience level (years)
QUANTITATIVE STUDIES							
Abbitt (2011)	45	n/a		n/a	Preservice teachers	n/a	n/a
Abner & Lahm (2002)	72	n/a		n/a	In-service teachers (0-12) Pre-service teachers	Ph. D. (1%) Master's+ (24%) Master's (25%) Bachelor's+60 (43%) Bachelor's (7%)	*M* = 10.1
An & Reigeluth (2011-12)	126	7%	93%	n/a	K-12 teachers	n/a	*M* = 10.2
Barron et al. (2003)	2,156	17%	83%	n/a	K-12 teachers English (33%) Math (28%) Science (20%) Social studies (19%)	Ph. D. (2%) Master's (36%) Bachelor's (61%) Other (1%)	0 -1 (6%) 2 -10 (31%) 11 – 19 (24%) 20+ (39%)
Brickner (1995)	24	13	9	n/a	Elementary (5) Middle (14) High (3)	n/a	n/a
Christensen (2002)	60	n/a		n/a	Elementary (PreK-5)	n/a	n/a
Derer et al. (1996)	405	n/a		n/a	79% Sp.Ed. teachers IN 89% Sp.Ed. teachers KY 89% Sp.Ed. teachers TN Elementary (46% - IN, 49%, KY, 49% TN)	53% inservice IN 44% inservice KY 52% inservice TN	n/a

Study	*N*	Gender		Race*	School Level/ Teaching area	Education level	Experience level (years)
		M	F				
				QUANTITATIVE STUDIES			
Ertmer et al. (2006-2007)	25	16		9	K-12	Master's (80%)	Average of 16 years <12 (48%)
Flanagan et al. (2013)	51	10%	90%	n/a	Middle School	Master's (65%)	1 - 25 years (range)
Franklin (2007)	100	n/a		n/a	Graduates of teacher preparation programs/ Elementary	BA/MT PG/MT	n/a
Gorder (2008)	174	16%	84%	n/a	K-12 teachers English (16%) Math/Science (17%) Social studies (4%) Fine Arts (5%) Business/Computers (17%) Multiple (21%) Other (20%)	Ph. D. (4%) Master's (34%) Bachelor's (62%)	0 -10 (11%) 11 – 15 (48%) 26+ (41%)
Jost & Mosley (2010)	224		n/a		89 preserviece 135 inservice teachers	n/a	n/a
Lahm & Sizemore (2002)	15	n/a		n/a	Speech-language pathologists (6) AT suppliers (4) Educators (2) AT practitioners (2) OT therapists (1)	Ph. D. (1) Master's (7) Bachelor's (4) No degree (3)	0 - 2 (7%) 2 – 5 (20%) 5 – 8 (7%) 8 – 15 (33%) 15+ (33%)
Lei (2009)	55	16%	84%	n/a	Preservice teachers	n/a	n/a
Lesar (1998)	62	2%	98%	97% WC 2% AA 2% other	ECE teachers	Master's (58%) Bachelor's (39%) High school (3%)	$M = 8.19$

Lowther et al. (2008)	927	n/a	n/a	K-12	n/a	n/a

QUALITATIVE/MIXED-METHODS STUDIES

Study	*N*	Gender (F/M)		Race*	School Level/ Teaching area	Education level	Experience level (years)
Ertmer et al. (1999)	7	0%	100%	n/a	Elementary (K-2)	n/a 86% moderate-very comfortable with technology	*M* = 12
Ertmer et al. (2012)	12	42%	58%		75% Elementary 17% Middle 8% High 1 computer teacher	n/a Technology awards	*M* = 14.8
Hughes (2005)	4	1	3	n/a	Elementary (1) Middle (1) High (2)	n/a	Novice (1) Mid-career (2) Veteran (2)
Hutinger et al. (1996)	14	n/a		n/a	Student-with-disabilities sample; Multiple disabilities	n/a	n/a
Todis (1996)	13	n/a		n/a	Student-with-disabilities sample; Cognitive disabilities	n/a	n/a

*(WC=White, AA = African-American)

Table D2

Quantitative Study Matrix

Study	Research questions	Research design	Sample	IV	DV	Results
Abbit (2011)	What is the relationship between preservice teachers' perceived knowledge and self-efficacy beliefs regarding their ability to successfully use tech in the classroom?	Quasi-experiment Pre/Posttest	45 preservice teachers	Pedagogical (PK) Content (CK) Technology (TK) Pedagogical Content (PCK) Technological Content (TCK) Technological Pedagogical (TPK) Technological Pedagogical Content (TPCK)	Self-efficacy beliefs to successfully use tech in teaching (SE-TI)	Positive correlations between TPCK and SE-TI (r =*.853*), TPK and SE-TI (r =*.644*), TCK and SE-TI (r =*.620*), TK and SE-TI (r =*.599*). Negative correlation between PK and SE-TI (r =*.337*)
Abner & Lahm(2002)	How do teachers currently use and integrate technology for teaching and learning in the classroom? How do teachers differ in the extent to which they integrate instructional technology based on the characteristics of gender, age, teaching experience, grade level taught, content area, educational level?	Survey	174 teachers Advanced Technology for Teaching and Learning Academy Dakota State University (SD)	Teacher Age Teaching Experience Grade Level Content Area Educational Level	Use of technology (for professional productivity, to facilitate and deliver instruction, for integration into teaching and learning)	Return rate 54% 99% of teachers believed they needed more training 83% could not use tech for lack of availability

Study	Research questions	Research design	Sample	IV	DV	Results
An & Reigeluth (2011-2012)	Teachers' beliefs and attitudes toward the use of tech Teachers' perceptions on barriers to creating tech-enhanced learner-centered classrooms Teachers' perceptions of effective PD programs Teachers' support needs	Survey	126 teachers (K-12) Texarkana Independent School District Texarkana Arkansas School District Pleasant Grove Independent School District (Texas and Arkansas)	Teachers' tech beliefs	Teacher's use of tech	Return rate: 32% Teachers believed tech is an important part of learning and teaching Teachers supported the use of tech in classroom Barriers to tech use: lack of technology, lack of time, assessment (also, lack of funding, limited resources, student behavior, class size, inclusion of severe-needs students, parents) *Attitudes toward tech was not ranked as a barrier
Barron, Kember, Harmes, & Kalaydjan (2003)	The degree to which ISTE educational technology standards are being implemented in classrooms	Survey	2,156 teachers Florida school district	Teaching experience Number of computers in classrooms	Integration of computers in classrooms (by school level, subject area	Return rate 35% Teachers used computers for Internet research (small extent – 21%, moderate extent – 19%, large extent 15%) Teachers used computers to solve problems/analyze data (small extent – 23%, moderate extent – 19%, large extent 8%) 13% had 0 computers in classroom, 26% had one (1), 21% had two (2), 13% had three (3), 10% had four (4), 12% had 5-9, and 5% had 10-20

Study	Research questions	Research design	Sample	IV	DV	Results
Brickner (1995)	The relationship between barriers to change to the degree and the nature of computer usage by mathematics teachers	Case Study (survey, observations, interviews, document review)	Three rural schools West Lafayette, IN	Teacher age Teacher gender Teacher education Teaching experience Perceived value of computers (user, for personal use, nonuser) Computer anxiety Self-perception of innovativeness Reasons for computer use Technological self-efficacy	Degree of computer use	Computer anxiety ($r = -.58$, $p < .05$) and degree of use Technological self-efficacy ($r = .63$, $p < .05$) and the degree of use Perceived value of computers and the degree of use ($r = -.04$, $p < .05$)
Christensen (2002)	Does needs-based technology integration education have a positive effect on teacher and student attitudes?	Quasi-experiment	60 teachers North Texas public school 900 students (PreK-5)	IV: IT training for teachers (IT) Teacher needs-assessment	Teacher enthusiasm (F1), anxiety (F2), acceptance (F3), email (F4), negative effect on society (F5), classroom learning productivity (F6), Kay semantic (F7), Vocation (F8), Prestige (F9), Teacher productivity (F10), aversion (F11), Gender bias (F12), Computer Importance (F13), Computer Confidence (F14), Relevance (F15), Computer Enjoyment (F16)	IT training produced positive results for F1, F2, F4, F6, F8, F9, F10, F11, F14, F16, Computer anxiety, confidence, liking (13 out of 22 variables were significant for $p < .05$) Computer use for IT teachers increased (13 out of 22 teachers in comparison non-IT group and 18 out of 19 in IT group)

Study	Research questions	Research design	Sample	IV	DV	Results
Derer, Polsgrove, & Rieth (1996)	What is the status of AT use for students with disabilities, 2) What are the benefits and barriers of AT use, and 3) What are the effects of AT use?	Survey	405 teachers, consultants, and speech therapists Indiana, Kentucky, Tennessee school districts	Teacher characteristics (geographic location, classroom setting, grade level, compute system) Teacher perceived benefits and barriers of AT Student characteristics (disability, type of AT)		32% return rate on survey Educational disabilities most used with AT: learning disabilities, communication disorders, mental retardation (ID), sensory disabilities, and physical disabilities Most used AT: high frequency (>25%) included computers (academic and leisure), academic software, tape recorder, video instruction; moderate frequency (10-24%) included books on tape, closed circuit TV, software, speech synthesizer, wheelchair, low frequency (5-9%) included language devices, communication board, alternative keyboard, hearing aids, adapted switch toys. Barriers to AT: lack of training (25.6%), lack of access to AT (22.3%), lack of funding (27.6%).
Ertmer et al. (2006-2007)	Identify enablers rather than barriers teachers perceived when implementing technology	Survey (interviews)	25 award-winning teachers in Midwest school district	Teacher characteristics (PD, Personal Beliefs, Commitment, Previous Success, Tech Support, Access to Hardware	Use of technology	Technology-using teachers with more experience (years > 13) rated intrinsic factors as being significantly more influential (p = .016) Experienced teachers (n =13) rated intrinsic factors as “extremely” influential (M = 4.65)

Study	Research questions	Research design	Sample	IV	DV	Results
Flanagan, Bouck, & Richardson (2013)	1) How often and in what manner do special education teachers in middle school use AT, 2) what are the perceptions of AT, 3) What are the perceived factors that encourage and hinder use, 4) what are the reported needs and preparation of teachers with AT?	Survey	51 teachers Midwestern school district	Factors that impact the use of AT and other technology in the classroom	Use and effectiveness of low-tech AT, use and effectiveness of high-tech AT, and general AT use	30.7% return rate Weekly use for high-tech AT included audio books/e-books (73%), spell check 57%), AlphaSmart (45%), Instructional software (41%), E-dictionary (37%), multimedia software (33%), concept mapping software (33%), word prediction (20%), speech-to-text (20%), Kurzweil (16%), screen readers (14%), reading pen (12%) Weekly use for low-tech AT included highlighters (73%), flashcards (67%), outlining/flow charting (55%), highlighting strips (41%), pencil grips (29%) Factors impacting use of AT: high cost (75%), insufficient training (47%), difficulty using (43%), increases learning (92%), assists students individually (84%), more than one student can use it (71%).

Study	Research questions	Research design	Sample	IV	DV	Results
Franklin (2007)	1) How do elementary teachers use computer technology for instructional purposes, and 2) what are the factors that influence their use of computers?	Survey	113 recent graduates from teaching programs Mid-Atlantic University	Access to AT Availability of AT School leadership	Use of AT	89% return rate Computer technology was used for locating/gathering materials (mostly access research and best practices for teaching), communication (mostly to communicate with colleagues and other professionals), posting information (administrative record keeping), and writing lessons (create instructional materials). Influencing factors: leadership, access and availability, incentives, personnel support, external constraints, and philosophy and preparation.
Gorder (2008)	How do teachers currently use and integrate technology for teaching and learning in the classroom? How do teachers differ in the extent to which they integrate instructional technology based on the characteristics of gender, age, teaching experience, grade level taught, content area, educational level?	Survey	174 teachers Advanced Technology for Teaching and Learning Academy Dakota State University (SD)	Teacher Age Teaching Experience Grade Level Content Area Educational Level	Use of technology (for professional productivity, to facilitate and deliver instruction, for integration into teaching and learning)	Teachers as technology operators (M = 4.01, SD = 0.73) Teachers as technology facilitators (M = 3.83, SD = 0.77) Teachers integrating technology (M = 3.07, SD = 0.86) Technology mostly used (Word processing software, Internet, presentation software, digital camera, scanners, graphics software, spreadsheet, email, database, concept mapping, student webpage, course management software)

Study	Research questions	Research design	Sample	IV	DV	Results
Jost & Mosley (2011)	How do teacher AT proficiencies relate to the AT adoption which facilitates access to the curriculum for students with disabilities and 'struggling' learners?	Survey	135 teacher students in Education Programs	Tech proficiency Teacher awareness of AT Working knowledge of AT	Adoption of AT	54.5% were somewhat confident about using AT 48.1% did not confident to recommend AT 69.2% were not knowledgeable about AT/UDL 60.3% no experience with AT
Lahm & Sizemore (2002)	Individual and group-level predictors influencing the approach (functional, clinical, combined) by educational professionals in deciding on the use of assistive tech for students	Survey	15 EC professionals (Teachers = 2, OT = 1, SLP = 6, ATS = 4, ATP = 2) Kentucky First Step programs	Functional Approach Clinical Approach Combined	Years of AT experience Level of education Philosophical beliefs Factors of decision making	Functional – 66.6% Clinical – 20% Combined – 13%
Lei (2009)	Beliefs, attitudes, and tech experience and expertise of *"digital natives"* as preservice teachers	Survey	70 freshmen students (valid responses from 55) University in Northeast US	Teacher beliefs, attitudes, and tech expertise	Tech use Tech proficiency Tech confidence Tech competencies	Beliefs, confidence, an interest in tech (positive - 66.4%, neutral – 25.4%, negative – 8.4) Tech proficiency in classroom tech (Avg % for beginner skills – 40.9%, Avg % for expert skills – 3.9%) Tech confidence (good = 48.2%, neutral = 29%, not good = 22.5%) Daily tech use (10% - less than 2h/day, 76% - 2- 4h/day, 14% - 4h+/day Mostly use of basic tech

Study	Research questions	Research design	Sample	IV	DV	Results
Lesar (1998)	Perceived barriers to the use of AT for young children with disabilities	Survey	62 ECE professionals North Carolina, Tennessee	AT preparation AT knowledge and usage Family involvement	Use of AT	Return rate: 40% 77% of teachers used personal experience to integrate tech 47% of teachers had previous tech coursework 50% of teachers needed help with integrating AT
Lowther, Inan, Strahl, & Ross (2008)	Is integration of technology successful in the absence of barriers?	Mixed-methods (Survey, classroom observations)	927 teachers	School locale Grade levels Number of students % of F/RL Ethnicity	TnETL program effectiveness Teacher perception of technology Student achievement (SA)	Treatment teachers > Control teachers for confidence on integrating tech (*ES* = +0.78> +0.76) Treatment teachers > Control teachers for using tech (*ES* = +0.69> +0.40) SA (5th grade) significant for treatment students; not significant for 8th grade treatment students

Table D3

Summary of data analyses in reviewed literature

	Descriptive	Inferential
Abbitt (2011)	Central tendency measures	Regression
Abner & Lahm (2002)	Central tendency measures	-
An & Reigeluth (2011-12)	Central tendency measures	-
Barron et al. (2003)	Central tendency measures	Chi-square test of independence
Brickner (1995)	Central tendency measures	Correlations
	Coding (qual)	
Christensen (2002)	-	ANOVA
		Multiple regression
		Time-lag regression
Derer et al. (1996)	Central tendency measures	Chi-square test of independence
Ertmer et al. (1999)	Coding (qual)	-
	Constant comparison analysis	
Ertmer et al. (2006-2007)	Central tendency Measures	*t* test
	Pattern analysis (qual)	Pearson correlation
Ertmer et al. (2012)	Central tendency measures	-
	Coding (qual)	
Flanagan et al. (2013)	Central tendency measures	Pearson correlation
Franklin (2007)	Central tendency measures	Regression
		Principal component analysis (Varimax)

Gorder (2008)	Central tendency measures	ANOVA
Hughes (2005)	Coding (qual)	-
Hutinger et al. (1996)	Coding (qual)	-
Jost & Mosley (2011)	Percentages	-
Lahm & Seizemore (2002)	Central tendency measures	-
Lei (2009)	Central tendency measures	Pearson correlation
Lesar (1998)	Central tendency measures	-
Lowther et al. (2008)	Central tendency measures	MANOVA MANCOVA
Todis (1996)	Coding	-

Appendix E

The School's Technology Inventory (Low/Medium/High classification)

Type of AT	AT
Low	Pencil grips Highlighters Graphic organizers Reading trackers
Medium	Online dictionaries Presentation software Online dictionaries Word processor Electronic worksheets Audio books
High	Moodle PowerSchool Lexia Reading Kurzweil 3000 TextAloud ReadPlease 2003 Voice-Dream WriteType Dragon Naturally Speaking Open Dyslexic Lexia Readable Tiresias Infofont Mahara myHomework App Everstudent IThoughts Evernote

Appendix F

Examples of SUBSTITUTION level of technology use (*included in teacher survey*)

Academic/Learning Task	SUBSTITUTION with Technology
Understanding literary text (English)	Text is available online instead of print
Traveling unit (Geography)	Word documents with text descriptions of destinations ***or*** Powerpoint presentation (or other presentation software) for geographical locations
Vocabulary activity (Reading, English)	Students use spreadsheets or other computer-based form to organize vocabulary instead of placing them in handwritten table
Experiment/Research report (Science)	Students use Word Processing to write a report instead of paper and pencil
Industrial Revolution (Social Studies)	Students use Word Processor to construct a timeline by hand

Examples of AUGMENTATION level of technology use (*included in teacher survey*)

Academic/Learning Task	AUGMENTATION with Technology
Understanding literary text (English)	Text is available online instead of print BUT additional functions are embedded (study guides, content links, dictionaries, glossaries so on)
Traveling unit (Geography)	Design a computer-based brochure or guide that incorporates the ability to hyperlink and embed additional content and references.
Vocabulary activity (Reading, English)	Provide image supports through online research to place words/concept in context and relate them to the surrounding world while assisting with visualizing and verbalizing.
Experiment/Research report (Science)	Build reports that include embedded materials and functions (hyperlinks, dictionaries, references) as well as allowing, for instance, file sharing online for group work (such as Google Docs)
Industrial Revolution (Social Studies)	Students use timeline software (online or locally networked) that allows display of images and other media (videos, artifacts so on).

Examples of MODIFICATION level of technology use (*included in teacher survey*)

Academic/Learning Task	MODIFYING with Technology
Understanding literary text (English)	Students use multimedia resources (textual, audio, video) to construct shared knowledge .
Traveling unit (Geography)	Students build presentations of geographical destinations using multimedia resources which will facilitate group collaboration and include additional functions such as student narration.
Vocabulary activity (Reading, English)	Students build online personal dictionaries to include word definitions that can be hyperlinked to other web-based resources (different contexts of word use, in different genres so on) and potentially produced as PDFs for storing and/or sharing via Dropbox.
Experiment/Research report (Science)	Students use sketch up to design a scientific process or concept which can be further submitted for comments and discussion via interactive wed applications or presentation software.
Industrial Revolution (Social Studies)	Students construct a map or collection of timeline data reflecting primary sources and/or artifacts available through online research and share it online via web applications (such as wikis, for instance).

Examples of REDEFINITION level of technology use (*included in teacher survey*)

Academic/Learning Task	REDEFINITION with Technology
Understanding literary text (English)	Accessing text is the pre-requisite for a higher-order task to establish the cultural impact of certain writing on the literary evolution and social context. Students can use a concept mapping tool and/or mind map (online or locally networked) to demonstrate the key elements through key words and images.
Traveling unit (Geography)	Students explore geographical locations through Google Earth and research further data from residents and/or visitors of such locations via social media sites, chat groups, and so on to validate findings/conclusions.
Vocabulary activity (Reading, English)	Students construct an eBook that incorporates multimedia to represent the journey of discovery, inquiry, and student-drive questions regarding word usage, meaning, and evolution (etymology).
Experiment/Research report (Science)	Students use web-based resources to design a science process and/or concept, which is further submitted for analysis and feedback to a Skype Expert Panel including actual professionals and practitioners in the field OR presented in a webinar format to select audience.
Industrial Revolution (Social Studies)	Students create digital stories to retrace the sequence of events included in a certain timeline.

Glossary

Academic support

A wide variety of instructional methods, educational services, or school resources provided to students in the effort to help them accelerate their learning progress, catch up with their peers, meet learning standards, or generally succeed in school.

Assistive technology

Any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities. [29 U.S.C. Sec 2202(2)]

First-order barriers

Factors that affect the implementation of an innovation (for this research study, assistive technology) which include inaccessible or missing resources such as equipment, training, lack of support, and funds as well as organizational factors such as insufficient time allocated for teachers to plan their lessons and related policies.

Second-order barriers

Factors that were intrinsic to teachers when faced with the implementation of an innovation (for this research study, assistive technology) and included things such as their underlying beliefs about teaching and how learning occurs that guided their practice.

Computer-assisted instruction

Instruction presented with the use of a computer.

Cognitive prosthesis

An electronic computational device that extends the capability of human cognition or sense perception.

Compensatory (technological) tools

Adaptive computing systems that allow people with disabilities to use computers to complete tasks that they would have difficulty doing without a computer, e.g., reading, writing, communicating, accessing information.

Educational technology

The study and practice of designing effective instruction using technology, media, and learning theory.

First-order barrier (to technology)

Barriers related to lack of resources, policies, and inadequate support that block the integration of technology in the classroom (Ertmer, 1999).

Hardware

The machines, wiring, and other physical components of a computer or other electronic system.

Implementation/Integration of technology

The use of technology resources - computers, mobile devices, networks, software applications, the Internet, etc. - in daily classroom practices, and in the management of a school.

Inclusive practice

Inclusive practice is an approach to teaching that recognizes the diversity of students, enabling all students to access course content, fully participate in learning activities and demonstrate their knowledge and strengths at assessment.

Instructional accommodation

A change in the course, standard, test preparation, location, timing, scheduling, expectations, student response and/or other attribute which provides access for a student with a disability to participate in a course, standard or test, and it does not fundamentally alter or lower the standard or expectation of the course/test.

Optical character technology (OCR)

The mechanical or electronic conversion of scanned or photographed images of typewritten or printed text into machine-encoded/computer-readable text.

Pedagogy

The method and practice of teaching, especially as an academic subject or theoretical concept.

Reading disability

A condition in which the individual displays difficulty reading resulting primarily from neurological factors.

Referral (special education)

The step in the process of special education which requires evidence of atypical academic performance including the evaluation of a child's cognitive and educational abilities in order to determine eligibility for specialized services.

Research-based intervention.

Strategies, teaching methodologies and supports that have been shown through one or more valid research studies to help a student improve academic, behavioral/emotional or functional skills.

Response to Intervention.

Multi-tier educational approach to the early identification and support of students with learning and behavior needs.

Screen reader

Software application that attempts to identify and interpret what is being displayed on the screen (or, more accurately, sent to standard output, whether a video monitor is present or not). Also, known as text reader software and speech-to-text (STT).

Scribe (software)

Speech recognition software, designed to be used with a microphone, which interprets spoken words to create text-style documents; it can also be used to carry out computer commands. Also, known as text-to-speech (TTS).

Second-order barrier (to technology)

Barriers related to fundamental beliefs about teaching practice and willingness to change one's practice that block the integration of technology in the classroom (Ertmer, 1999).

Self-efficacy belief

One's belief in one's ability to succeed in specific situations.

Software

The programs and other operating information used by a computer.

Spell check technology

Software applications that assist with spelling by checking for errors and, in some cases, offering replacement options.

Struggling reader

Student impacted by a reading disability (phonemic awareness, decoding, fluency, comprehension) who can otherwise demonstrates the intelligence, motivation, and education to develop into a good reader (Lyon, Shaywitz, & Shaywitz, 2003).

Supplementary aid

Broad category of aids, services, and other supports that are provided in general education classes, other education-related settings, and in extracurricular and non-academic settings, to enable children with disabilities to be educated with nondisabled children to the maximum extent appropriate.

(Teacher) Attitude

A settled way of thinking or feeling about teaching and learning, typically one that is reflected in a teacher's behavior.

Teacher belief

The assumptions teacher make about their students and how their students learn (Calderhead, 1996).

Technological Pedagogical Content Knowledge (TPACK)

Conceptual model for the knowledge that supports effective technology integration into classroom practices (Mishra & Koehler, 2006).

Testing accommodation

Changes made in the administration of the test in order to remove obstacles to the test-taking process that are presented by the disability without changing the constructs being tested.

Universal Design for Learning

Educational research-based framework that suggests that a one-size-fits-all approach to curricula is not effective and requires multiple means of representation and expression of curriculum as well as student engagement.

Voice recognition technology

Software application that provides translation of spoken words into text. It is also known as "automatic speech recognition" (ASR), "computer speech recognition", or just "speech to text" (STT).

Word prediction technology

Software applications that provide assistance to students who have difficulty writing by predicting the target word as the student types in the first letter or letters of the word.

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