Students with Special Educational Needs and Assistive Technologies: A Literature Review

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ABSTRACT
The term *assistive technologies* refers to the equipment, devices and apparatus, and the services, systems, processes and adaptations made to the environment that support and facilitate their functions, used by persons with special education needs. This study is a literature review of the use of assistive technologies in the education of students with special educational needs. To compile the works related to this subject, electronic databases, journals and other relevant sources were curated. The applicable information found within these sources was then analyzed under two general themes: a) the use of assistive technologies, and b) assistive technology implementation models. The results of this study shows various types of assistive technology are used in special education and the use of assistive technologies generally have a positive effect on the students with special education. The results are discussed within the framework of the use of assistive technologies in special education and model implementations with the aim of contributing to the current assistive technology implementations presented in the literature.

Keywords: Assistive technologies, assessment of assistive technologies, technology, students with special needs, special education.

INTRODUCTION

Technological developments have led to important transformations in many aspects of life, not least of all education. The technologies used in special education have significantly changed over the course time (Edyburn, 2001). Assistive technologies in particular have helped to facilitate the skills that persons with special educational needs struggle to utilize in daily life (Gierrach and Stindt, 2009).

In the education process, assistive technologies offer various solutions in providing students with support that meets their needs (McKnight and Davies, 2012). These assistive technologies significantly contribute to aiding persons with special educational needs in learning, building self-confidence, being independent and achieving a high quality of life (Reed, 2007). Furthermore, they serve as key tools for enabling students to access education, actively and independently participate in the education process, interact with their peers and have control over their own learning experiences (Winter and O'Raw, 2010). The use of assistive technologies helps to facilitate the improved performance of the students by providing support, such as adapting content and activities of the curricula, specific to their needs within a minimum-restricted environment, (Wojcik and Douglas, 2012; Parette and Peterson-Karlan, 2007; Parette, Stoner and Watts, 2009). In short, assistive technologies serve to increase both the functional performances and the academic success of the students (Edyburn, 2005; Edyburn, 2006; Alnahdi, 2014).

Assistive technologies are defined in various ways in the literature. Hersh and Johnson (2008a) define assistive technologies as the equipment, devices, apparatus, services, systems, processes and modifications made to the environment for use by disabled and/or elderly people to secure their full, active and easy participation in society. Winter and O'Raw (2010), on the other hand, define them as the equipment, tools and product systems used to enable improvement of the functions of disabled people. According to Lancioni et al. (2013), assistive technologies are various devices whose aim is to help the disabled and persons with special educational/rehabilitation needs to better function in daily life and attain a higher quality of life.

During the education process, the needs of persons receiving special education show variance. Technologies such as voice recognition applications, mobile devices, symbol-based interaction and virtual reality may be used to support persons with different educational needs during their education process (McKnight and Davies, 2013). A range of technologies can be used to support students in reading, writing, walking, sitting, seeing and hearing and

in fostering communication skills and participation in activities (Reed, 2007). These technologies that support active participation in the learning environment rapidly change and develop (Lahm and Sizemore, 2001).

This study aims to review the literature on the implementation trends and models of assistive technologies in the education process. Two themes were developed to govern the review of the literature: a) assistive technologies used, and b) implementation models of the assistive technologies used for providing assistive technology support for the students with special educational needs. The study questions determined according to the general themes are:

a) Which assistive technologies are used in special education?
b) What are the assistive technology implementation models in special education?

METHODS

Study Method

The use of assistive technologies in special education is a newly-arisen area and the relevant issues have relatively recently been taken into consideration (Edyburn, 2001). Generally, assistive technologies aim to help people perform the actions they need in their daily life more easily and successfully (Edyburn, 2005). To enable students with special education to be successful during their education, appropriate services as well as access to the relevant technology should be provided (Kentucky Department of Education. 1997; Edyburn, 2008). The use of assistive technologies and the themes of assistive technology models in special education were determined to analyze the assistive technology models setting the framework of the services provided during education via the assistive technologies existing in the literature. The studies in the literature related to the use of assistive technologies by students with special educational needs were analyzed within the framework of two general themes.

Electronic databases and two journals were curated to create a general profile of the assistive technology implementation trends in the education process. It is recommended to select the journal which will be included in literature reviews among the journals with high quality or specific to the study area (Singh, Haddad and Chow, 2007). This study included the Journal of Special Education Technology, which publish the technological practices, research and policies in special education, and the International Journal of Special Education, which publish original articles in special education.

A literature review is the process of searching quality academic literature databases in order to access applicable research manuscripts (Levy and Ellis, 2006). Webster and Watson (2002) noted that *"a systematic search should ensure that you accumulate a relatively complete census of relevant literature'(p.16).* To access the studies and publications on this subject, a search of the databases of ERIC (http://eric.ed.gov/), Google Academic/Google (http://scholar.google.com.tr/http://google.com.tr/), Springer(http://link.springer.com) and ScienceDirect (http://www.sciencedirect.com/) was conducted, where the keywords used during the search were *assistive technology*, *guide for assistive technology*, *assessment of assistive technology*, *technology*, *ICT*, and *persons with special educational needs*. The academic databases used in this study were selected considering the opportunity to provide access to comprehensive educational (ERIC) and multidisciplinary (Springer, ScienceDirect, Google School) articles and publications.

A review was performed of the publications found in the electronic pages of the Journal of Special Education Technology and the International Journal of Special Education dated between 2010 and 2015.Assistive technology guides from technology centers in the USA and UK, and other guides and reports were also accessed, in addition to the studies and books on assistive technologies found in the scanning of the databases.

Selection

The English-based documents were selected by considering the title and the information in the abstract/content as they related the general themes of the use of assistive technologies and implementation models. This study included the results of the analysis of the studies (n: 49), guides (n: 14), books (n: 4), and reports (n: 2) dated between the years 1995 and 2015. A total of 48 sources from the electronic databases of ERIC (n:3), Springer (n: 2), Google Scholar/Google (n: 42), and Science Direct (n: 1), and 21 articles from the Journal of Special Education Technology (n:16) , and International Journal of Special Education (n: 5) were included in this study.

While the term "persons with special educational needs" was used in this study, it was determined that the use of the term "disabled/disability" in the sources analyzed remain unchanged when referred to in this study.

FINDINGS

The Use of Assistive Technologies in Special Education

Today, a variety of assistive technologies are used to bring out the cognitive potential of the students, provide them with communication opportunities, enable the curricula to achieve their objectives and empower the students to participate in the education process. The assistive technologies used in the education process are categorized in various ways in the literature. McCulloch (2004), for example, categorized assistive technologies into low technologies, such as magnifiers and pencil holding devices, and high technologies, such as computers. Some researchers (Day, Dell and Smith, 2011; Gierach, 2009; Reed, 2007; Colleman, 2011) categorize assistive technologies based on the reading, writing, visual, hearing, and communication skills and competence that students are expected to acquire within the education process. McKnight and Davies (2013), on the other hand, proposed that assistive technologies be analyzed by being grouped according to the concepts of 1) users' needs, competences and aims, 2) technologies and capacities, and 3) content (e.g. educational content). Similarly to the main categorization approach of some researchers (Day, Dell and Smith, 2011; Gierach, 2009; Reed, 2007; Colleman, 2011),the sources accessed for this study were analyzed by being grouped according to the basic tasks required in the education process. The assistive technology implementations regarding *communication; reading; writing; mathematics; seeing and hearing skills; positioning-sitting and movement skills; social skills and making use of leisure time; daily life skills; organization and working skills; and computer skills* were compiled from the sources able to be accessed.

Communication: Assistive technologies help to facilitate communication for students with special educational needs in different situations and environments (Cumley, Maro and Stenek, 2009). The methods used to help students who have difficulty in speaking communicate with their environment are called Augmentative/Alternative Communication (AAC). These methods include aided and/or unaided symbols. Assistive technologies provide the students who cannot effectively use speech with various opportunities such as the use of simple communication boards or high technology electronic systems (Cumley, Maro and Stenek, 2009).

Generally, a number of technologies, including communication boards/books with pictures, eye gaze boards/frames, speech generating devices, text-based devices with speech synthesis and picture exchange communication systems, can be used to support persons with communication problems and speech disorders (PECS) (Annex-1) (Coleman, 2011; Reed, 2004; Reed, 2007, Reed, 2009; Reed and Bowser, 2013; McMullock, 2004; Day, Dell and Smith, 2011).

Studies show that the use of assistive technologies support the students' skills required for communication. Rodríguez et al. (2008) reported that communication technologies provided persons with speech disorders the ability to communicate with others. Coleman et al. (2015) found that the strategy of using PowerPoint presentations to teach vocabulary had a positive effect on improving the vocabulary of third-grade hearing impaired students in secondary school. Furthermore, in a study by Ferreira et al. (2013) which analyzed the impact that the assistive technology of computer games had on children with Cerebral Palsy who were unable to speak, the results revealed that the children used the communication forms of sound or facial expressions, suggesting that assistive technologies are important for social interaction.

Reading: Students with special educational needs may experience difficulties in understanding and remembering written texts during the education process (Reed, 2004; Reed, 2007). Assistive technologies facilitate the access of the students with physical, visual or hearing incompetence and the students who have difficulty in communication to reading texts (Fruchterman, 2008). Cumley (2009) recommends the use of tools and strategies that meet the needs of the students with physical incompetence to improve their reading skills and states that for example, the tools and strategies such as 1) Standard texts 2) Books adapted for access, 3) Low-Tech Modifications to text 4) Handheld devices to read individual words, 5) Use of pictures/symbols with texts 6) Electronic Texts 7) Modified Electronic Texts 8) Text readers 9) Scanner with OCR and text reader and 10) Text Reader with Study Skill support can be used for students with physical incompetence. Jansson (2008) expresses that assistive technologies such as audio texts or Braille can be used for students with visual incompetence to support their reading skills. In summary page turning tools, course materials printed in Braille, magnifiers and screen reader software can be used as assistive technologies to support the reading skills of students (Annex 1) (Adebisi, Limsan and Longpoe, 2015; Coleman, 2011; Reed, Cumley and Walser, 2004; Reed, 2007; Reed, 2009; Manning, 2008; Mahajan, 2014; Reed and Bowser, 2013; McCulloch, 2004; Day, Dell and Smith, 2011).

Studies accessed in the literature show that assistive technologies can affect the reading skills of students with special educational needs in different ways. Earman-Stetter and Tajero-Hughes (2010) indicated in their literature review conducted on computer-aided education for reading comprehension skills (between 1985 and 2009) that the use of different kinds of tools in computer-aided education was shown to have a positive effect in most of the

studies. Similarly, in another study conducted by Earman-Stetter and Tajero-Hughes (2011), it was shown that daily computer-aided reading practice positively affected the reading comprehension skills of the students with learning difficulties. Meyer and Bouk (2014) reported that the students believed they read faster and more fluently by using text-to-speech software. The present study found there to be no difference between using and not using this software. Armstrong and Hughes (2012) observed that the reading comprehension scores of three out of five children increased as a result of the story book-reading practices aided by the computer software that had been prepared to support the reading skills of autistic children. Further, Gonzalez (2014) found in his study involving 17 students with reading disabilities that they succeeded in re-telling stories after undergoing e-book reading practices. The pre- and post-practice scores of these students on the multiple-choice reading comprehension questions were shown to be no different.

Writing: Writing skills require certain cognitive skills, such as the ability to bring words together, as well as certain physical skills (Reed, 2007). Nankee, Stindt and Lees (2009) indicated that the assistive technologies and strategies such as 1) Environmental and seating adaptations 2) A variety of pencils or pens 3) Adapted pencils or pens 4) Adapted papers 5) Writing templates 6) Prewritten words or phrases 7) Label makers 8) Portable talking dictionaries 9) Portable word processor 10) Computers with accessibility features 11) Computers with word processing software 12) Alternative keyboards 14) Computers with scanner 15) Computers with word prediction and 16) Computers with voice recognition software can be used in education of writing skills. Various aids, including word processors, tools that facilitate the holding of pens, and computer software, to name a few, are available to support the writing skills of students (Annex 1) (Adebisi, Limsan and Longpoe, 2015; Coleman, 2011; Reed, 2004; Reed, 2007; Manning, 2008; Reed, 2009; McCulloch, 2004; Day, Dell and Smith, 2011).

Studies may have different results regarding the effect of assistive technologies for writing skills depending on the assistive technology used. For example, according to Peterson-Karlan (2011), different types of computer software such as voice recognition, word estimation and text-to-speech, facilitate successful outcomes for students with writing difficulties. Belson, Hartman and Sherman (2013) found that the use of digital pens by persons with learning difficulties positively affected the quality of note taking), while McCartney Prest, Mirenda and Mercier (2010) indicated in their study on the use of symbol-supported computer software in teaching writing to persons with Down Syndrome that using computer software improved their writing speed and quality.

Mathematics: Students with special educational needs can encounter different problems related to understanding and remembering written texts or to completing certain tasks during the education process (Reed, Cumley and Walser, 2004). Obukowicz (2009) recommends the use of the assistive technologies and strategies such as 1) Math manipulatives 2) Low tech physical access tools such as rulers, stamps, and adapted manipulatives 3) Abacus/Math Line 4) Adapted math papers such as enlarged worksheets, graph papers, and guideline papers 5) Adapted math tools such as calculators, adapted measuring devices, and adapted time tools 6) Math "Smart Charts", Math scripts 7) Digital access to math and 8) Math tool bars (Equation editor) in teaching mathematics to students with special educational needs. Different technologies, such as abacus, extended worksheets, and audio calculators (Annex 1), enable students to improve their mathematics skills (Adebisi, Limsan and Longpoe, 2015; Akpan and Beard, 2014; Coleman, 2011; Reed, Cumley and Walser, 2004; Reed, 2007; Manning, 2008; Reed, 2009; McCulloch, 2004; Day, Dell and Smith, 2011).

The study results about supporting the mathematical skills of students with special educational needs show that assistive technologies positively affect these students' mathematical success. For example, Bouck et al. (2015) stated that the use of calculators in mathematics courses positively affected the success of disabled students (learning difficulties, autism spectrum disorder, emotional disorders, health problems etc.). In a study conducted by Bouck et al. (2013) on teaching mathematics through digital audio books and computer software(ReedHear software: audio text, volume determination, digital magnification, tracking the words read),they found that students with low vision succeeded in using the technology and in understanding mathematical texts.

Vision and Hearing: Information derived from the environment is largely based on the visual and auditory senses. Alternative solutions enable persons with visual and hearing disorders to retrieve information (Hersh and Johnson, 2008). There are different technologies that people can use, depending on their specific hearing and vision abilities. For example, some persons with vision loss may need magnifiers or figure-ground color contrast, while others may benefit from materials printed in Braille (Annex 1). (Coleman, 2011; Reed, 2004; Reed, 2007; Reed, 2009; McCulloch, 2004; Day, Dell and Smith, 2011; Jansson, 2008b). Jansson (2008b) stated that persons with visual disorders can be provided with visual information through relief images and maps, while Heckendorf (2009) highlighted that FM devices, hearing aids, visual-stimulation devices and smart phones facilitate access to information in different environments for persons with hearing disorders.

Isaila (2014) analyzed the effect of assistive software for students with visual disability, and emphasized that assistive technologies are important tools and computer-aided education is a preferred method in education. Screen reader program, a type of assistive technologies, provide students with visual disability with access to the information in written texts via computers (Isaila, 2014). Isaila (2014) found that 87.8% of the students who used assistive software in a special education school reported an effective, interesting and interactive learning while 12% of them expressed the use of assistive software as boring.

Positioning, Seating and Mobility: Providing students the ability to sit and move in a manner appropriate to their needs is of great importance. For example, Butler (2009) indicated that assistive technologies help children with motor disabilities to participate in activities with their peers. Stindt, Reed and Obukowicz (2009) highlighted that the assistive technologies such as 1) Walking devices - Crutches/Walker 2) Grab bars and rails 3) Manual wheelchairs 4) Powered scooters, toy cars or carts 5) Powered wheelchairs with joystick or other control and 6) Adapted vehicles for driving can be used to enable mobility.

On the other hand, TVSS is a device that helps visually impaired people to find direction with the help of vibration. Jansson (2008b) reported that canes for the visually impaired people, vibrating direction finding devices (Tactile Vision Substitution System – TVSS) and other such technologies support visually impaired people in finding their way and moving independently.

Technologies and equipment, such as appropriate size chairs and tables, alternative chairs, walking devices, electric wheelchairs, white sticks, or direction finding devices etc. (Annex 1) help students to sit and move (Reed, 2004; Reed, 2007; Manning, 2008; Reed, 2009; Day, Dell and Smith, 2011; Jansson, 2008b).

Social Skills and Leisure: Students with special educational needs may struggle to adopt social skills and to make use of their leisure time. Comer (2009) states that the assistive technologies such as 1) Typical toys, puzzles, balls, utensils or instruments adapted; adjustable equipment; flexible rules; add visual/auditory clarity 2) Specially designed utensils or equipment; electronically or mechanically adapted utensils and equipment 3) Electronic aids such as remote controls, timers, CD players, and speech generating devices 4) Computer-facilitated and computer-based activities 5) Online and virtual recreational experiences 6) Electronic aids such as remote controls, timers, CD players, and speech generating devices 7) Computer-facilitated and computer-based activities and 8) Online and virtual recreational experiences can be used for the recreation and leisure skills. Generally, different assistive technologies, such as toys, computer games, or sports equipment, adapted to the needs of students with special educational needs (Annex 1), enable them to make use of their leisure time and to participate in social activities (Reed, 2004; Reed, 2007; Reed, 2009; Day, Dell and Smith, 2011).

Studies show that assistive technologies can be used to support those social skills which persons with autism disorder have difficulty in performing in daily life (Lang et al., 2014). Schmidt (2014) found in his study on the use of a 3-dimensional learning environment in teaching social skills to persons with autism spectrum disorder that the teaching objectives were achieved and that the children were able to use the social skills that they had learned in the 3-dimensional learning environment in their daily life. Tools such as audio balls, audio step counters, audio positioning devices (GPS- Global Positioning System), and audio sea voyage devices facilitate the ability of persons with visual disorders to play sports (Herhs and Johnson, 2008b). Audio descriptions of theater, television and cinema productions and other media publications enable persons with visual disorders to easily understand media publications (Hersh and Johnson, 2008b).

Daily Living: Students with special educational needs may have difficulty in daily-life functions, such as eating, cooking, dressing and shopping. Technologies such as adapted toys or sports equipment (Annex 1) can support persons with special educational needs in their daily lives (Bryant, Seok and Ok, 2012; Reed, 2007; Gierrach and Stindt, 2009; Day, Dell and Smith, 2011). For example, the assistive technologies such as 1) Simplified cookbooks such as 4 ingredient cookbook 2) Modified cookbooks (picture supported) 3) Visual or verbal directions for using heating equipment such as stove, oven, and microware 5) Visual directions to insure safety (what to do in case of spills or fire, 911 directions) and 6) Adapted timers (visual, talking, large display) can be used to support the skills required for cooking in daily life (Gierrach and Stindt (2009).

Regarding to support daily life skills; Bouck et al. (2013) showed that two mentally-disabled students benefited from the use of audio records when creating a shopping list. Herhs and Johnson (2008b) highlighted the effectiveness that tools such as adapted needles for sewing or distance measuring devices had in accommodating the daily life needs of the visually-impaired. Douglas, Wojcik and Thompson (2012) revealed that Apple's smart

phones and computers feature 280 applications that aim to support persons with mental and developmental disorders in their daily lives and suggested that the effect of these applications on learning should be investigated.

Organization: The basic competences required in the education process include organizing and remembering information, managing time well, and having work skills. Various assistive technologies, such as control charts or electronic schedules (Annex 1), can be used for those who lack proper organization and working skills (Adebisi, Limsan and Longpoe, 2015; Reed, 2004; Reed 2009; McCulloch, 2004; Day, Dell and Smith, 2011; Reed and Bowser, 2013). For example, Obukowicz, Stindt, Rozanski and Gierach (2009) recommend the use of the assistive technologies such as 1) Tabs 2) Sticky notes and index cards 3) Highlighters 4) Handheld recorders 5) Key words 6) Study guides 7) Task analysis 8) Digital highlighters and sticky-notes 9) Handheld scanners/electronic extraction 10) Electronic organizing 11) Study grid generators/grading rubric 12) Online search tools 13) Online web trackers 14) Online sorting file tools 15) Digital graphic organizers and 16) Online manipulatives, interactive, tutorials, and animations for organization and information management.

Study results Show that assistive technologies can be effective in the development of organization skills. Mechling (2005) indicated in the literature review he conducted on the use of assistive technologies that the studies on this subject found that the use of assistive technologies (pictorial, tactile or audio stimulation and computer-aided systems) resulted in the improvement of the capabilities of mentally-impaired people to initiate and complete their daily activities. Additionally, Stephenson (2015) showed in his study that the use of tablet computers had a positive effect in teaching daily routine tracking to students with special educational needs.

Computer Access: As computers provide convenience in many areas of daily life, they can be of fundamental importance for persons with special educational needs in enabling them to learn new skills and acquire information, to demonstrate what they learn in school, and to participate in class activities (Lindstrom-Drescher, 2009; Brodin and Peg, 2004; Alcade, Navarro, Marchena and Ruiz, 1998). Persons with special educational needs who struggle to use computers can benefit from the use of other technologies, such as screen reading software, adapted keyboards, and screen keyboards (Annex 1) (Coleman, 2011; Isaila, 2014; Reed, 2004; Reed, 2007; Manning, 2008; Reed, 2009).Lindstrom-Drescher (2009) states that 1) Positioning of the student and equipment 2) Standard keyboard and mouse with accessibility/access features built into the operating system 3) Standard keyboard and mouse with adaptations 4) Rate enhancement 5) Alternate keyboard and mouse 6) Onscreen keyboard 7) Voice recognition software 8) Eye gaze 9) Morse code and 10) Switch access can be used for access to computers.

Provision of students with special educational needs with access to computers can also lead to supporting the different skills of these students such as communication or writing. For example, writing skills of students who cannot use pens and papers due to physical impairment can be supported via computers. Similarly, in a project conducted in Switzerland on the use of tablets in special education schools, Karlsudd (2014) found that tablets helped students to be more active in the education process, that they offered alternative communication opportunities through audio, pictures etc., and that they provided more economic resources for learning.

Technology Implementation Models in Special Education

Analyzing the special education policies and movements of thought throughout history, medical and social models are observed to have significant effects on these policies (Kökkaya, 2006). As of 1950s and 1960s a "social model" approach has been adopted for individuals with disabilities in countries such as the USA or England (Özgökçeler and Alper, 2010).

Two basic models – the medical model and the social model –have been adopted in assistive technologies implementations. In the medical model, works are conducted on the particular disability of individuals and the effects of this disability. In the social model, the focus in on the effect of the factors of process, operations, equipment, materials, activity, and system on the easy and safe use of assistive technologies (Hersh and Johnson 2008a). The aim of assistive technologies social model is to provide individuals with disabilities with the opportunities they need in their social life. Adoption of social model in assistive technology applications leads innovations regarding the social inclusiveness of individuals with special educational needs. In addition, social model approach indicates that environmental arrangements such as schools, hospitals, healthcare centers, sports centers, bus stops, banks, etc. should be made to provide all members of community with access to education, employment, and daily life activities. The implementation models of assistive technologies within the framework of the social model show variance in the literature (Hersh and Johnson, 2008b).

Models used to determine and use the appropriate assistive technologies to be utilized in education of individuals with special educational needs. Edyburn (2001) revealed that there are twelve different model implementations on

the use of technologies in special education. Table 1 presents a summary of the models explained in Edyburn's study.

Table 1. Models of Special Education Technology

	Models	Authors
1	The SETT Framework Model	Joy Zabala, 1995
2	Education Tech Points Model	Gayl Bowser and Penny Reed, 1995
3	The Human Activity Assistive Technology- HAAT Model	Alebert M. Cook and Suzan M. Hussey, 2002
4	Wile's Model of Human Performance Technology	David Wile, 1996
5	Has technology been considered?	Antonette C. Chambers, 1997
6	The AT CoPlanner Model	Haines, Gladene Robertson, Robert Sanche et al., 1997
7	The A3 Model	Roger, O. Smith, Todd, D. Schwanke and Dave L. Edyburn, 2001
8	The ABC Model	Rena Lewis, 1993
9	King's Adaptation of Baker's Basic Ergonomic Equation- BBEE	Thomas W. King, 1986
10	Stages	Madalaine K. Pugliese, 2000
11	Edyburn's Model of the Technology Integration Process	Dave L. Edyburn,1998
12	The Quality Indicators for Assistive Technology Services Model	The QIAT Consortium, 2000

(Edyburn, 2001)

In the literature review conducted by Watt, O'Brian and Wojcik (2004), they addressed the 'Chambers' Consideration Model, Education Tech Points, SETT Framework, and Unifying Functional Model to assess the assistive technologies used in special education. Watt, O'Brian and Wojcik (2004) observed that the strengths of these models were their ability to provide students with more than one opportunity and to take into consideration the students' needs and the results obtained.

The studies on the assistive technology models in special education accessed within the scope of the present study addressed the following models, applications of which is often explained:

-Student Environment Task Tool Framework (SETT)
- Education Tech Point
- Human Activity Assistive Technology (HAAT)
- Has technology been considered?
-Quality Indicators for Assistive Technology Services

The information on the five models encountered in technology implementations in special education, according to the data obtained from the sources accessed within the present study, are summarized below.

Student Environment Task Tool Framework (SETT): In this model developed by Zabala, information is obtained on the students, environment, tasks and tools in order to make effective decisions on assistive technologies. This model aims to determine the assistive technologies for persons with disability, to monitor the common action steps to be followed in preparing curriculum, and to ensure consensus. It is recommended that the following questions be answered within the scope of this model (Zabala, 2000).

1. **Students:** What must the students do? What special needs and skills do the students have?
2. **Environment:** What are the educational and physical arrangements? Are there special issues to be considered? What materials and equipment are used within the particular educational environments? What supports are suitable for both the students and the personnel working with the students? How do the attitudes and expectations of the people around the students affect their performance?
3. **Tasks:** What are the activities that enable the students to achieve the determined objectives? What are the important elements of these activities?
4. **Tools:** Do the assistive technology tools and strategies require the students with special needs and abilities to perform certain tasks in certain environments? What kinds of assistive technologies do the

students need when performing certain tasks in certain environments? Which strategies can be used to improve the performance of the students?

In the guide prepared by Reed (2009) based on this model, it is recommended that information be obtained about the competencies, incompetencies, ages, environments (class, home etc.), health status, computer access, communication, writing, reading, mathematics, organization, making use of leisure time, the visual and hearing skills of the students, as well as the services they receive and the assistive technologies they previously used. Reed (2009) listed the questions that needed to be addressed concerning the determination of the requirements persons with special educational needs had for assistive technologies and the services to be provided as:

1. Which tasks do the students want to perform (writing, reading, communication, hearing etc.)?
2. Do the students use special strategies when performing the tasks given to them?
3. What are the assistive technologies (tools, software and equipment) used by the students?
4. Does the use of assistive technologies enable the students to show more effective performance in a minimum restricted environment and with minimum assistance?

Reed (2009) also recommended that other information be obtained, such as the people with whom the students interact, the arrangements needed in different environments, the position of the students in the class, the tools, such as whiteboards and illumination devices, required for the students, and seating arrangements, by observing the environment of the student, interviewing the teachers, and carrying out implementations and assessments according to the IEP.

The guide prepared by Manning (2008) for conducting assessments in schools or in assistive technology centers within the scope of this model includes the action steps and the forms that can be used.

Education Tech Point: This approach was designed by Bowser and Reed to guide the decision-making process for assistive technology services (Bowser and Reed, 1995). The target groups for this model are families, caregivers, and the personnel working in the fields of education and law (Reed and Bowser, 2013). Bowser and Reed (1995) presented the stages of decision-making for the assistive technologies to be used in the education process as 1) Application, 2) Assessment, 3) Trial, 4) Plan Development, 5) Implementation, 6) Periodical Monitoring and Provision of Transition. The stages recommended in this model can be used in referral, evaluation and IEP development processes. The structure of the model supports the process of providing students with assistive technology and monitoring assistive technology. Education Points questions help determine the students' needs in the institution where they continue their education. The application stages of the model include initial referral questions, evaluation questions, extended assessment questions, plan development questions, implementation questions and periodic review questions (Bowser and Reed, 1995).

Human Activity Assistive Technology (HAAT): A theoretical framework was developed in this model to define the basic factors that affect the use of assistive technologies (Hersh and Johnson, 2008b, p. 2). The model, which recommends that assistive technology services focus on increasing the individuals' performances, is defined under the titles explained below:

1. Human (Senses, processing, motor skills),
2. Activity (Performance in skill sets, such as self-care, and in certain environments, such as school or work place),
3. Assistive technology (Technological features or processes, environmental features), and
4. Context (Environment, social status, cultural status, physical status) (transferred from: Edyburn, 2001).

Determination process of the assistive technologies based on this model generally includes four components and the interaction between them (Edyburn, 2005). Power Dirette (2014) proclaimed that this model, which is commonly used throughout Western Europe, established the basic concepts of development of technology and assessment of the effect of technological tools.

Has technology been considered?: In this model developed by Chambers (1997), the aim is to guide the decision-making process for assistive technologies according to the students' needs. Chambers (1997)recommends the IEP team ask the following questions during the decision-making process on the appropriate assistive technology for the students:

1. What do we want the students to do within the curriculum?
2. In which educational tasks (reading, writing, listening, mathematics, movement, sitting, seeing, self-care etc.) are the students unable to participate?
3. Will assistive technologies be able to support the achievement of these objectives?

4. What has been done to meet the needs for special education?
5. Do we as a team have adequate knowledge on the issues, such as assistive technology tools and/or services?
6. Under which conditions and criteria, in which environment, and for how long should the implementations be performed?
7. What has happened in the environment, technology and the process?

Based on Chambers (1997) model, the guide prepared by Wojcik and Douglas (2012) on the decision making process for the assistive technologies to be used by the students recommends that the IEP Team;

1. Analyze the academic skills, functional skills and existing assessment data of the students,
2. Determine annual objectives, including targets and criteria,
3. Determine whether or not the students can achieve the determined objectives without assistive technologies,
4. Determine whether or not the IEP team has the knowledge required for making a decision,
5. Determine the support, adaptation or arrangements that the students need,
6. Collect more information or consult an expert about the area that shall be needed for the team,
7. Determine whether or not the students already use this assistive technology, and if so, how well are they able to use it.
8. Define the required supports, services and assistive technologies to best enable the students to participate and succeed in education, and follow the action steps.

Wojcik and Douglas (2012) stated that the most important factor in the education process is the effective use of the assistive technologies in supporting the students' functional skills, such as reading, communication, movement, etc. They also expressed that the students' educational performance should be supported, being sure to take into consideration that assistive technology is not specific to one certain group of disability or one certain skill. They recommended to first use the low-cost and easy-to-use low technologies, and then move on to considering the high technologies when making a decision on the assistive technologies to be used in the education process.

Quality Indicators for Assistive Technology Services: In the USA, although relevant legislation (IDEA'97) includes provisions for the use of assistive technologies, no standard definition exists for the quality of the assistive technology services. The Quality Indicators of Assistive Technology (QIAT) Consortium prepared indicators to assess the quality of assistive technologies in 2000. These indicators are: 1) Administrative Support, 2) Consideration of Assistive Technology Needs, 3) Assessment of Assistive Technology Needs, 4) Documentation in the IEP, 5) Assistive Technology Implementation, and 6) Evaluation of Effectiveness (Edyburn, 2001).

The quality indicators for assistive technologies updated by the said institution included the phased indicators for 1) Consideration of Assistive Technology Needs 2) Assessment of Assistive Technology Needs 3) Including Assistive Technology in the IEP 4) Assistive Technology Implementation 5) Evaluation of the Effectiveness of Assistive Technology 6) Assistive Technology Transition 7) Administrative Support of Assistive Technology Services and 8) Professional Development and Training in Assistive Technology, as well as common errors that may be encountered (QIAT, 2012. The guide prepared by the Minnesota Department of Children, Families and Learning (2003) for the assistive technology services emphasizes that the quality indicators for assistive technologies were based on the provision of cooperation among the team members as well as the legal requirements and the fulfillment of the responsibilities by the team members. The general aim of this model is to support the process of developing and evaluating the assistive technology services for students with disabilities (Zabala, 2007).

Lahm and Mendonca (2008) reported that a large number of tools are used during the process of assistive technologies assessment, and determined from their literature review that 47 formal and informal assessment tools can be used in schools. Lahm and Mendonca (2008) categorized the assessment tools for assistive technologies under 1) Identification/Interference 2) Determination of Satisfaction 3) Determination of the Results and 4) Research Objective. Table 2 shows the 8 assessment tools specified by Lahm and Mendonca (2008) which are used in the assessment of the assistive technologies for persons with special educational needs.

Table 2. Assistive Technology Assessments Tools	
Categories	
Diagnostic/ Intervention	1. Assessing Student Needs for Assistive Technology (ASNAT) (4th edition) 2. Education Tech Points: A Framework for Assistive Technology Planning 3. Functional Evaluation for Assistive Technology (FEAT) 4. Matching AT & Child- MATCH 5. Matching Persons with Technology - MPT 6. University of Kentucky Assistive Technology (UKAT) Toolkit)
Satisfaction	1. Quebec Evaluation of Satisfaction with Assistive Technology - QUEST-Version 2.0)
Outcomes/ Research	1. Psychosocial Impact of Assistive Devices Scale (PIADS) (Version 4.2)
(Lahm and Mendonca, 2008)	

In addition, the assistive technology assessment tools analyzed by Lahmm and Mendonca (2008) include:

- *Screening tools providing a quick look at an individual for deficits that may be addressed with assistive technology and suggest a further assessment if needed,*
- *Implementation instruments going beyond the identification of a device and providing practical suggestions for implementing AT and concrete measurements that can be used to demonstrate progress toward the goals,*
- *Follow-up instruments that plan for periodic check-ups similar to the implementation instruments.*
- *Impact instruments document changes in human performance and the system as a whole that contribute to task performance (p.3).*

Besides, the purposes that have the fewest instruments available are referral, matching person to technology, acquisition, and outcomes.

DISCUSSION AND CONSLUSION

Students with unique characteristics and needs should be provided with equal learning opportunities in the education process. Providing access to the appropriate assistive technologies and supporting their education are among the fundamental factors in creating equal education opportunities for persons with special educational needs. This study aimed to present the current implementations found in the literature on the use of assistive technologies during the education of persons with special educational needs.

Technologies that serve to improve the students' quality of life in a manner appropriate to their individual differences and needs can be used to support persons with special educational needs in many areas of education. The results of the studies analyzed for the present research show that assistive technologies are used for supporting persons with special educational needs in numerous areas, such as reading, writing, communication, daily life, etc. Further, the studies in the literature indicate that the use of assistive technologies in education has positive effects. As seen from the literature review conducted, the nature of the studies (software, features of the devices, etc.) have changed over time, with various assistive technologies being recommended for different disability groups (Chambers, 1997; Reed, 2004; Reed, 2007; Manning, 2008, Reed, 2009; Day, Dell and Smith, 2011, Jansson, 2008b)

Studies in the literature show that assistive technologies can be used to support the education of students with different impairments such as physical, visual and hearing incompetence or learning disability and application of these technologies generally results in positive. McKnight and Davies (2012) indicated in their literature review that more focus has been put on some disability groups than the others. The present study also includes a lower number of studies on people with hearing and physical disabilities.

Special educational needs of the individuals show difference in the education process. Professionals and researchers working in the area of special education should understand the needs and capacities of the students to provide them with the most appropriate support. (McKnight and Davies, 2012). In this regard, models have been developed to enable students with special needs to benefit from the appropriate assistive technologies in education process. The literature shows that different models have been developed for the use of technology and that five models in particular are more frequently used (Reed, 2007; Reed, 2009; Day, Dell and Smith, 2011; Watt, O'Brian and Wojcik, 2004). Study results show that the models applied in this area allow the determination of the needs of students with special educational needs for assistive technology according to their individual needs. Provision of

the opportunity to individually evaluate students facilitates the integration of them into the education life in line with their needs. In addition, assistive technology assessment tools have common purposes at the screening, implementation, follow-up and referral stages (Lahm and Mendonca, 2008).

Increasing knowledge and experience of the professionals in this field will lead to an increase in educational opportunities for students with special educational needs. Development of appropriate assessment tools for assistive technologies will facilitate the access to appropriate assistive technologies and inclusion in social life and education of students with educational needs. Teachers can have difficulty in providing equipment, determining the appropriate learning materials, and using different teaching methods according to the learning needs of their students (Williams, 2005; Bell, Cihak and Judge, 2010; Petçu, Yell and Fletcher, 2014). Stoner et al. (2008) indicated in their study that teachers have difficulty in determining their students' needs, identifying and using the assistive technologies used in the literature, and allocating adequate time for the use of assistive technologies in pre-school period. In addition, Williams (2005) emphasized that teachers working in the field of special education need guides that include sample practices for teaching process, guide applications and technical support.

Significant contributions can be made to the body of literature related to this field by conducting studies on the needs of students, teachers, parents, and administrators for assistive technologies in special education, on the assessment of the existing needs and how to meet them, and on the assessment of the assistive technology implementations. McKnight and Davies (2012) recommended in their study on the education process that the following be taken into consideration: a) the needs and capabilities of the students, b) the capacity of technology, and c) the educational environments. The number of those who can benefit from this literature review will significantly increase if the results of the studies on assistive technologies are shared in congresses and symposiums as well as on a common website. Moreover, it is important that pre-service teachers trained in special education and studying in undergraduate and graduate education programs be provided with the information and skills on assistive technologies and on the use of computers.

Assessment of assistive technologies, preparation of appropriate assessment tools for training the teachers in line with the appropriate model, preparation of guide materials, provision of teacher trainings, and sharing up-to-date sample implementations based on the current assistive technologies and implementation models will help these implementations become widespread as well as being effective and efficient. Cooperation between special education professionals, therapists, social workers, funding bodies, engineering communities and other researchers as well as creating an effective model framework for assistive technology implementations preparing assessment instruments and guide resources for determination of then needs for assistive technologies, and sharing the current practices are important in this field.

This literature review regarding the assistive technologies and models implemented in special education is considered as the first stage. It will be helpful that the themes in the present study be respectively analyzed in the future studies and studies be conducted on the effects of the existing models for the use of assistive technologies in education and on the development of models. In addition, researchers should analyze the tools and indicators regarding the assessment process of assistive technologies.

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Annex 1: A Sample List of Assistive Technology for Persons with Special Educational Needs	
Communication	
❒Communication board/book with pictures ❒Eye gaze board/frame ❒ Simple speech generating device ❒ Speech generating device with levels ❒ Speech generating device with icon sequencing	❒Speech generating device with dynamic display ❒ Text-based device with speech synthesis ❒Picture Exchange Communication System PECS ❒Smart phones
Reading	
❒ Adapted books for access e.g. page separators ❒ Modified text: size, color, spacing ❒ Enlarged print text ❒ Braille printed materials ❒Audio books, MP3 player ❒ Tape recorder ❒Picture symbol supported text ❒Tracking aids, e.g. Reading windows ❒Magnifier ❒Electronic magnifier	❒Talking electronic dictionaries ❒Digital e-Readers ❒ Word scanners ❒ Digital books with text highlighted as read ❒ Text-to-Speech ❒ Digital books with adapted text ❒ Closed circuit television-CCTVs ❒ Screen reader ❒ Optical Character Recognition (OCR) ❒ Microsoft Word
Writing	
❒ Environmental and seating adaptations ❒ Variety of pens/pencils ❒ Adapted pen/pencil ❒ Pencil or pen with adaptive grip ❒ Adapted paper, e.g., raised line, highlighted lines ❒ Slantboard to create slanted writing surface ❒ Writing templates ❒ Picture Supports to write from/about ❒ Word cards/Word banks/Word wall ❒ Pocket dictionary/Thesaurus ❒ High contrast pen ❒ Portable, talking spellcheckers/dictionary/thesaurus ❒ Portable word processing device ❒ Alternative keyboards ❒ Computer with scanner ❒ Proofreading	❒ Word processing with spell checker ❒ Voice recognition software ❒ Computer with voice recognition software ❒ Word prediction software ❒ Word processing with digital supports ❒ Talking word processing ❒ Tools for citations and formats ❒ Typing with audio support ❒ Tape or digital recording device ❒ Braillewriter ❒ Slate and stylus ❒ Typing with Braille support ❒ Computer-based recording software ❒ Braille keyboard ❒ Electronic Braille note taker
Mathematics	
❒ Abacus ❒ Enlarged math worksheets ❒ Tactile/audio graphics ❒ Voice recognition software ❒ Calculator ❒ On-screen/scanning calculator ❒ Money calculator	❒ Talking watches/clocks ❒ Talking calculator ❒ Models, 2D, 3D geometric shapes ❒ Tactile measuring devices ❒ Braille Monitor ❒ Alternative keyboard ❒ Electronic Mathematics Worksheets
Vision	
❒ Eyeglasses ❒ Magnifier ❒ Large print ❒ Embossed pictures ❒ Embossed maps	❒ Screen magnification software ❒ Screen color contrast ❒ Screen reader, text reader ❒ Braille translation software ❒ Closed circuit television, CCTV
Hearing	
❒ Pen and paper ❒ Computer/portable word processor ❒ TDD/TTY for phone access with or without relay ❒ Signaling device e.g., flashing light or vibrating pager ❒ Closed Captioning ❒ Real-time captioning	❒ Flash for alert signals on computer ❒ Phone amplifier ❒ Personal amplification system/Hearing aid ❒ FM or loop system ❒ Infrared ❒1:1 Communicators ❒ Computer-aided note taking

<table>
<tr><td colspan="2">Positioning, Seating and Mobility</td></tr>
<tr><td>❒ Standard seat/workstation at correct height and depth
❒ Standard seat correct height and depth
❒ Nonslip surface on standard seat to prevent slipping
❒ Modifications to standard seat or desk
❒ Alternative chairs</td><td>❒ Grab bars and rails
❒ Manual wheelchair
❒ Powered wheelchair joystick or other control
❒ Powered toy car
❒ Adapted vehicle for driving</td></tr>
<tr><td>❒ Adapted/alternate chair, sidelyer, stander
❒ Custom fitted wheelchair
❒ Walking devices/walker</td><td>❒ Cane
❒ Tactile Vision Substitution System- TVSS
❒ Global positioning system GPS</td></tr>
<tr><td colspan="2">Social Skills and Leisure</td></tr>
<tr><td>❒ Adapted toys
❒ Adapted sporting equipment
❒ Modified rubber stamp, rollers, brushes
❒ Arm support for drawing/ Painting</td><td>❒ Software to complete art activities
❒ Games on the computer
❒ Other computer software
❒ Electronic aid to control/ operate TV, CD player</td></tr>
<tr><td colspan="2">Daily Living</td></tr>
<tr><td>❒ Universal cuff/strap to hold items in hand
❒ Color coded items for easier locating and identifying
❒ Adaptive eating devices
❒ Adaptive drinking devices
❒ Light switch extension
❒ Radio/ultra sound to remotely control appliances
❒ Adaptive bathing devices</td><td>❒ Adaptive equipment for cooking
❒ Adaptive driving equipment
❒ Adapted toothbrushes, raised toilet seat
❒ Adaptive dressing devices
❒ Adaptive sewing devices
❒Interface and switch to turn on electric appliance</td></tr>
<tr><td colspan="2">Organization</td></tr>
<tr><td>Information Management
❒ Tabs
❒ Sticky notes, index cards
❒ Highlighters
❒ Key words
❒ Study guide
❒ Task analysis
❒ Digital highlighters
❒ Handheld scanners
❒ Electronic organization
❒ Online search tools
❒ Online web trackers
❒ Online sorting file tools
❒ Digital graphic organizers
❒ Online manipulatives, interactive, tutorials, animations
❒ Recorded material, e.g., books on tape, taped lectures)
❒ Prewriting organizers</td><td>Time Management
❒ Checklists
❒ Schedules- visual
❒ Portable, adapted timekeepers
❒ Electronic reminders
❒ Digital planners (PDAs), cell phones
❒ Web-based planning tools
Material Management
❒ Checklists
❒ Container system
❒ Coding system
❒ Electronic filing and storage
❒ Portable electronic storage
❒ Computer-based tools
Self-Management
❒ Sensory regulation tools, e.g. Sunglasses
❒ Movement and deep pressure tools
❒ Fidgets
❒ Auditory reminders
❒ Visual reminders
❒ Electronic reminders</td></tr>
<tr><td colspan="2">Computer Access</td></tr>
</table>

❒ Positioning of student ❒ Arm support ❒ Standard keyboard/mouse with accessibility/access features built into the operating system ❒ Standard keyboard/mouse with adaptations ❒ Alternate keyboards ❒ Alternate keyboard/mouse ❒ Onscreen keyboard ❒ Voice recognition software ❒ Eye Gaze ❒ Morse Code	❒ Switch Access ❒ Color scheme ❒ Large operating system features ❒Built-in magnification ❒ Fully-featured magnification ❒ Magnification with screen reader ❒ Screen reader ❒ Screen reader with Braille device ❒Keyguard ❒Enlarged or Braille/tactile labels for keyboard ❒ Alternate keyboard with enlarged keys ❒ Braille keyboard