Status of STEM Education for Persons with Disabilities

BY:

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President George Bush Senior signed the Americans with Disabilities Act (ADA) into law on July 26, 1990. Since that time, the reauthorization of the Individuals with Disabilities Education Act (IDEA) as amended in 1997, has occurred with various amendments thus making it possible for children with disabilities to more likely receive a quality education. In 1996, an amendment to the Copywrite Act (Public Law 108-446), which is referred to as, "The Chaffee Amendment," was past by Congress and signed into law by President Clinton. This amendment removed the publisher's permission to be given in order that a textbook be transcribed into Braille, large print, or put onto tape for persons who are blind or otherwise known as print impaired. It was through these major legislative acts and others that caused significant improvements in the opportunities for people with disabilities to pursue higher education in the United States (1).

The Federal Rehabilitation Act of 1973 created the Federal rehabilitation system whose function is to invest in Americans with disabilities to make them employable. Section 504 provides legal coverage for persons with disabilities not eligible under IDEA. This section also guarantees no person with a disability shall be discriminated against from educational programs receiving federal funding. Each state has a state agency whose responsibility is the implementation of these services to its disabled population. Although the quality of service varies from state to state, how these services are implemented also varies. In a number of states, the rehabilitation system has in place a separate agency for the blind. One major justification for this separate agency for blind persons is as a result of the specialized nature of services to blind and visually impaired persons. The knowledge base required is specialized to the point where councilors need to be up-to-date on technologies, employment opportunities, and other services newly available to blind persons (1).

With qualified and well-trained rehabilitation personnel, tends to lead to higher job placements for blind and visually impaired persons in competitive employment. The trend nationally indicates states with these separate agencies for the blind tend to have higher job placement ratings and more diverse employment opportunities. This includes placements into STEM employment in industrial, academic, and government employment.

With good rehabilitation also leads to good blindness skills training. The use of Braille, text-to-speech computer output, along with good quality orientation and mobility training aids in a blind persons ability to secure employment. This is also essential for blind persons seeking employment in the science and technology and engineering careers. A National Library Service statistic indicates just over 70% of blind and visually impaired persons are unemployed or under employed. Of the approximate 30% employed, over 90% of those can read and write Braille as part of their daily routines. This implies a

strong correlation between a good knowledge base with Braille and a blind persons ability to attain successful gainful employment. Also, the use of adaptive technologies aids in the completion of daily responsibilities in the workplace is critical in obtaining successful employment in the STEM professions (2, 3).

The ability to travel to and from as well as around the workplace is essential. Once a blind person has eliminated their fears related to these skills, the philosophy regarding their blindness plays a key roll in their successful placement. Once the blind person feels comfortable about their blindness, and they can convey a positive attitude regarding their blindness to their co-workers, they can then do the same to others in their community. This positive attitude about blindness is essential in opening doors of opportunity in the STEM career paths. A strong knowledge base on technologies and service providers in the blindness field is also important in giving a blind or visually impaired person the most opportunities in the STEM professions.

Recently, within the last three years, an organization known as Bookshare.org has come into existence, and has revolutionized the way in which blind and visually impaired students can receive their textbooks for both K-12 level and college level courses. Bookshare.org is a membership driven entity that allows its members to take advantage of the Chaffee amendment and scan in textbooks into electronic format. These scanned files are then edited and submitted to Book share for consideration to be added to its electronic book library. To date, there are over 10,000 titles in the Bookshare.org collection, with more being added every day.

Another organization known as Recordings for the Blind and Dyslexic, (RFBD), records textbooks and makes them available on audiotape and in DASY book formats. The creation of the DASY recorded book standard has revolutionized the way at which persons who are otherwise print impaired now can interact with their textbooks. This new innovative format allows a person with a visual impairment to directly enter in page numbers into their book reader and the device jumps directly to the top of the page they were interested in. This new format also allows a user to high light important passages or phrases directly on the book. This capability was never before available to this population of textbook readers. It is through these and other informational innovations that are making it more likely that students who are blind or visually impaired can pursue career paths in the science technology engineering and mathematics (STEM) fields.

By giving people with print impairments more equal access to the information in a timely manner is making it possible for these under represented populations to become more prominent and play a bigger roll in STEM careers. Since blind and visually impaired persons spend a great deal of their time learning and practicing the alternative skills of blindness such as Braille, use of the long white cane, computers with text-to-speech output capability, and other home management skills, these daily activities allow for a person in this population to utilize and practice the use of the scientific method. It is this developed skill that is practiced to the point where the person does not even realize they are using the method.

This well developed skill can be employed in solving problems in the laboratory, it is my belief that this will compliment the skills of sighted and otherwise other non-print impaired scientists that have been employed to solve a particular problem. For example, a blind persons daily practicing of the collection of information as to where they are, and where they are going helps in the maintaining and development of problem solving skills. It is this untapped skill in the STEM career paths that is desirable in the daily use of the scientific method (5).

These skills referred to as the skills of blindness are imperative in determining the success or failure of a blind person to achieve a STEM career. The use of Braille is essential in the recording of data observation. It also assists in a blind students ability to study higher levels of mathematics such as algebra 2 and calculus. The use of the white cane or use of a guide dog will aid in a blind persons ability to navigate safely within a laboratory setting. It will also allow such an individual to attend conferences and meetings relating to their specific area of expertise. The text-to-speech interface will aid in the blind persons ability to read journal publications online along with the composition of their own intellectual works for publication. These along with an overall mastery of time management and basic organizational skills are critical in their ability to carry out the many tasks that a scientist is expected to perform on a daily basis. A blind person enrolling in a training program for blind adults can master these skills. These full-time residential programs tend to offer the most comprehensive training opportunities. Many of these programs are overseen by state rehabilitation agencies, while others are privately operated. The privately operated training centers for the blind tend to offer more opportunities for skill and confidence building activities for the students. A student's ability to have confidence in their use of the skills plays an integral part of how much the individual learns to rely on their skills. The more confident they become in the use of the techniques of blindness, the more competent they tend to be in the laboratory and in their place of employment. These skills are essential in a blind or visually impaired person's success in achieving employment in a STEM profession (4).

Through the development of more access technologies (AT) this too is allowing more doors of opportunity to be opened for persons who are blind or visually impaired to study STEM career paths. One major barrier, which is being worked on, it a blind persons ability to access a PDF published data file format via text-to-speech output. Adobe Acrobat has made strides in recent years to make these files more accessible, however the equal access has not yet been reached. Also, with the improvements of Microsoft Windows accessibility, along with the release of the Micro-Soft Windows Longhorn operating system due out some time in the Fall of 2006, it is our hope that software applications running on this platform will be more easily accessible from the get-go than in previous windows operating systems.

The creation of more easily useable Braille translation software packages is making the production of textbooks and other Braille materials more available than at any other time in the history of the world. It is now possible to use a Braille translation software package called Win-Braille available from Sighted Electronics, in conjunction with one of their Index Basic D Braille embossers to do a direct print to Braille translation directly

in the PDF or Microsoft Word document. This has eliminated the need to import from Word into another software application for the Braille translation to be carried out. This has also minimized the amount of reformatting that is necessary as a result of the importing of the document from one application to another. Sighted Electronics makes the Win-Braille software available free of charge to any of its customers who purchase its Braille embossers and offers lifetime software upgrades for this software product thus insuring the best in Braille translation capability to its customers.

Through legislation past in 2004 as an amendment to IDEA, which is known as the Instructional Materials Accessibility Act (IMAA) allows for a standardized format of electronic book to be developed by the Library of Congress and requires all copywrited materials published in the United States to be submitted and made available for the Library of Congress' Books for the Blind Program. These standardized formats would be made available upon request to its subscribers to meet their textbook formatted needs. If the patron wishes to listen to their book via speech, the file will be compatible for this purpose. If the patron wishes to have their textbook put into Braille, this format will be conducive to doing so. Previously, the process to transcribing a book into Braille entailed the following steps:

1. Scan textbook into a word processor file format.
2. Spell checking each page of the textbook.
3. Imported from the word processor to the Braille translation software application.
4. Translate text from print to Braille and reformatting for proper Braille formatting use.
5. If mathematical equations were necessary, these would have to all be entered into the text at their appropriate places by hand using the Braille Code for mathematics known as Nemith Code.
6. The text would then be embossed and bound into volumes for shipping to the blind student.

This steppy process would on average take six to nine months to carry out. This process would involve a great deal of labor and cost as a result. It is common for textbooks to exceed $10,000 for textbooks that used tactile graphics and mathematical notation. This absorbatent cost tended to limit which colleges and universities in what textbooks if any they provided to their blind or visually impaired students. Those institutions that did provide such materials tended to provide them in limited fashion because of their high costs (5).

Through the passage of IMAA, this will allow for textbooks to be easily produced in Braille to blind and visually impaired students who need them by or before the first day of class. This never before had been the case. By providing these textbooks in this standardized format will allow K-12 students to receive their books. There is now a legislative initiative in Congress urging the passage of similar IMAA legislation to apply to higher education. It is this legislation that will open up true equal access to textbooks for blind and visually impaired students.

Once the textbooks are provided to blind and visually impaired students in the formats of their choosing, access technology should be made widely available in the classroom and in the laboratory. Text-to-speech along with refreshable Braille displays aid blind and visually impaired students in the classroom when taking notes, giving presentations, or in their at home studies. These software applications currently have limited functionality with scientific software packages commonly used in teaching labs. It is the hope of these software companies that produce the text-to-speech output interfaces to make them more users friendly with more software applications including those in teaching laboratories.

When a blind or visually impaired student can be given a more interactive laboratory experience will inspire them to want to pursue a STEM career path. Currently, the common method used by blind and visually impaired students is to work with a sighted lab assistant whose responsibility is to provide verbal descriptions as to what is occurring in the laboratory. They are also responsible for providing safety information to the blind student. The blind student then has the option to recording their observations on a note taker or computer, or the assistant recording them in a print notebook. The lab assistant is to work under the direction of the blind student, however, this does not always occur. Many times the sighted lab assistant has already taken the class and hence has carried out the next step before the blind student has instructed them to doing so. It is imperative for these students who serve in this capacity to refrain from doing anything, unless there is a safety matter in question, doing tasks without the direction of the blind student. This lab assistant to blind student relationship is described as the passive approach to the laboratory experience (1).

Once the need for a sighted lab assistant can be minimized, or if possible eliminated, this interaction with the collection of observation data will hopefully increase the blind students desire to study STEM career paths. A research project known as Independent Laboratory Access for the Blind (ILAB), being conducted in the Mallouk lab in the chemistry department at Penn State has the goal of creating a more active roll for blind and visually impaired students in the laboratory (6).

This NSF-RDE sponsored research is allowing the creation of a standard suite of tools to be made accessible and widely available for both blind, visually impaired, and teachers. The widely used lab probes available from Vernier are being used as the platform for this project. Other low-cost tools are also being developed to give a blind researcher access to color information as well as the formation of precipitates. As color changes and formations of precipitations indicates the occurrence of a chemical reaction, this information is viewed as vital to a blind students experience in the laboratory. Where as previously this information would have verbally been spoken to the blind student, now the blind students ability to use the tools they have been given will affect the quality of their observations they are able to record. Once the ILAB project has been completed, the Vernier Software and Technology company has agreed to sponsor future text-to-speech script files to be used with the Job Access for Windows Software screen reader available from Freedom Scientific to be continued. This partnership insures that with future Logger Pro software and JAWS screen reader upgrades, this work will continue to

benefit blind and visually impaired students, as well as help teachers of these and otherwise print impaired minority groups (6).

With the passage of legislation in Congress giving people with disabilities more opportunities in society, along with the development of new adaptive technologies will increase employment opportunities in the STEM career paths. By encouraging these under represented populations and urging their participation will add to the expertise in the sciences a strength that will be unparalleled in American society today. Once the playing field has been leveled and the contributions of persons with disabilities will be valued in the STEM education, then persons with disabilities will be able to contribute freely to the sciences. This will lead to a more enriching and powerful knowledge base and provide an edge not otherwise currently available in other cultures around the world today. This I feel will change in the years to come, but it will allow for the United States to be the trail blazer in the world by setting a high bar of expectation for persons with disabilities participation in the science technology engineering and mathematics professions.

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