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Applications of Assistive Technology in Higher Education and the Workforce for Individuals with Disabilities

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Abstract. Assistive technology (AT) has been beneficial for people who have disabilities and chronic medical conditions to allow them to function more effectively and integrate more readily within the society in which they live. This article offers examples of AT, including computer assisted technologies, sensory technologies, robotics, neuroprosthetics, orthotic and prosthetic devices, and mobility technologies. Benefits of technology are described. The article discusses two areas for the practical application of technology: assistive technology in higher education and computer applications in employment.

There are 650 million people or 10% of the world population who have disabilities and chronic medical conditions. "As the population ages, this figure is expected to increase" (Disabled World Weekly News, 2014, p. 1). In the United States, there are currently 56.7 million people who have at least one disability, representing 19% of the civilian population. This means that two out of every ten adults have reported disabilities. Individuals with vision disabilities account for 8.2 million people, while 7.6 million individuals have hearing difficulties. There are 30.6 million people who have difficulty walking or climbing stairs, 3.6 million of which are wheelchair users. Furthermore, there are 13.5 million persons with difficulties concentrating, remembering, or making decisions. According to the U.S. Social Security Administration, 33% of 20-year-old workers will become disabled before reaching retirement age (Disabled World Weekly News, 2014). People with disabilities are considered to be the largest minority group in the United States and in the world. Assistive technology has come to play an increasingly important role in the lives of people with disabilities, in the provision of education, in the employment sector, in the fostering of communication, and more.

Technology is one of the primary engines for economic activity, education, and innovation throughout the world. Various countries are committed to the development of technology, underlying the strength and vitality of those economies. Developments in mainstream technology have profound implications for individuals with disabilities. In the current technological world, the line of delineation between assistive technology and mainstream technology is becoming more difficult to draw. Substantial progress has been made in the development of AT, facilitating activities of daily living that significantly benefit individuals with disabilities of all ages (Cook, Pulgar, & Hussey, 2008). Such devices and adaptations improve quality of life, independence, and community involvement.

People with disabilities are experiencing the benefits of assistive technology, and are increasingly using it to participate in mainstream society. This development, in turn, helps society as individuals with disabilities become more independent and less reliant on public services and charitable organizations. As the income for people with disabilities increase, their purchasing power to buy goods, services, and products also increases. The field of AT is helping people with disabilities to increase or restore functioning, enhance quality of life, and mainstream into society.

Definitions

Assistive technology is defined in the Technology-Related Assistance for Individuals with Disabilities Act of 1988 as "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of people with disabilities." *Technology service* is "any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device" (Assistive Technology Act, 1998). In the United States, 25 million Americans with disabilities are using assistive devices, equipment, computers,

and other apparatus. People benefit from AT at work, in school, at home, and in leisure activities.

Use of Technology

Practitioners using AT are able to provide more meaningful, practical, and realistic clinical counseling and rehabilitation services for their clients. As noted by Scherer (2007), technology is radically changing the lives of individuals who have disabilities. AT has helped enhance the quality of life and extend the lifespan of persons with congenital and developmental disabilities, as well as those who have acquired disabilities and chronic medical conditions (Falvo, 2014).

Devices and equipment may be low-tech (mechanical) or high-tech (electromechanical or computer-related) and can help compensate for sensory or functional loss. AT provides the means to move (e.g., adaptive equipment on vehicles, wheelchairs, scooters, lifts), speak (e.g., augmentative and alternative communication devices), read (e.g., Braille input, voice recognition devices), hear (Telecommunication Devices for the Deaf [TDD], hearing aids, audio loops), and manage self-care (e.g., remote environmental control systems, prosthetics and orthotics, devices to aid a person in grooming, eating, and other activities of daily life).

Examples of Technology

Computer Assisted Technologies

Computer assisted technology includes software that allows individuals with disabilities to adapt to their surroundings and increase their independence (Scherer, 2007). Eye-gaze technology is one example (Collinger et al., 2013). This technology works by tracking the movement of the eye, which in turn activates a computer. The camera is typically attached to the head; however, the weight of the camera requires the head to be positioned and supported. The user needs sufficient head control and ability to gaze directly at the camera. Researchers are working on innovative gaze technology featuring virtual reality goggles that include an integrated camera and viewing screen to provide communication through icon choice. The user chooses targets by gazing at the icons on the computer screen; the camera, integrated within the goggles, tracks eye gaze motion and relays information for instant processing (Brodwin, Boland, Lane, & Siu, 2012a).

People with disabilities benefit from a number of software programs, including screen reading software that helps users who are blind to operate computers, magnification programs for those with low vision, and voice command software for people with hand or arm limitations. Mobile smartphone technology has made significant contributions in the field of assistive technology. Products that were once difficult to obtain and expensive are now more readily available via a downloadable application. Optical character recognition (OCR) scanning programs (for people with visual impairment), for example, once required a computer, screen reading software, and scanner to convert print documents into characters with text-to-speech output. Now, only a camera-equipped smartphone and the OCR application is needed.

Global Positioning System (GPS) applications on smart phones help people with visual impairment travel independently. Some connect via Bluetooth to shoes with vibration sensing, telling users when to turn right or left. This technology also informs users about objects in their vicinity and guides them through slow moving traffic. New technology to sense fast traffic, stairs, and sharp drop-offs are being developed. Some smartphones come with built-in assistive technology, such as screen readers, touch assistance for individuals with mobility impairment, and flash alerts and Telecommunication Devices for the Deaf (TDD) for the Deaf and hearing impaired. Smartphone technology has made assistive technology less costly and accessible to more individuals.

Sensory Technologies

Accommodations for people with visual impairments include both optical and non-optical devices. Examples of optical devices are magnifiers, specially coated lenses, and telescopes. Non-optical visual aids include talking clocks and watches, talking calculators, closed-circuit televisions that enlarge print electronically, and personal computers and peripherals with the capacity of print magnification, speech output, and optical scanning (Brodwin, Siu, & Cardoso, 2012b). Other assistive devices that aid navigation include white canes with laser or ultrasonic technology. These devices enhance the reach of a white cane by informing users when objects are approaching, if objects are at head level, or the presence of stairs and drop offs.

Additionally, hearing aids, TDD, electronic ears, amplified telephones, telephones or alarms that use flashing lights for alerts, and audio loops are helpful devices for persons who are Deaf or hard-of-hearing. Many technologies used by hearing people are useful to people who have hearing losses, such as web-based chat, Facebook, twitter, e-mail, and text messaging. Text-based telephone relay systems and video relay systems are additional communication technologies developed for people who are Deaf or hard-of-hearing.

The infrared system is a more complicated hearing device. This system transmits sound into light which is sent to a receiver worn by an individual. The light is decoded and converted back to a magnetic signal that is picked up by the person's telecoil. Because the sys-

tem does not penetrate walls, it is useful in confidential situations. Sound is transmitted to the listener clearly and free of distracting noise in the environment (National Institute on Deafness and Other Communication Disorders [NIDCD], 2011).

Robotics

Robotics are able to accommodate for manipulative tasks, perform functions through prosthetic (e.g., artificial extremity) applications, render movement in spinal cord injuries (e.g., paralysis), and perform task operations in fixed workstation (at the work site) technologies (Cook et al., 2008). A person needing the assistance of a robotic arm can attach it to a power wheelchair, from which he or she can control it using a toggle interface. Robotic devices provide assistance with such functions as drinking, retrieving items from shelves, manipulating objects, and participating in games or leisure activities. People with disabilities can operate fixed workstation (desktop) robots to manipulate objects. Similarly, someone using a desktop vocational robot can use it to perform daily activities such as preparing and eating meals, writing, reading, operating a keyboard, using a telephone, and grooming.

Neuroprosthetics

Neuroprosthetic devices are used to compensate for damaged or missing motor or sensory functions. The cochlear implant for individuals with hearing impairments represents one example. This technology has been further refined and sophisticated with the use of military technology. Neuroprosthetic devices are connected to an individual's nerves and controlled through nerve impulses. These devices help restore function of a missing or injured limb, and can also help restore one's sense of touch (Berg et al., 2013). Neuroprostheses are especially useful for individuals with tetraplegia (quadriplegia), by restoring control of movement of the limbs via a direct connection to the brain (Collinger et al., 2013). Neuroprosthetic technology has been developed to improve sight in people with visual disabilities; by using retina implants or artificial retinas, individuals with macular degeneration can regain elements of sight (Humayun et al., 2012). There is promising research indicating that neuroprosthetics will go beyond assistive technology and rehabilitation by actually restoring function.

Orthotics and Prosthetics

Orthotic and prosthetic devices are used to assist persons with disabilities. Orthoses are made to support or correct a physical limitation (e.g., braces, sprints). Prostheses are artificial limbs utilized in place of a person's limb deficiency. In the last 15-20 years, upper extremity prosthetic systems have become more commercially available (Collinger et al., 2013). People using hand motion control systems can now execute multiple functions at the same time. While previous control systems employed skin surface sensors (electrodes) placed over the controlling muscle, new systems include muscle implants, avoiding the need for skin surface contact. A more experimental surgical procedure involves an electrode sensor implant in the brain, so that the thought of flexing or extending an elbow, opening or closing a hand or finger, results in the intended motion. The goal is to make the movement so intuitive that the thought of an action will result in the physical motion (Berg et al., 2013).

The field of lower extremity prosthetics has developed in recent years as well. Microprocessor controlled orthotic ankle and knee joints are now common. The C-Leg, for example, allows the user to flex his or her foot and shin. This also reduces the demands of walking, allowing a user to navigate stairs, ramps, and other previously difficult terrains without the risk of falling (Edelstein & Moroz, 2010).

Mobility Technologies

Mobility restrictions affect all areas of a person's life, including self-care, school, work, recreation, and leisure. Limitations due to weakness, balance, gait, stamina, and motor limitations can be improved with low-technology supports such as canes, crutches, walkers, as well as manual and power wheelchairs. Mobility technology is a specialty field that focuses on transportation, including driving a vehicle. Assessments begin with defining a consumer's goals, abilities, and needs and determining how impairments affect functioning. The underlying priority is comfort and daily use of the technology (Collinger et al., 2013). Use of mobility devices is highly affected by the environment in which it is used, such as navigation within tightly enclosed settings or movement across certain terrains and surfaces (Cook et al., 2008). Mobility systems can be costly and funding criteria often influence choice, adaptability, and factors regarding a person's physical growth needs, as well as supporting technologies.

Benefits of Technology

Increased educational and employment opportunities and a greater sense of personal well-being has led to enhanced upward social mobility by individuals with disabilities. Technological devices, equipment, and services have allowed many people with disabilities to: (a) exert greater control over their own lives; (b) participate in and contribute more readily and fully in activities at home, school, employment, and the community; (c) interact to a far greater extent with people without disabilities; and (d) benefit from opportunities taken for granted by people without disabilities (Brodwin et al., 2012b; Scherer, 2007).

The main reason people with disabilities stop using AT is due to difficulties they encountered using the product. To reduce discontinuance, the user needs to be involved throughout the selection, acquisition, and learning of the use and proper functioning of the technology (Riemer-Reiss & Wacker, 2000). AT aims to enhance functional independence for people with disabilities. The focus, therefore, is not on what an individual cannot do, but instead on what he or she can do. By exploring a person's capabilities, functional limitations, and attitudes about technological devices, rehabilitation practitioners can help people with disabilities achieve their goals.

Assistive Technology in Higher Education

Assistive technology in the higher education setting allows students with disabilities to have access to classes, activities, and services. With new technology and a good fit between student need and assistive devices, more students are pursuing higher education and reaching their educational goals. A range of services and accommodations are available to students with disabilities to support student success, productivity, independence, and participation. Assistive software available to students includes Jaws, Dragon Dictate, Zoom Text, Microsoft Reader, and Text Aloud (Los Angeles Valley College, 2014). These programs help individuals with vision impairments or upper extremity limitations read and type text. Many of these programs are now downloadable apps on smartphones. Software programs used in the academic setting to participate in class are also easily transferable to use in employment or leisure settings.

Assistive devices commonly used in higher education include modified keyboards, key guards, joysticks, head pointers, and Daisy Readers. Alternative media formats are often available in Braille, large-print, and audio. Personal FM units or closed-captioned TV, screen enlargers, magnifiers, light boxes, and scanners are additional technology often used by students with disabilities. Medical documentation is often required by college officials to verify the disability and to better provide educational supports (Los Angeles Valley College, 2014). Proper accommodations for an individual in the higher education setting not only supports academia, but also encourages practices necessary for integration and independence in the workforce.

Computer Applications in the Workplace

Assistive technology and computers are effective and powerful devices for helping restore functioning in employment, enhancing quality of life, and eliminating both physical and attitudinal barriers (Brodwin et al., 2012a; Martin et al., 2012). Computers in business, industry, and government increase productivity and self-sufficiency of almost all workers who use them, especially employees who have disabilities. An employee with a disability with the right computer technology can function as effectively as a worker without limitations. Computer applications include input and output devices (e.g., voice, Braille), alternate access aids (e.g., headstocks, light pointers, pointing aids, eye gaze, touch screens), interface devices, modified and alternative keyboards, trackballs, joysticks, switches, and special software, enabling people with disabilities to access and use computers effectively.

Conclusion

People with disabilities and chronic medical conditions are benefiting from the use of AT and its applications in activities of daily living, higher education, and employment. Through the effective use of technology, these individuals can more readily interact in all segments of the society where they live. Technology helps *level the playing field* in all areas of life and living.

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