

Ranking the Needs of Students with Disabilities at the University of Sharjah and Identifying the State of the Art of Assistive Technologies

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Abstract

Every human being has the right for education regardless of her or his culture, race or disability. Students with disabilities are having a challenging experience when they go through the education stages during their life. Education institutions should care about the needs of students with disabilities and try to do whatever is needed to accommodate them in the education programs. Therefore, the purpose of this paper is to identify the needs of students with disabilities and identify the available assistive technologies used with the various types of disabilities. Based on the results of a literature review, legal documents, and ISO standards, it was possible to identify eight needs for the students with disabilities. Furthermore, we identified the state of the art of the technologies that are internationally available and being used with five types of disabilities, i.e. deafness, blindness, dyslexia, physical disability, and autism. Benchmarking University of Sharjah's assistive technologies with best practices at other international universities enables the University of Sharjah to know where it stands with respect to other's best practices. Furthermore, they can develop the needed strategies required to adopt the best practices, which will enhance the disabled student's life in the campus.

Keywords

Students with disability; disability needs; assistive technologies; University of Sharjah; Disability Resource Center; education strategies

1. Introduction

Education is critical for the development of cultures and technologies, especially in the higher education institutes. It is an absolute right for every human being, regardless of their culture, race, or disability (The United Nations and UN General Assembly, 1948). Students with disabilities are having a challenging experience when they go through the education stages during their life. Their disability can stop them from reaching the goals they set and achieving their dreams. That is why education institutions should care about this group of students, i.e. students with disabilities, identify their needs and try to do whatever is needed to accommodate them in the education programs. Universities these days are becoming more aware of the importance of including students with disabilities in their campuses, and are aware that these students often can achieve high level of success and innovation, based upon that, universities are offering and searching for the best practices and the most recent technologies to make the learning process for these students as smooth as possible (Vrășmaș, 2014). Therefore, in order to provide best education to people with disabilities the University of Sharjah has founded Resource Center for People with Disabilities. The vision statement of the center is "To provide high-quality university education to people with disabilities at the University of Sharjah equal to that of other students at the University." It has stated two missions, and 10 main objectives, for more details, see the center website link (<http://www.sharjah.ac.ae/en/Administration/DRC/Pages/default.aspx>).

Based on the directions of the University administration and in collaboration with Ms. Fatima Ibrahim the Director of the Resource Center for People with Disabilities, and the sustainable engineering asset management (SEAM) research group started a project with senior students from the IEEM department, see the link (<http://alwatannewspaper.ae/?p=84518>). In this paper part of the project results are presented. The purpose of this paper is to identify the needs of students with disabilities and identify the available assistive technologies used with the various types of disabilities.

The organization of the paper is as follows. Section II addresses the type of disabilities under study. Section III illustrates the needs of students with disabilities and rank them. Section IV lists the assistive technology for each disability type. Section V provides a conclusion.

2. Types of disabilities

In the literature, the disabilities are classified into various categories (Lopez-Gavira *et al.*, 2016). However, in this study we focus on the following five types of disability that the Disability Resource Centre are dealing with:

- **Auditory perception:** problems related to ears, or weakness of hearing. Thus, one cannot communicate or distinguish between sounds or know which sound to focus on, for example: deafness.
- **Visual perception:** problems related to eyes. One cannot distinguish between different shapes, letters, and colors, or may be blind, too, for example: blindness.
- **Information processing speed:** when one is slower than average in grasping or comprehending information, for example: dyslexia.
- **Imputed limbs:** having one or more missing limbs that will have an effect on the learning process of the person, for example: physical disability.
- **Social disconnection:** having problems in communicating or getting along with people around them, for example: autism.

3. The needs of students with disabilities

To identify the needs for students with disabilities we analyzed published papers, legal documents and ISO standards which provided us with more understanding to the problems these students with disabilities are facing. The problems varied from lack of awareness among peers which led to social disconnection as Kowzalski *et al.* (2016) mentioned, to difficulties in accessing facilities within the campus (Ineland, 2016). Moreover, we also conducted several interviews with students with disabilities to identify these needs and their categories. These categories cover all the needs for students with disability throughout their university life. Moreover, we have interviewed the head of disability resource center at University of Sharjah to validate the final needs categories. Below we present the categories which we have found:

- **Awareness level:** This need is related to the level of awareness of the needs of disabled people available with the people who are dealing (indirectly/directly) with disabled students (Kayhan, N., Sen, M., Akcamete, 2015). This category can be enhanced by providing more events for spreading awareness among university students so that more people become capable of dealing with disabled students. Moreover, this category even be improved by providing special training programs for the faculty and other university staff members (Greenbaum *et al.*, 1995). In addition, introducing volunteering programs for raising awareness. This will promote social inclusion of disabled students and reduce the social-economic burden as described by Chen and He (1997).
- **Assistive Technologies:** This refers to any piece of equipment, product, or system either software or hardware, that is used to increase functional capabilities of individuals with disabilities. This need focuses on the provision and usage of assistive technology among students with disabilities (Lersilp, 2016).
- **Adjustability of Educational System:** This need covers the importance of providing flexibility while attaining education throughout the university life for disabled students to overcome their inability. This can be achieved by providing examination accommodation, flexible class timings, also substituting courses in

the study plan without effecting the major requirements (Bjekić *et al.*, 2014, Vrășmaș, 2014, Kayhan, N., Sen, M., Akcamete, 2015).

- **Disability Support Services:** In this paper, disability support service refers to the range of day to day supports funded to assist people to live in their community. This category includes providing a personal-care or/and a personal-assistant. A personal-care is a person who assists the student with disability with day-to-day hygiene issues and laundry services and a personal-assistant is a person who assists the disabled student with academics, for example, a personal assistant can be a note-taker or can even be a sign language interpreter (Kowalski *et al.*, 2016).
- **Sports:** Sports refers to the activities involving physical exertion and skill in which an individual or team competes against others for entertainment. This category deals with sports for students with disabilities. In many occasions the universities do not provide a financial budget for sports equipment which was discussed by Kayhan et al. (Kayhan, N., Sen, M., Akcamete, 2015). Introducing sports events will motivate disabled students which will bring about better academic performance (Yazicioglu *et al.*, 2012).
- **Student Evaluation:** It is the process of assessing student performance to be able to provide the correct education throughout the academic life. This need focuses on providing counselling services to measure student performance throughout the academic year (Kayhan, N., Sen, M., Akcamete, 2015). Counselling will assist college students with disabilities in managing problems related to the career, academic achievement, and mental domains. The counselling service can be either provided onsite or online. Lan (Lan, 2016) describes the importance of cyber counselling for students with disabilities in his paper which does indicate the need for this service among students with disabilities (Lan, 2016).
- **Disabled Friendly Transportation:** This category focuses on whether the university is well equipped with all the requirements to transport disabled students from and to the university easily and with comfort. For example, this category may include Paratransit services for students with disability (Paratransit Service, 2017).
- **Ease of accessibility in Facilities:** This category deals with providing the students ease of accessibility in the campus (US Department of Justice, 1990, 2008). The concept focuses on enabling access for people with disabilities through the use of assistive technology or designing the facility layout which may have ramps in accordance to the ISO standards (ISO/IEC, 2009) or even providing tactile paving.

After identifying the needs for students with disability, the next step was to validate and rank these needs with the help of opinions from the experts and people working with them. The results of the ranking are illustrated in Fig. 1. We can see that there is a need to improve the “awareness level” of the people who are dealing (indirectly/directly) with disabled students, since it got the highest importance weight. This was followed second by the need to “the disability support services”. In third place comes the need of more “assistive technologies”, followed by “adjustment in educational systems”. The least important need was the “sports”, preceded by “accessibility in facilities”.

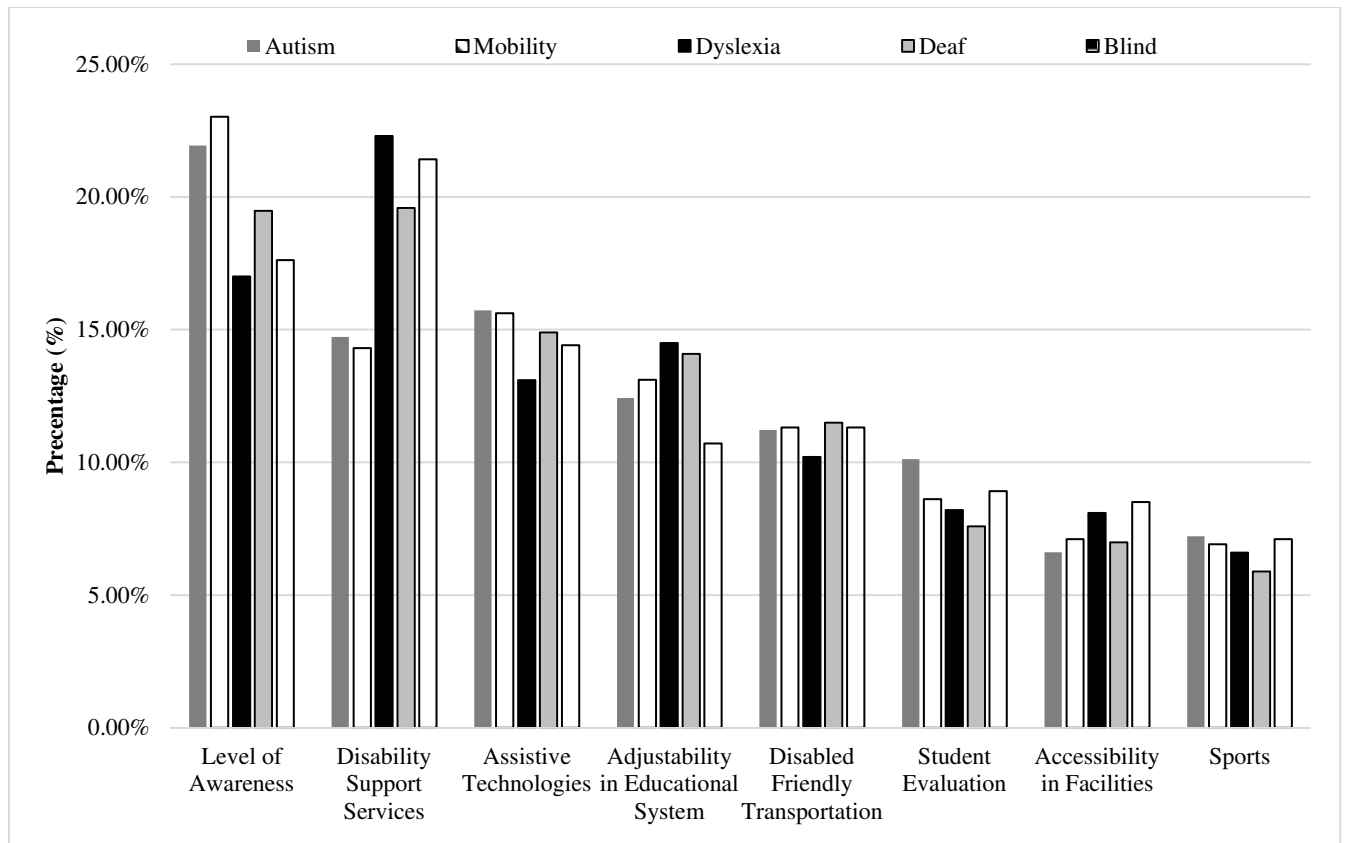


Figure 1. Summary of the importance categories for each disability type

4. Assistive technology for students with disability

In the following, we present the results of the identified assistive technologies used with each type of disability.

4.1 Assistive Technology for Students who are Deaf or Hard of Hearing

- **Assistive Listening Devices (ALDs)** are used to improve the signal-to-noise ratio in any given situation. In addition to increased volume, ALDs provide the listener with a direct connection to the sound source and help minimize the effects of background noise, distance and room acoustics. Among the various ALDs one can use Frequency Modulation (FM) systems with which the sound is transmitted on a specific frequency or channel similar to a radio. In addition, one can use Infrared systems that utilize light waves to transmit sound from the transmitter to a special light sensitive receiver. Furthermore, Induction Loop (IL) systems that utilize electromagnetic energy to transmit the signal. Also, we have the one-to-one communicators that require the listener and sound source are close together because the transmitter and receiver are connected by a wire or cord that transmits the sound.
- **Personal Amplification devices** that are designed to provide an individual with increased access to sound across all environments. These include the following:
- **Hearing Aids** are available from numerous manufacturers, but all have the same basic components and purpose of amplifying sound. Styles of hearing aids include behind-the-ear (BTE); in-the-ear (ITE); and in-the-canal (ITC). They vary based primarily on size and features.
- **Voice to Text / Sign:** There are several commercially-available products that utilize voice recognition software to convert voice to printed text or computer-generated sign language.
- **Caption Mic:** With minimal practice, a voice captionist repeats what was said by an instructor into a microphone that converts the information to captioning to be read by the deaf or hard of hearing individual.

- **iCommunicator:** Performs as a communication tool that converts the spoken word into text, instantly translating it into Sign-Language or Computer-Generated Voice, providing access to acoustic information in real-time. This software is able to convert speech to text; speech/text to video sign-language; or speech/text to computer generated voice.
- **Video Remote Interpreter:** When an interpreter is not available to attend a function in person, video remote interpreting provides another option. Utilizing a phone or other computer devices or software, an interpreter in another location can listen to a presentation and use sign language to relay the information presented through a web camera or video phone.
- **Real Time Captioning:** Real time captioning provides a typewritten account of all verbal information presented within a lecture, meeting, discussion or presentation. All of these systems require the skills of a trained captionist and specialized software or equipment such as a computer. They typically vary based on the amount of information represented within the visual display of information ranging from summaries to word for word transcription. The following are examples of such technologies:
 - **CART (Communication Access Real Time Captioning)** - Provides a word-for-word transcription (similar to a court reporter) using a stenotype machine, laptop computer and real time software.
 - **CPrint** – Developed as a speech to text communication access system at the National Technical Institute for the Deaf (NTID), a college of Rochester Institute of Technology (RIT). This system condenses information using a meaning-for-meaning translation (not verbatim).
 - **Remote Captioning:** Rather than having a captionist physically present, the user can listen in using a phone, cell phone, or computer microphone which allows the captionist to transmit the text back to the consumer using a modem, internet or some other data connection.

4.2 Assistive Technology for Students who are Blind or Have Low Vision

Here we present the technologies used in the case the students are having low vision problems or when they have complete blindness. In addition, we discuss the tools that can be used by teachers to help these students. following technologies:

4.2.1 Low Vision under this category we have identified the following technologies

- **Long Cane-** a walking tool used to support independent travel or to identify for others that a person is visually impaired or blind.
- **Monocular-**an optical device used for close-ups of distant objects. It may be used in classroom to read more for or presentation projected on large screens.
- **Digital talking compass-**a directional device that announces the directions through an audio output.
- **Manipulatives-** toys, shapes, models and other objects to support the learning process. Real objects should be used whenever possible. They may complement and/or replace pictures they might not be clear or meaningful.
- **Adapted games-** for computer games specially designed to accommodate vision loss.
- **Typoscope-**a rectangular cutout used to provide borders which outline the area for one to write their signature.
- **Voice output measuring and household devices-**various kinds adapt. Appliances with speech output and/or tactile markings.
- **High contrast or large numbered watches and clocks.**
- **Magnification** - there are four types of magnification: relative-size (large format, bigger manipulatives), relative-distance (material presented closer to student), angular (lens-based magnifiers), and projection (camera-based electronic magnifying devices).
- **Specialized lighting** – lamps and lights with various types of illumination may enhance the visibility of the working surface.
- **Material positioning devices** – simple page holders, foldable book holders, or more sturdy book stands, and slant boards enable better positioning of the material to decrease distance, angle, or glare.
- **Audio support** – software or hardware that gives information through auditory channel in addition to the primary channel whether it be visual, or tactual.

- **Text-to-speech** – software that converts digital text into audio. It is implemented in talking programs, like word processors, or is part of read aloud imported text.
- **Portable reading devices** – hardware that supports various formats of audio text. Information may be stored either as audio files on media cards, or as sound tracks on CDs.
- **Large key calculators** – oversized tool to accommodate vision needs.
- **Audio graphic calculator** – software or hardware that gives students with visual impairments visual and auditory access to graphing.
- **High contrast (20/20) pen** – simple writing tool that makes letters more visible due to high contrast ink.
- **Money management software-programs** to assist in managing financial activities like balance check books, etc.
- **Large print or magnified screen typing instruction software/programs** to assist in keyboard instruction.
- **Brightly colored/high contrast balls.**
- **Lightbox**-a device that provides a lighted working surface to give higher contrast or attract visual attention.

4.2.2 Blindness for this category the following technologies are identified:

- **Long Cane**
- **Braille** – a special typewriter that produces immediate text in Braille as it is being typed. It is the most common mid-tech device used for typing in Braille.
- **Electronic Braille note-taker** – a device with numerous functionalities used to input, store, and output text either in Braille or print. Depending on the model, note takers may have Braille or QWERTY keyboard, speech only output, or speech and Braille output. The newest devices store various types of files using internal drives or memory cards. They also have Internet capabilities.
- **Electronic Braille typewriters** – a tool that is a combination of Braillewriter and electronic note-taker. It produces an immediate hard copy of Braille, allowing prior insertion and proofreading of text.
- **Tactile images** – graphical information created in tactile format that is accessible for blind people. There are a number of methods to create tactual images. Some may require specialized equipment, while others can use low-tech materials.
- **Tactile-audio presentations** – overlays and devices linked to a computer to output auditory information assigned to a specific area in the overlay that is put over a touch sensitive board.
- **Portable reading devices** - portable players that play back different types of audio that is stored on CDs or removable media cards.
- **Talking software or hardware calculators** – math support with speech output functionalities.
- **Braille calculator** – math support device with Braille display.
- **Audio graphic calculator** – software or hardware that gives students with visual impairments visual and auditory access to graphing.
- **Math tiles** – a set of Braille tiles with a magnetic board to help blind students understand different math concepts.
- **Text-to-audio conversion software** – programs that allow converting digital text into audio formats.
- **Abacus** – low-tech tool for calculation tasks.
- **Math support software** – programs to give access and explain math concepts.
- **Audio support** – software or hardware that gives information through the auditory channel in addition to the primary channel, whether it is visual, or tactual.
- **Text-to-speech** – software that converts digital text into audio. It is implemented in talking programs like word processors, or is part of read-aloud imported text.
- **Audio graphic calculator** – software or hardware that gives students with visual impairments visual and auditory access to graphing.
- **Adapted cane**- modified tool that enhances safety in traveling. It is used with people who have other concerns in addition to blindness. •
- **Electronic Travel Devices (ETDs)**- electronic devices that are a secondary tool used in addition to obtain or adapted cane.
- **Braille compass**-I directional device with a priest arrow; braille characters indicate the four directions of the world
- **Talking GPS-positioning tools** separately informed person about the current position and route

- **Manipulatives-extra objects** should be used whenever possible, shapes, models, and other objects to support learning process.
- **Sign maker**-a device that helps create Braille labels to be used for marking all kinds of objects
- **Talking watches, clocks-timepieces with speech output**
- **Talking Typing Instruction Software**-programs to assist in keyboarding instruction
- **Adapted games-Board or computer games** specially designed to accommodate vision loss.
- **Swing cell**-a tool that assists instruction in Braille.
- **Images-tactile, graphic, audio description or real object.**
- **Braille blocks**- plastic box with Braille characters to assist instruction in Braille.
- **Money management software** – programs to assist in managing financial activities like balancing checks, etc.
- **Talking dictionary** – hardware or software tools to assist in language-related tasks.
- **Talking test software** – software that reads out the content of the test entered by the teacher or another person that administers the test.
- **Word-prediction software** – programs that support composition of sentences.
- **Organization tools** – software or hardware to facilitate organization and learning material management.
- **Tactile-audio systems** – haptic devices that enhance tactile exploration.
- **Image simplifying software** – programs that convert images from visual to textual by simplifying their content.
- **3-D images for concept development** – tactual images to complement or supplement textual information.

4.2.3 Finally, in the following we discuss the tools that can be used by teachers to provide academic service for students with visual impairments

- **Text-to-Braille translation software** – programs that translate print to Braille
- **Embossing** – aka Braille printer, a device used to emboss text in Braille
- **Braille instruction support tools.**
- **Scanner with Optical Character Recognition (OCR) software** – device used to convert paper text into digital format. Optical Character Recognition OCR is software that converts the image of the text on pages that are being scanned and turns it into e-text.
- **Image simplifying software** – programs that convert images from visual to textual by simplifying their content.
- **Image embossing devices** – hardware that makes flat print images tactually accessible.
- **Color copier with enlarge function** – a device that allows enlargement of print material.
- **Text-to-audio software** – programs that convert electronic text into an audio format. Some programs also save files as portable audio files like .mp3 or .wav.
- **Voice recording software** – programs that allow digital voicing recording and editing. Files can be saved in various formats and subsequently either listened to on the computer, or transferred to portable media players.

4.3 Assistive Technologies for Students with Dyslexia

In the following we present the technologies used in the case the students are having problems related to the speed of information processing, i.e. Dyslexia.

- **Changing the Readability of Text:** Using Wite-Out on challenging vocabulary and replacing the words with easier synonyms can change the readability of the text. Another solution is to summarize the text on the computer with easier vocabulary and less details. Paste the summary over the existing text so that the student's book "looks" like their peers. Enlarging the font, increasing the line or word spacing, or increasing the margins on the document so that fewer words are on a line can increase readability.
- **Marking Text** - Color Coding Text for specific words for students to identify important vocabulary.

- **Independent Reading** – Recording spelling of words, giving definition or synonyms to unfamiliar vocabulary on Language Master (or introduce students to Google Vocabulary Pronunciation Through Google Translate)
- **Talking Dictionaries** - The various talking products such as those from Franklin Electronic Publishers are especially helpful for students who stumble over new words or larger words as they are reading.
- **Reading Pens** - A single word scanner can be of great help to an advanced reader who struggles with large, multi-syllabic or unfamiliar words.
- **Use of Pictures/Symbols with Text** - Adding pictures to text can be very helpful for students who struggle with reading text.
- **Electronic Text** - Electronic text allows the students to manipulate/access the text
- **Text Reader** – Introducing the Text to Speech Software

4.4 Assistive Technologies for Students with Mobility Impairment

Here we present the technologies that can be helpful in case the student is having one or more missing limbs, i.e. physical disability.

- Crutches/Walker
- Grab bars and rail
- Manual wheelchair
- Powered scooter or cart
- Powered wheelchair
- Adapted vehicle for driving.

4.5 Assistive Technology for Students with Autism Spectrum Disorder

Assistive tools for students with Autism Spectrum Disorder (ASD) can be divided into various sub-categories such as sensory input, motor movements i.e. limb movement, receptive and expressive communication, behavior, social interaction, and transition which can cause difficulties in academics.

Most students, including many students with ASD, benefit from participating fully in classroom activities. However, many students, especially those with ASD, can learn and absorb information in ways that are not immediately apparent. All students should be encouraged and supported in actively engaging, fully possible, in the learning process. Differentiating instructions, and providing varied instruction for all kinds and levels of learners, will support greater participation for all students.

In the following, we present examples assistive technologies that can be used by students with ASD:

- **Highlighter Tape:** Many individuals with ASD possess relative strengths in their reading recognition skills (decoding) but experience significant difficulty understanding what they have read.
- **VoicePod:** The VoicePod is a digital recording and playback system ideal for photos, language cards and communication symbols. It features thirty-six reusable, two-sided sleeves with a unique identification strip to access recordings.
- **Word Processing programs and tools:** Most common example Microsoft Word and other software within the package
- **Overhead Projectors:** Still in use; can provide a unique way to approach teaching and an opportunity to stand and engage more of the body while working on problems.
- **Video Taping:** The use of video can provide students with visual images of many academic processes from writing to creating projects to working in a team.
- **Computers:** Computers are often highly motivating and engaging for students with ASD. Learning on the computer lacks the ambiguities and distractions of other teaching methods in the classroom.
- **Online Learning:** Online learning involves courses offered by postsecondary institutions that are 100% virtual
- **Touch Window:** An alternative to the use of computer mouse.

- **IntelliKeys:** This is a popular alternative keyboard that easily connects to a computer and works with either Macintosh or Windows. The student simply pushes various locations on an overlay placed in the IntelliKeys to access programs.
- **Trackballs:** An alternative to the use of computer mouse.
- **SMARTBoard:** A SMARTBoard (or an interactive white board) with Notebook software can provide a wide variety of organizational and curriculum materials that can be extremely engaging for students with ASD

5. Conclusions

In this paper it was possible to identify the needs of the students with disability, validate these needs and rank them with the help of expert opinion. It was found that there is a need to improve the “awareness level” of the people who are dealing (indirectly/directly) with disabled students, since it got the highest importance weight. This was followed second by the need to “the disability support services”. In third place comes the need of more “assistive technologies”, followed by “adjustment in educational systems”. The least important need was the “sports”, preceded by “accessibility in facilities”. Knowing these results can help the decision maker to prioritize what should be improved first and initiate improvement projects accordingly.

The details of the methodology of using the multi-criteria decision-making tool will be presented in another future paper. For one of these needs, i.e., assistive technologies, in this paper we identified the state of the art of the technologies that are internationally available and being used with five types of disabilities. These five types of disabilities are the ones that are being dealt with by the Disability Resource Centre at the university of Sharjah, i.e. deafness, blindness, dyslexia, physical disability, and autism. The results will help Disability Resource Centre to Benchmark the University of Sharjah’s assistive technologies with best practices at other international universities which enables the university of Sharjah to understand where does it stand with respect to others best practices and develop the needed strategies to adopt the best practices which will enhance the disabled student’s life in the campus.

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