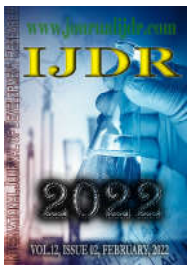
ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 12, Issue, 02, pp. 54203-54211, February, 2022
https://doi.org/10.37118/ijdr.23972.02.2022



RESEARCH ARTICLE OPEN ACCESS

THE IMPLEMENTATION OF ASSISTIVE TECHNOLOGY (AT) FOR STUDENTS WITH LEARNING DISABILITIES VS.UNIVERSAL DESIGN FOR LEARNING

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ARTICLE INFO

Article History:

Received 20th December, 2021
Received in revised form
14th January, 2022
Accepted 29th January, 2022
Published online 26th February, 2022

Key Words:

Learning disabilities, Assistive Technology (AT), Universal Design for Learning, Cognitive impairment, Developmental impairment, General learning disability, Mental (psychiatric disorder), Physical impairment, Sensory impairment.

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ABSTRACT

This current empirical study aims to explore various aspects regarding the significance of implementing assistive technology in the learning environment. The study also aims to highlight the primary components of inclusion achieved through the use of AT. Further, the study seeks to identify the types of assistive technology and the advantages of adopting AT in a modern learning environment. Additionally, the study aims to specify areas where assistive technologies can be helpful. Finally, the study explains how to implement AT in learning environment and elaborates the relationship between AT and the universal design for learning as well as the principles of universal design.The study concluded that due to the potential contribution of the assistive technology, ranging from low-tech to high-tech, can empower students with learning disabilities, Furthermore, the current study concluded that assistive technology, through the implementation of a broad scope of technologies, can create a great deal of opportunities for all students with learning disabilities and enhances their academic performance in academic settings. It also contributes to providing a model for self-actuated learning among students with learning disabilities through raising their level of self-determination. It was also found by the current study that there are various assistive technologies available nowadays and among these technologies, the most effective ones are those which are created and constructed with a universal design. Actually, assistive technology could be undergone a universal design process that aims to design a general AT products with certain structures that allow it to be used by everyone (not individually). It was found that the Universal Design for Learning (UDL) emphasizes the precise aims of learning environments which are supporting the process of learning and fostering the changes in knowledge and skills. Based on that, the UDL framework aims to ensure that the pedagogy's components, including the processes that are embedded in classrooms and curricula, the techniques, methods, and scaffolds, are all accessible. Furthermore, there are principles of universal design that are necessary for communicating the concept of universal design and all of its various aspects. These principles also encapsulate the existing knowledge base. Finally, it is significant that the assistive technology and the universal design should be interacted and integrated in order to achieve optimal and practical results.

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Citation: ***Abdulhameed Hasan Talafha.*** "The implementation of assistive technology (at) for students with learning disabilities vs.universal design for learning*", International Journal of Development Research*, 12, (02), 54203-54211.

INTRODUCTION

After the era ofthe universal technological boom and revolution that the world has witnessed in which technologies are replaced by other innovative, advanced, novel and accelerated technologies in a short amount of time. The innovations of such technologies with its potential impact are characterized by rapid diffusion as well as applications that lead to a remarkable change in the society and increases efficiency and productivity. Due to the previous mentioned era of technological boom and revolution, individuals who suffer from learning disabilities start to live their life easily, thanks to the electronic tools, technological techniques and devices that have contributed greatly to providing a lot of services for this category of the society and reshape the overall society. In consonance with Paz & Stringer (2021), technology, as a matter of fact, has the ability to be the great equalizer for teaching process that is carried out in a classroom with diverse learners who are characterized with diverse disabilities. Furthermore, technology can assist teachers to personalize lessons and skills enhancement for students with learning disabilities through exposing them to technological gadgets such as tablets, computers, smartphones, etc. It is ironic that learners with special needs and learning disabilities encounter fewer barriers

when they access into the virtual world (digital world) than what they experience in the physical world. Such virtual world leads the way in creating innovative solutions that would allow students with learning disabilities to fully integrate with their peers in the same classroom. These potentially life-changing devices and applications are generically known as 'assistive technology' (Parette and Blum, 2015). In fact, assistive technology (AT) represents the means of translating the broad intentions of the inclusion of learners with learning disabilities into everyday practical realities (See Figure 1 below):

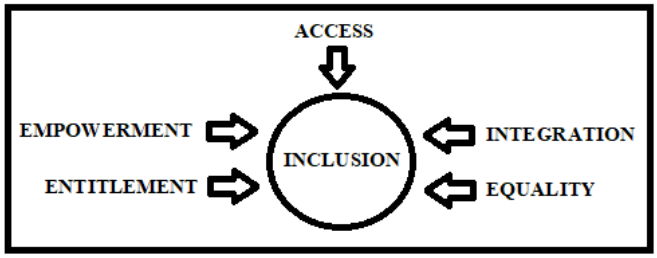

Figure 1. The primary components of inclusion achieved through the use of AT. (Source: First Discoverers, 2021)

Further, when implemented thoughtfully, assistive technologies, through its potential contribution, can empower students with learning disabilities, supports their inclusion in classroom with their peers, and increase their independence (ibid).

Problem Statement: The National Education Association (NEA) reported that the number of students who are enrolled in special education programs has risen 30% over the past 10 years. For example, in the United States of America, almost every general education classroom includes students with learning disabilities. In fact, three out of every four students with learning disabilities spend part or all of their school day in a general education classroom (Teach-Thought, 2022). However, in the domain of special education, educators interact with individuals with learning disabilities and/or special needs as well as their families who seek support. One major aspect of this support that can be provided is the assistive technology. Ranging in sophistication from 'low' technologies to 'high' technologies, various tools of assistive technology may be found in any given classroom which can assist students with learning disabilities to learn more in an effective way and to make a difference in how students with learning disabilities learn (Ahmed, 2018). A great deal of research has been conducted on AT to explore how it can be integrated into the general curriculum and to measure the importance of its implementation in the classroom (Edyburn, 2006; Carlson, Ehrlich, Berland, & Bailey, 2001 in Ahmed, 2018). However, assistive technology, which became a growing and dynamic field nowadays, has been recently a controversial aspect associated with students with learning disabilities because of the variation of people's attitudes towards its use in the learning environment. Some people consider AT as a tool that enables students with learning disabilities to succeed, while other peoplebelieve that AT makes those students dependent and deprive them of being be able to do the tasks on their own (ibid)

For those people who have different perspectives regarding the use of assistive technology, and in light of the complexity of tasks given to students with learning disabilities and the fact that some students may have difficulties in different areas like reading, listening, writing, etc. Yet, if those students are prevented from accessing assistive technology and hence become unable to access the general education curriculum, it can lead to a dependency on others. Furthermore, many students with learning disabilities are currently included in an inclusive classroom which may help them to overcome some of their challenges, yet it may also create other problems if they are unable to increase their learning and academic performance through having access to assistive technologies' tools as these tools have the potential to increase, maintain, or improve the functional capabilities of the students with learning disabilities (Edyburn, 2006). Therefore, students with learning disabilities need to have an accessible educational environment and to be enrolled in the Least Restrictive Environment (LRE) in order to promote the classroom acceptance of them and also to allow them to participate in the classroom as well as in the general education curriculum. To do so, there are many techniques that have to be considered, one of which is assistive technology. Edyburn (2004) asserted that AT can help create the accessible environment that children with disabilities, parents, and special educators are looking for. Students with disabilities can be as successful as their peers and the can understand the context of the subject being taught when the educational system provides the necessary accommodations. At the top of these accommodations is the assistive technology that can aid students with learning disabilities to overcome and bypass their learning challenges. Finally, even though education professionals understand the importance of assistive technology, it is unknown what the general public understands about the importance of using assistive technology in the students' daily and academic life (Ahmed, 2018).

Hence, this study aims to explore various aspects regarding the significance of implementing assistive technology in the learning environment and the relationship between AT and the universal design for learning.

People with Disabilities VS. Learning Disabilities: As for the concept of 'people with disabilities' in particular, it refers to the individuals who have condition(s) or impairment(s) including: 1) cognitive impairment (also known asmental retardation) that encompasses various intellectual/cognitive functioning deficits in two or more adaptive behaviors that appears in the developmental period before adulthood and caused by brain injuries, stroke, side effects from medications, and dementia; 2) developmental impairment that include chronic conditions that are due to mental or physical impairments such as such as dyslexia, autism, Down Syndrome, Tourette's syndrome, Attention Deficit Hyperactivity Disorder, etc.; 3) general learning disabilityand mental retardation that are characterized by significantly impaired intellectual and adaptive behavior. General learning disabilities is subdivided into syndromic intellectual disability and non-syndromic intellectual disability; 4) mental or psychiatric disorder that are characterized by a behavioral or mental pattern that causes significant distress or impairment of personal functioning which are diagnosed by usually a clinical psychologist or psychiatrist such as depression,dementia, bipolar disorder, schizophrenia, and other psychoses; 5) physical impairment that is characterized by a limitation on a person's physical functioning, mobility, dexterity or stamina such as sleep disorders and epilepsy; 6) sensory impairment that is characterized by the biological system's inability to carry out the process of gathering information about the world and responding to stimuli, i.e., the brain receives signals from the senses, which continuously receive information from the environment, interprets these signals, and causes the body to respond, either chemically or physically; or 7) a combination of multiple impairments that causes disability which may be present from birth or can be acquired during a person's lifetime and which makes it more difficult for the person to do certain activities or effectively interact with the world around them (Campbell, 2017; Boat& WU, 2015; Plomin, *et al*, 2012; Stein, *et al*, 2010; Jessica, *et al*, 2005; Stiker, 2000). On the other hand, the concept 'learning disabilities' is defined as "a retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, writing, arithmetic, or other school subjects resulting from a psychological handicap caused by a possible cerebral dysfunction and/or emotional or behavior disturbances. It is not the result of mental retardation, sensory deprivation, or cultural and instructional factors" (Kirk, 1962 in Kavale&Forness, 2000, p.5).

Assistive Technology (AT): Assistive technology (AT) are the assistiveand rehabilitative devices, object or system that are utilized to help disabled people. In accordance with Parant, *et al* (2017), assistive technology can mitigate the effects of disabilities of people with disabilities. These disabilities limit their ability to perform

activities of daily living (i.e., self-care activities) independently. In other words, AT promotes greater independence among disabled people through enabling themto perform tasks they were formerly unable to accomplish, or had great difficulty accomplishing. Assistive technology is considered as part of the overall process of occupational therapy that aims to maintain, adapt aspects of the environment, and improve the quality of life for people with disabilities who face challenges when performing their basic and instrumental occupations and activities, including educational and learning activities independently. In other words, the application and employment of assistive technology enables disabled people to optimize functional participation in various challenging occupations through enhancing the utilization of the needed technology to perform such activities in order to improve the quality of their life. Similarly, Hetzroni & Shrieber (2004) defined assistive technology as a broad range of devices ranging from low-tech to high-tech such as interactive multimedia systems and computer. Hetzroni & Shrieber (2004) and Blackhurst (1997) also stated that assistive technology that is included in the learning environment helpsincreasing individualswith learning disabilities' productivity. Furthermore, IDEA amendments of 1999 defined assistive technology 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 the functional capabilities of a child with a disability" (IDEA Amendment of 1997, Sec. 602 in Bigelow, 2008: p. 4). CPIR (2021) asserted that Assistive technology is implemented, in the least restrictive environment, to enables students with learning disabilities to participate more fully in all aspects of their lives, including their homes, their schools, and their communities. AT also helps students with learning disabilities access their right to a free appropriate education. Assistive technology aims to fulfill several goals including improving, increasing, and maintaining the functional capabilities of the students with learning disabilities. For instance, it aims to facilitate independence and create a great deal of opportunities for all students with learning disabilities (Nelson, 2006). Nelson added that assistive technology enhances the academic performance of students with learning disabilities in academic settings through the implementation of a broad scope of technologies. It also contributes to providing a model for self-actuated learning among students with learning disabilities through raising their level of self-determination. Hence, teachers of students with learning disabilities should acquire the needed knowledge and awareness of assistive technology and how to implement them effectively in the instruction which will allow themto provide cognitive access for all learners and in an independent manner. Accordingly, parallel experiences for all learners will be maintained (Edyburn, 2006).

Types of Assistive Technology: An example of Assistive Technology (AT) is the utilization of a wide range of techniques and tools for individuals with visual impairments (also known as vision loss. Those individuals suffer from visual acuity and/or decreased ability to see to a degree that causes difficulties), such as 'Braille' and 'Braille embossers' (Which is a system of raised dots formed into units called 'braille cells' that the capability to represent words, punctuation marks, and numbers. Hence, the users use their fingers to read the code of raised dots), 'Screen readers' (which are software programs and variety of platforms such as 'Microsoft Narrator', 'Google TalkBack', 'Apple VoiceOver', 'Google TalkBack' and that help in conveying the displayed information through voice 'text-to-speech tools' that provide verbal descriptions to describe and read what is happening on the screen loudly such as e-mail messages, documents that is in an electronic form, and web pages through magnifying the screen and control the keyboard for low vision individuals), 'Desktop video magnifiers'(which are electronic devices that use a camera that comes in sizes and styles and which is connected to a monitor and a display screen to perform digital magnification of printed materials), 'Large-print' and 'tactile keyboards' (which provides individuals with visual impairments with the ability to magnify the screen -zoom in- as well as changing the background color of the screen through using a large-print keyboard with the 'bump dots' on the keys, i.e., it has large letters printed on the keys), 'Screen magnifiers software' (which is software that interfaces with a computer's graphical output to present enlarged screen content such as the text. In fact, it grants users low vision to have greater computer accessibility and a wide range of visual abilities through which they could enlarge the texts and graphics on their computer screens for easier viewing), 'Wearable technology' (which are smart electronic devices such as 'OrCam device', 'Brainport', and 'OrCam device' that can be worn on the body and aim to explore how the visually impaired can receive visual information through the previous mentioned wearable devices), and finally the 'Voice recorders'(Aymeric, et al., 2017; Barrué, 2012).

Another example of Assistive Technology (AT) is the utilization technological devices for individuals with hearing impairments, i.e., people who have difficulty in receiving and communicating auditory information and hence they rely on visual and tactile mediums, to improve the level of sound available to them. This include the use of 'Assistive Listening Devices' (ALDs) which are utilized for the sake of improving the 'signal-to-noise ratio' (SNR). In fact, Assistive Listening Devices rely on transmitting the individual's voice to the receiver(s) through various ways including: Frequency Modulation system through which the individual's sound is transmitted on a specific frequency or channel. At the same time, the receiver canreceive the sound through hearing aids that is connected to a Direct Audio Input device. The other Assistive Listening Device is called 'Infrared system' through which a transmitter is used to transmit and broadcast uninterrupted light waves (signal) via a clear line of connection to a special light sensitive receiver worn by the individual receiver. 'Induction Loop system' is a further Assistive Listening Device. This system employ electromagnetic energy to transmit the signal to small areas and larger areas as well. Moreover, 'Personal Amplification'(PA) such as the electroacoustic hearing aid is another Assistive Listening Device. 'Multi implanted' devices use several technologies such as 'Bone Anchored Hearing Aid' and 'Cochlear' to amplify the sounds and makes speech more intelligible for the wearer of the hearing aid. In addition, various technological Assistive Listening Devices are also employed by the hard-hearing individuals to support their communication such as a) 'Teletypewriters' that enable hard-hearing individuals to place phone calls using text through a regular phone line, i.e., this technology allows converting the text into voice; b) 'Voice Carry Over Telephone' that is employed by individuals with hearing loss who are unable to hear over the telephone to speak to the other party and read their incoming message on the telephone's display screen; c) 'IP Relay Services'that is employed by Hard-Hearing individuals as well as deaf people, with the assistance of a third party called a communication assistant, to allow them using the phone through communicating by text, in a way that when a user calls someone, the communication assistant receives the user's call and type to the deaf/hard of hearing person.

Similarly, when the receiver responds, the communication assistant passes along the information to the person on the other end of the line; d) 'Video Relay Services' (also known as 'Video remote interpreting')through which communication devices are utilized to carry out a video telecommunication service. Several devices are also used, for example videophones and webcams which allow providing the Hard-Hearing individuals and deaf people to obtain an interpretation of spoken language and sign-language services with the assistanceof an interpreter who interprets audio to the Hard-Hearing individuals and deaf people by sign language, and in return, when the Hard-Hearing individuals and deaf people respond, they sign to the interpreter and the interpreter uses his/her voice to conveythe message back; e) 'Real Time Captioning' through which all verbal information are conveyed in a typewritten with the assistance of anof a trained captioner who uses a specialized software on a computer. Such softwareincludes 'Real-Time Stenography' and'Open Captioning systems' with the assistance of voice writer and operator who are responsible fortranscribing and convertingspoken speech to written text using keyboard or stenography methods. Another method is 'C-Print; which is a 'speech-to-text' (captioning) technology, 'Remote Captioning', and 'Video Captioning' (Maiorana-Basas&Pagliaro, 2014; Stacie Heckendorf, 2009)

Assistive Technology (AT) is also utilized for individuals with cognitive impairments. For more clarification, Assistive Technology for Cognition is the utilization of high technology to contribute to the cognitive processes including memory, attention, the ability to recognize emotion, planning, self-regulation, and the ability to sequence activities. Assistive Technology for Cognition include programs such as 'Wakamaru' and 'NeuroPage'. AT also plays a significant role in enhancing the cognition process through several types of technology such as: Memory aidswhich assistindividuals with cognitive impairmentto be able to remember certain information as well as learning new information, reading, and writing. For instance, a Smartpen software and Digital voice recorders allow individuals with cognitive impairment to records handwritten notes. This can have carried out through creating an audio recording of the text and a digital copy. Accordingly, individuals with cognitive impairment can download the targeted notes onto a computer for increased accessibility and then the program can read it back to them. DVRs allow to record in the moment information and simply recall this information later. Furthermore, another software, called the Educational Software, contributes in assisting individuals with cognitive impairment to read, learn, and comprehend. In addition, Educational Software has many sub-software such as 'Notetakers', 'text enlargers','Readers', and 'Word predictions'(Gillespie, Best & O'Neill, 2012; LoPresti, Mihailidis & Kirsch, 2004; Wilson, 1997).

On the same line, Castelo (2020) elaborated various ways through which educators can implement assistive technology in the classroom. 1) For blind or visually impaired students: many devices such as 'Google Chromebooks'(on the Chrome browser) that have a built-in screen reader that is called 'ChromeVox' which works as an audiovisual assistance through its feature of readingthe content of the lesson out loud for thestudents. 'Google Chromebooks' has another feature through which it makes on-screen content easier to read using screen magnifiers, high-contrast mode and select-to-speak feature. In addition, for students who need 'Braille' support, 'Google Chromebooks' allow teachers to plug in or pair a 'Braille' keyboard with Bluetooth. Furthermore, with the use of 'Microsoft Office 365' as well as 'G-Suite application' for Education, the students are allowed to perform dictation tasks through typing using their voices; 2) for deaf or hard of hearing students: using 'FM systems' (which are wireless devices that directly transmit sounds to a hearing aid), these systems allow to communicate clearly with students who have hearing loss, even in a noisy classroom. Further, educational apps, for example:'Flipgrid' with closed-caption features is a video technology that is used in the classroom and videoconferencing tools (e.g., 'Microsoft Teams'), that is equipped with live captioning and subtitles are also used; 3) for students with speech disabilities: using 'Speech-to-text' software and word prediction tools, dictation tools, (e.g., 'Office 365 applications') to allow students with speech disabilities to communicate with their colleagues and teachers through software like 'AI-enabled add-in' that enables the students to speak into a microphone and their speech is later converted into text which is displayed on the computer's screen; 4) for students who need mobility assistance: through considering a significant component of a modern learning environment, teachers should adopt flexible furniture for the sake of optimizing their classrooms for students who need mobility assistance.

For instance, Standing desks, wobble stools,interactive displays, and exercise balls should be utilized in order to present more comfort and freedom for the students and hence they would move around in the classroom freely and help those who are physically unable to use a keyboard or computer mouse by offering them touch-screen monitors; and 5) for students with learning, cognitive and developmental disabilities as well as students who are in need for assistance with learning, attention and organization: through the implementation of tools as'audio books', 'memory aids', 'text-to-speech systems', VR experiences that are created for students with autism, using helpful tool such as'Microsoft's Immersive Reader', canassist students with dysgraphia and those with dyslexia.by having any written text to be read out loud and broken into syllables. Furthermore, downloadable fonts such as 'OpenDyslexic' is utilized to enhance students with dyslexia's readability and reading speed. In addition, another software such as 'Microsoft's Tell Me'can be implemented as it has a feature that allows students to access commands on Office 365 applications without having to remember them. Finally, 'Livescribe Echo Smartpen' is another tool can be also implemented which performs as an 'all-in-one microphone', speaker and storage device. Congruent with Vice (2021), other assistive technologies can be implemented by the educators to help students with disabilities such as: 1) Voice and Audio Technology: which is a software that has a voice command and audio recording and which is available on modern computers. This software listens to the speech of the students with hearing impairments and relays verbal communication through text or audio, hence students can take notes for themselves. The students can also benefit from the use of handheld 'Text-to-Speech' devices; 2) Spellcheck: which is through the employment of proofreading programs, built-in editing tools and online writing programs, assist the students to deal with the spelling and grammar difficulties. In fact, computers, similar to the use audio and voice command,can improve the motivation on the students who have issues with spelling and grammar and fit the students' needs in a way that these programs send a notification if the student spell any wordincorrectly or if his/her use of grammar is wrong as well; 3) Talking Calculator: despite the fact that learning mathematics is not preferable especially for the students with dyscalculia, (dyscalculia –also called dysarithmia and math dyslexia- is defined by Rotzer, et al (2009) as a disability that have an impact on the understanding and comprehending abilityof the student towards arithmetic, understanding numbers, and performing mathematical calculations).

In addition, dyscalculia, similar to impact of dyslexia on reading, hinders the students' ability to perform the fundamental mathematical skills as well as concepts. Actually, students who have dyslexia(Also called 'reading disorder', is defined by Peterson, et al (2012) a disability that is characterized by difficulty in reading, spelling words, reading rapidly, writing words, "sounding out" words in the head, pronouncing words when reading aloud), are often have dyscalculia. additionally, dyscalculia causes studentsto see numbers on a calculator misplaced and therefore, when the students use a regular calculator, they become frustrated and this eventually causes poor test scores. On contrary, the students can bypass that obstacle through using a talking calculator; and 4) Interactive Whiteboards: these boards are used in particular for students with 'Attention Deficit Hyperactivity Disorder' (ADHD) which is considered as a less visible disability. In fact, it is quite challenging to keep the students with ADHD's attention. So, with the utilization of the interactive whiteboards technology that can offer a visual stimulation of the lessons delivered in the classroom, this can help the students stay focused and undistracted, especially with the use of colorful lesson plans that have the ability to teach them what they really need to learn while entertaining them (Vice, ibid).

Advantages of Adopting assistive technology in a modern learning environment: Assistive technology is considered important as, in consonance withCPIR (2021), it plays a significant role in increasing the students with learning disabilities' opportunities for having appropriate education and enabling them for having social interactions. In addition, Assistive technology, as a tool, supports students with learning disabilities' participation in learning experiences and to benefit from the general education curriculum in the least restrictive environment. It also helps them access extracurricular activities at their homes and schools. Nowadays, schools all over the world increasingly embrace modern learning environments through integrating assistive technology into the curriculum and classrooms. Whether assistive technology is High-tech (refers to devices or equipment with digital or electronic components, such as augmentative communication devices, alternative keyboards and power wheelchairs. It also includes software or built-in accessibility features on devices such as text to speech, word prediction and optical character recognition) or Low-tech (refers to simple adaptive tools such as timers, graphic organizers and flexible furniture), yet educators intend to implement digital tools

in the classroom to meet the individual needs of the students with learning disabilities and help them to overcome learning challenges.
According to Castelo (2020), an example of how assistive technology (including tools, software, equipment that are implemented by educators in a modern learning environment to help students with learning disabilities to work around learning, communication, and mobility challenges) can help those students to reach their full potential and give the, a more personalized and accessible learning experience. For example, in Minnesota- USA, the Academy of Whole Learning, a K–12 private school for students with autism spectrum disorder and individual learning needs, introduced virtual reality technology - Using Lenovo VR headsets and Google Expeditions- in their classrooms, students had the chance to take a tour across the world -from the Great Barrier Reef to the North Pole- without ever having to leave their classroom. Actually, the immersive VR experience have assisted students with learning disabilities to stay focused and engaged during their lessons. In addition, this experience has blocked out any classroom distractions and made students feel as if they were actually in the environment they were exploring. Moreover, through these virtual experiences, the students had the opportunity to practice social skills, had the ability to access grade-level content, build friendships, and allow them to be independent (ibid).

Vice (2021) stated that a great deal of information for schools and educators about assistive technology devices, items, product system, and equipment was reported in the Individuals with Disabilities Education Act (IDEA) and the (1997) amendments regrading this Act. Vice added that assistive technology in implemented to fulfill the target of increasing, maintaining, and improving the functional capabilities and strengths of the students with learning disabilities and accordingly allow them to counterbalance and bypassing their disabilities, as well as succeeding in the classroom and beyond (2021). In other words, with the use of assistive technology, educators can create more inclusive classrooms and empower students with learning disabilities to participate in the general education curriculum. (Figure 2) summarizes the areas where assistive technologies can assist to put a learner with learning disabilities on a par with his/her classmates.

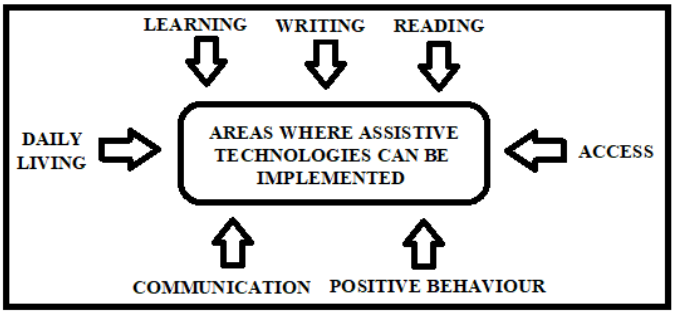

Figure 2. Areas where assistive technologies can be helpful. (Source: First Discoverers, 2021)

Below, are an available assistive technology tools and equipment that are implemented to enhance participation in areas mentioned in (Figure 2) for students with learning disabilities (First Discoverers, ibid):

- Writing: 'pencil grips', 'word processing software';
- Reading: 'talking book readers', 'electronic books';
- Communication: 'augmentative communication devices' (for instance:'communication boards', 'speech-generating tools', 'software avatars for signing');
- Learning: 'configurable software', 'visual aids';
- Access: 'switches', 'touch monitors', 'adapted mouse', 'joystick', 'touch screens', 'large keyboards', 'keyboard masks', 'colour-coded keys';
- Daily living: 'velcro fasteners', 'picture-dial phones';
- Behaviour support: 'visual timers'.

Moreover, Vice (2021) added that assistive technology, besides its role in educating students and ensuring that all students with learning disabilities have an equal opportunity to learn, canalso contribute to maintaining a safe learning environment as well as maintaining a safe use of technology. Hence, with the use of assistive technology, schools can make sure that the online learning spaces are safe for students with learning disabilities, especially to protect them from being bullied. Vice confirmed that 63% of students with disabilities are more likely to experience cyberbullying than their peers. So, withthe implementation of software like 'LearnSafe' (which is a screen monitoring software), instances of cyberbullying can be flagged by schools and accordingly students with disabilities can be protected from emotional harm, including chronic depression and suicidal ideation.

How to implememnt assistive technology in learning environment: As reported by CPIR (2021), in order to implement assistive technology in learning environment, educators need to consider carefully what environments the student with learning disabilities accesses now. In addition, the tasks the students are required to accomplish as well as the challenges that student with learning disabilities face while accomplishing these tasks should be also considered. Such considerations help the educators to identify the current educational need(s) of the student and to further identify the ability of the assistive technology to enable the student to meet their instruction goals. Besides, there are various areas of learning disabilities to be considered by the educators (but are not necessarily limited to). These areas include: cognitive processing, levels of independence, communication, daily organization, self-care, mobility, recreation, seeing, hearing, handwriting, written expression, spelling, reading, mathematics, etc. Correspondingly, Paz & Stringer (2021) reported that educators can determine which appropriate assistive technology to adopt and which type of technology that can help students with learning disabilities to succeed through looking at the students' needs as well as the task that is being attempted. Based on that, the appropriate assistive technology must be carefully chosen to allow facilitating the academic studies of the students with learning disabilities.

Paz & Stringer (2021) also recommended a criterion through choosing a robust system that can address a number of needs for the students with learning disabilities and then stick with the appropriate tools that meet these needs, particularly web-based tools and web-based Apps which are flexible and can be installed and accessed at home and at school from any device through a simple login process and their installment and update are free of charges. Additionally, CPIR elaborated that through carrying out an assistive technology's need evaluation, educators should firstly determine whether a student with learning disability needs an assistive technology device or service, and secondly the nature of these AT devices or services, and thirdly the extent to which these AT devices or services must be provided. Based on that, any needs of AT identified should be reflected in the content of the provided instructional program (2021). To sum up, once the area(s) of educational need(s) of the students with learning disabilities have been identified, educators will then need to review what types of assistive technology have been tried in the past in order to address the actual need(s) of the students. This process may include a variety of interventions achieved through strategies or modifications of the available low-tech and/or high-tech assistive technology(s) devices to meet the student's specific learning need(s). For instance, if a student with a mathematical learning disability is unable to memorize multiplication facts, in this case, the educator can utilize an assistive technology's low-tech device such as a calculator (a calculator here is considered as a supplementary educational aid) in such a regular education environment in order to meet the student's need.

Assistive Technology VS. Universal Design for Learning: Hallahan & Kauffman asserted that there are various assistive technologies available nowadays and among these technologies, the most effective ones are those which are created and constructed with a universal design, i.e., "the design of new instructional programs to make them

usable by the widest possible population of potential users" (2006: p. 541). Assistive technology (AT) is specifically designed to helpdisabled individuals to encounter and overcome barriers in their environment and sinceit targets individuals, hence it can be adapted, customized, and fitted to each individual in accordance with his/her strengths and weaknesses. In that regard, assistive technology is characterized of being personal and unique. On contrary, assistive technology could be undergone a universal design process that aims to design a general AT products with certain structures that allow it to be used by everyone (not individually). With such universal design, the barriers for any individual could be reduced whether the individual has disabilities or not. In other words, those who are targeted are not individuals, in fact they could be groups of individuals and/or a whole community of learners. Accordingly, the use of universal design can increase the opportunities for the widest possible range of learners as such design is characterized of being engineered for flexibility and of being variable rather than dedicated, i.e., universal design is not personal or unique and it accommodates diversity in an inclusive way (Rose, et al., 2005).

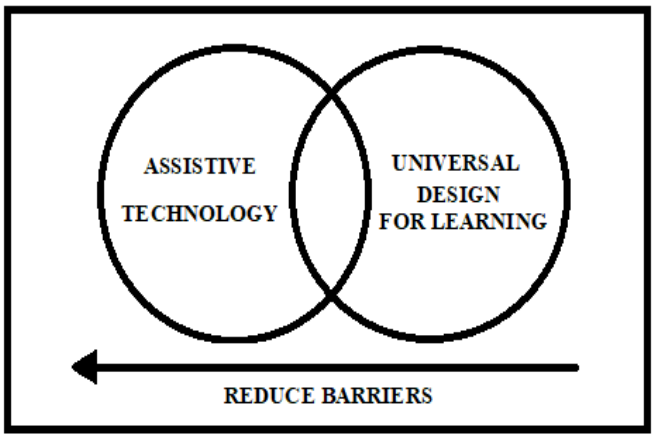

Figure 3. The relationship between assistive technology and universal design for learning. (Source: Rose, et al., 2005: P. 509)

Rose & Meyer (2002) stated that the term Universal Design for Learning emphasizes the preciseaims of learning environments which are supporting the process of learning and fostering the changes in knowledge and skills, not providing materials, knowledge, accessible spaces, and new information only. Based on that, the UDLframework aims to ensure that the pedagogy's components, including the processes that are embedded in classrooms and curricula, the techniques, methods, and scaffolds,are all accessible. Rose & Meyer further pointed out that the framework of UDL is based on the principles of neuroscience of learning which emphasize the key aspects of pedagogy: 1) the means of representing information, 2) the means for the expression of knowledge, and 3) the means of engagement in learning (ibid, 2002). The Center for Universal Design (1997) at North Carolina State University assembled a set of principles of universal design (Version 2.0) that would encapsulate the existing knowledge base. It is worth mentioning that the seven Principles of Universal Design apply to all design, disciplines, and all users(whether with disabilities or not). In addition, these principles, which has four or five guidelines that elaborate eachprinciple, are useful for the designing process, evaluation the old and new designs, and for the instruction process in which students and practitioners are guided on how to deal with what universal design encompasses and how it may be achieved.

The seven principles are: 1) Equitable Use: the design is useful and marketable to people with diverse abilities. The guidelines for principle one include: (a) provide the same means of use for all users: identical whenever possible, equivalent when not, (b) avoid segregating or stigmatizing any users, (c) make provisions for privacy, security, and safety equally available to all users, and (d) make the design appealing to all users; 2) Flexibility in Use: the design accommodates a wide range of individual preferences and abilities. The guidelines for principle two include: (a) provide choice in methods of use, (b) accommodate right- or left-handed access and use, (c) facilitate the user's accuracy and precision, and (d) provide adaptability to the user's pace; 3) Simple and Intuitive Use: the use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. The guidelines for principle three include: (a) eliminate unnecessary complexity, (b) be consistent with user expectations and intuition. (Sc) Accommodate a wide range of literacy and language skills, (d) arrange information consistent with its importance, and (e) provide effective prompting and feedback during and after task completion; 4) Perceptible Information: the design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

The guidelines for principle four include: (a) use different modes (pictorial, verbal, tactile) for redundant presentation of essential information, (b) maximize legibility of essential information, (c) differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions), and (d) provide compatibility with a variety of techniques or devices used by people with sensory limitations; 5) Tolerance for Error: the design minimizes hazards and the adverse consequences of accidental or unintended actions. The guidelines for principle five include: (a) arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded, (b) provide warnings of hazards and errors, (e) provide fail-safe features, and (d) discourage unconscious action in tasks that require vigilance; 6) Low Physical Effort: the design can be used efficiently and comfortably and with a minimum of fatigue. The guidelines for principle six include: (a) allow user to maintain a neutral body position, (b) use reasonable operating forces, (c) minimize repetitive actions, and (d) minimize sustained physical effort; and 7) Size and Space for Approach and Use: appropriate size and space is provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility. The guidelines for principle seven include: (a) provide a clear line of sight to important elements for any seated or standing user, (b) make reach to all components comfortable for any seated or standing user, (c) accommodate variations in hand and grip size, and (d) provide adequate space for the use of assistive devices or personal assistance (Story, 1998: PP. 7-10).

Story (1998) added that since the Principles of Universal Design are necessary for communicating the concept of universal design and all of its various aspects, more efforts must be paid in order to make the principles of universal design applicable. To fulfill this objective, certain strategies should be adopted to specify the ways that the guidelines may be achieved. In addition, certain tests should be utilized to provide empirical tools to assess whether the guideline has been achieved. For instance, to apply the Principle of Flexibility in Use (i.e., the second principle), some strategies should be followed, including: (a) provide choice in methods of use through: 1) allowing a choice of modes of input, such as keyboard or speech, 2) providing redundant modes of output, such as visual and auditory, 3) providing connectivity for assistive devices, if used, such as headphones or infrared devices; (b) accommodate left- or right-handed access and use through: 1) making the device symmetrical, reversible, or re-arrangeable to suit both left- and right-handed users; (c) facilitating the user's accuracy and precision, 3) making controls easy to grip and to move, whether they turn, slide, or press.

Provide sufficient but not excessive friction in moving parts to facilitate precision, 4) making buttons large enough with sufficient space between buttons to facilitate accurate keying, 5) if a key or card must be inserted into the device, slope or bevel the entry hole to facilitate its insertion, and 6) providing a palm rest or elbow rest below control panels; and (d) provide adaptability to the user's pace through allowing novice users to move slowly and to access additional help messages, as needed. Allow expert users to move quickly and skip intermediate steps, when possible (ibid, P. 10). Additionally, there are certain tests for thePrinciples of Universal Design. For instance, to test the Principle of Flexibility in Use (i.e.,

the second principle), several question should be asked including (Story, 1998: P. 10): 1) Can the device be used with a closed fist or open palm, either left or right? 2) Can it be used with a bilateral closed-fist grip? 3) Can it be used with a pointing tool? 4) Can the device be used with an elbow, foot, or other body part? 5) Can the device be used with imprecise movements/limited coordination, e.g., using the non-dominant hand? 6) Can the device be used from a seated or standing position? 7) Can the device be used from different heights or different angles? 8) Are built-in adjustments easy to make? and 9) Can the device be used with assistive technology, such as a hearing aid, a prosthesis, or a wheelchair?

Finally, it is significant that the assistive technology and the universal design should be interacted and integrated in order to achieve optimal and practical results (Hitchcock & Stahl, 2003).

CONCLUSION

This current empirical study aims to explore various aspects regarding the significance of implementing assistive technology in the learning environment. The study also aims to highlight the primary components of inclusion achieved through the use of AT. Further, the study seeks to identify the types of assistive technology and the advantages of adopting AT in a modern learning environment. Additionally, the study aims to specify areas where assistive technologies can be helpful. Finally, the study explains how to implement AT in learning environment and elaborates the relationship between AT and the universal design for learning as well as the principles of universal design. The study concluded that due to the potential contribution of the assistive technology, ranging from low-tech to high-tech, can empower students with learning disabilities, supports their inclusion in classroom with their peers, mitigate the effects of disabilities of students with learning disabilities, help those students to reach their full potential, and increase and facilitate their independence (AT promotes greater independence among disabled people). In addition, when implemented thoughtfully, AT can increase, maintain, or improve the functional capabilities of the students with learning disabilities and enabling them to perform tasks they were formerly unable to accomplish. Further, AT can help creating the accessible environment that students with learning disabilities, their parents, and their special educators are looking for. Students with disabilities can be as successful as their peers and the can understand the context of the subject being taught when the educational system provides the necessary accommodations. Actually, ATenables students with learning disabilities to participate more fully in all aspects of their lives, including their homes, their schools, and their communities.

Furthermore, the current study concluded that assistive technology, through the implementation of a broad scope of technologies, can create a great deal of opportunities for all students with learning disabilities and enhances their academic performance in academic settings. It also contributes to providing a model for self-actuated learning among students with learning disabilities through raising their level of self-determination. Additionally, assistive technology plays a significant role in increasing the opportunities of students with learning disabilities for having appropriate education and enabling them for having social interactions. In addition, Assistive technology, as a tool, supports students with learning disabilities' participation in learning experiences and to benefit from the general education curriculum in the least restrictive environment. It also helps them access extracurricular activities at their homes and schools.Moreover, besides its role in educating students and ensuring that all students with learning disabilities have an equal opportunity to learn, AT can also contribute to maintaining a safe learning environment as well as maintaining a safe use of technology. So, schools, with the utilization of assistive technology, can make sure that the online learning spaces are safe for students with learning disabilities, especially to protect them from being bullied (also called 'cyberbullying'). It was also found by the current study that there are various assistive technologies available nowadays and among these technologies, the most effective ones are those which are created and constructed with a universal design. Unlike AT which is designed to help disabled individuals to encounter and overcome barriers in their environment and since it targets individuals, hence it can be adapted, customized, and fitted to each individual in accordance with his/her strengths and weaknesses. In that regard, assistive technology is characterized of being personal and unique. On contrary, assistive technology could be undergone a universal design process that aims to design a general AT products with certain structures that allow it to be used by everyone (not individually). With such universal design, the barriers for any individual could be reduced whether the individual has disabilities or not. Actually, the use of universal design can increase the opportunities for the widest possible range of learners as such design is characterized of being engineered for flexibility and of being variable rather than dedicated.

Besides, it was found that the Universal Design for Learning (UDL) emphasizes the precise aims of learning environments which are supporting the process of learning and fostering the changes in knowledge and skills. Based on that, the UDL framework aims to ensure that the pedagogy's components, including the processes that are embedded in classrooms and curricula, the techniques, methods, and scaffolds, are all accessible. In fact, the framework of UDL emphasize the key aspects of pedagogy. Furthermore, there are principles of universal design that are necessary for communicating the concept of universal design and all of its various aspects. These principles also encapsulate the existing knowledge base. Finally, it is significant that the assistive technology and the universal design should be interacted and integrated in order to achieve optimal and practical results.

Recommendations: Finally, the current study recommends that educators should implement digital tools in the classroom to meet the individual needs of the students with learning disabilities and help them to overcome learning challenges as students with learning disabilities need to have an accessible educational environment and to be enrolled in the Least Restrictive Environment (LRE) in order to promote the classroom acceptance of them and also to allow them to participate in the classroom as well as in the general education curriculum. To do so, there are many techniques that have to be considered, one of which is assistive technology. The study also recommends that teachers of students with learning disabilities should acquire the needed knowledge and awareness of assistive technology and how to implement them effectively in the instruction which will allow them to provide cognitive access for all learners and in an independent manner. Accordingly, parallel experiences for all learners will be maintained. It is also recommended that with the use of assistive technology, educators can create more inclusive classrooms and empower students with learning disabilities to participate in the general education curriculum. Hence, schools should embrace modern learning environments through integrating assistive technology into the curriculum and classrooms (whether High-tech AT or Low-tech AT).

As for the implementation of AT in learning environment, the study recommends that educators should determine which appropriate assistive technology to adopt and which type of technology that can help students with learning disabilities to succeed through looking at the students' needs as well as the task that is being attempted. Adding to that, educators need to consider carefully what environments the student with learning disabilities accesses now. In addition, the tasks the students are required to accomplish as well as the challenges that student with learning disabilities face while accomplishing these tasks should be also considered. Such considerations help the educators to identify the current educational need(s) of the student and to further identify the ability of the assistive technology to enable the student to meet their instruction goals. Besides, there are various areas of learning disabilities to be considered by the educators (but are not necessarily limited to). These areas include: cognitive processing, levels of independence, communication, daily organization, self-care, mobility, recreation, seeing, hearing, handwriting, written expression, spelling, reading, mathematics, etc. Finally, the study recommends

that an assistive technology's need evaluation should be carried out by educators. Besides, a criterion should be adopted to choose a robust system that can address a number of needs for the students with learning disabilities and then stick with the appropriate AT's tools. Educators should firstly determine whether a student with learning disability needs an assistive technology device or service, secondly determine the nature of these AT devices or services, and thirdly determine the extent to which AT devices or services must be provided. Based on that, any needs of AT identified should be reflected in the content of the provided instructional program. In fact, once the area(s) of educational need(s) of the students with learning disabilities have been identified, educators will then need to review what types of assistive technology have been tried in the past in order to address the actual need(s) of the students. This process may include a variety of interventions achieved through strategies or modifications of the available low-tech and/or high-tech assistive technology(s) devices to meet the student's specific learning need(s).

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