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The use of assistive technology to minimise educational learning barriers for learners with cerebral palsy

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Abstract

Cerebral palsy (CP) poses unique challenges in education because of motor impairments and communication difficulties. Assistive technology (AT) offers innovative solutions to address these barriers and create inclusive learning environments. In this article, we examine the use of assistive technology in minimising learning barriers for learners with cerebral palsy. We conducted semi-structured interviews with educators teaching at a CP school and learners who have been diagnosed with CP and observed lessons. The findings illustrated that learners with CP experience many barriers to learning, but with the use of AT by learners and educators, these barriers can be minimised. Recommendations include more training for learners and educators in the use of AT and a more supportive environment. More research is needed on the training programs needed to educate learners and educators on AT and how educators can use AT to bring about transformation in their lessons.

Keywords: assistive technology, cerebral palsy, learning barriers, inclusion

Introduction

Cerebral palsy (CP) is a complex neurodevelopmental disorder that affects movement, muscle tone, and motor skills (Landsberg et al., 2019; Vitrikas et al., 2020). According to Andrews et al. (2020) it can pose significant challenges for education. Numerous obstacles can prevent learners with cerebral palsy from learning and engaging in educational activities (Landsberg et al., 2019). Motor impairments, such as restricted movement and a lack of

dexterity, make it difficult for learners to engage in writing, object manipulation, or freely traversing the physical world, according to Scharf et al. (2019). For Landsberg et al. (2019) and Fox (2013), communication problems, such as speech and language impairments, can make it difficult for learners to communicate their thoughts, take part in debates, and form bonds with their classmates and teachers. For learners who have cerebral palsy, these obstacles frequently result in slower academic growth, fewer social interactions, and decreased self-esteem (Gulati & Sondhi, 2018). However, Liu et al. (2013) have noted that in recent years technological developments have created new opportunities for improving the educational experience of learners with CP. According to Bagon et al. (2018) and Liu et al. (2013) using assistive technology is one such development that aims to reduce barriers to education and increase accessibility and inclusion for students with CP.

AT refers to a broad category of equipment, hardware, and software used to support individuals who have impairments (Patel et al., 2020). Lino et al. (2020) explained that in the educational process for learners with cerebral palsy, AT can make a significant difference. They stated that AT can improve their learning experience, communication, and access to educational resources. According to Lino et al. (2020) educators and caregivers can enable learners who have cerebral palsy to overcome challenges and realise their full potential by using AT.

Despite the advantages that AT offers, there is limited research on the integration of AT in supporting learners with CP and educators teaching learners with CP. Most studies focus on one type of disability, such as the study on autism done by Pennington (2010). Research on AT focuses mostly on software programs or learner characteristics (Florian & Hegarty, 2004). The few studies that address barriers to learning for learners with CP, such as the study of Hasselbring and Glaser (2000) that focused on technology use for learners with special needs in general, do not address the problem in any depth. There is a dearth of studies on how AT can minimise and address barriers to learning specifically for learners with CP.

In this article, we explore the various forms of AT that have been developed specifically to address the unique needs of learners with CP. We delve into the ways in which AT can minimise learning barriers and promote inclusive education.

We intend to increase awareness and encourage the adoption of inclusive educational methods by shedding light on the use of AT to assist learners with CP. Educators, parents, and caregivers may create a learning environment that promotes active involvement and equips learners who have CP to succeed academically and personally by embracing these technological innovations.

Background

This study was conducted at an LSEN (Learners with Special Education Needs) school. The school specialises in the education of learners with physical disabilities such as CP, poliomyelitis, muscular dystrophy, congenital amputation, phocomelia, spina bifida, arthrogryposis, and hydrocephalus.

Each classroom can accommodate up to a maximum of 12 learners and is equipped with various support devices (technological and physical) to ease learning and teaching. These devices include adapted keyboards, rollerballs, joysticks, buddy buttons, head clickers, onscreen keyboards, head pointers, speech books, and metal keyboard covers. There are class aides assigned to each classroom to assist educators and learners. Learner support includes having an aide turn pages, move learners in wheelchairs, feed learners during breaks, help them to use the bathrooms, assist learners doing practical subjects such as Consumer Studies to perform some tasks such as stirring food on hot stoves, and help learners with their assistive devices.

The school is state-aided, so subsidised by the Department of Education. Further funding must be obtained by holding fund-raisers and through donations. The school makes use of members of the public and of professionals such as therapists, a doctor, nurses, educators, and a psychologist to deliver much-needed services to these learners. The school also offers speech therapy and audiology assistance, remedial therapy, physiotherapy, occupational therapy, and a clinic.

Literature Review

Barriers experienced by learners with CP

Learners with CP experience several barriers in the educational environment. These barriers can be physical and/or cognitive (Landsberg et al., 2019).

Physical barriers

According to Scharf et al. (2016) learners normally develop four categories of skill—communication, fine motor, gross motor, and social skills. Learners with CP experience impaired gross motor functioning (Landsberg et al., 2019) and restricted capability of achieving normal physical tasks such as walking, running, balancing and posture control (CerebralPalsy, 2020). They also experience impaired fine motor skills, also known as manipulative skills (Landsberg et al., 2019). This involves problems in the use of small muscles in activities such as feeding themselves, grasping, reaching, and holding writing tools, etc. (Scharf et al., 2016) and this leads to problems with writing and using keyboards (Landsberg et al., 2019). Poor fine and gross motor skills may lead to learners being dependent on others to assist them with tasks such as eating, washing, bathing, and dressing (Scharf et al., 2016). Communication skills may also be impaired (Landsberg et al., 2019) leading to barriers in socialisation (Fox, 2013) or having slow and slurred speech (Cerebral Palsy Guidance, 2020) that may be a result of impaired facial muscle functioning (Landsberg et al., 2019). Social skills may be hindered because of poor communication skills and having academic difficulties that lead to learners having low self-esteem and being bullied (Cerebral Palsy Guidance, 2020). Landsberg et al. (2019) reported that learners have problems with social skills because they are unable to articulate and produce speech. According to Scharf et al. (2016) learners with physical barriers also struggle with the acquisition of literacy skills.

Cognitive barriers

Several studies indicate that learners with CP have problems with numeracy and arithmetic, learning and comprehension problems, working memory, non-verbal understanding, reading skills, executive functioning, problem-solving, and hyperactivity based on also having a short attention span (Cerebral Palsy Guidance, 2020; Jenks et al., 2009; Rosenbaum et al., 2007; Van Rooijen et al., 2016). According to Van Rooijen, et al. (2016) learners may also have a delay in the mastering of counting, solving simple arithmetic operations, and subitizing.

Learners with CP may also experience behavioural problems such as anger, anxiety, emotional outbursts, and depression (Cerebral Palsy Guidance, 2020; CerebralPalsy, 2020). Cerebral Palsy Guidance (2020) explained that behavioural problems develop because of learners feeling misunderstood or experiencing learning difficulties.

AT integration to support learners with CP physically

There are ways in which AT can be integrated into lessons to support learners with CP. Landsberg, et al. (2019) suggested the use of assistive drawing devices, hand-grip assistive devices, a moving drawing board, adapted keyboards and mice, voice- or eye-activated computers and computer programs, and a mouthpiece instead of a computer mouse or keyboard. Electronic communication boards, speech-generating devices, and eye-tracking devices can be used to aid communication (CerebralPalsy, 2020). Word prediction and spelling- and grammar-check software can be used to support writing and typing (Cerebral Palsy Foundation, 2019; Cerebral Palsy Guidance, 2020). Cerebral Palsy Foundation (2019) also explained that magnifiers, larger text and fonts, and sound amplifiers can support learners with CP.

AT integration to support learners with CP cognitively

Raja (2016) reported that AT may support learners with classroom participation, accessing and understanding the content, and with organisation and memory. She further explained that educators should provide material in an electronic format, calendars, categorisation and organisation tools, and should record lectures. Learners should use assistive software such as magnification, text to speech, and smart devices in the classroom to ease teaching and learning (Raja, 2016).

Technology integration to support learners with CP is an area that has been under-researched. Many researchers, such as Lamichhane (2013), Kouroupetroglou (2013), and Landsberg, et al., (2019), explore the definition of CP, the symptoms, the types, and possible solutions to the problems encountered by such learners. Rahamin (2004), Kouroupetroglou (2013), and Hasselbring and Glaser (2000) who do investigate technology integration, consider physical disability as a whole. These scholars, while covering the definition of CP and the associated challenges extensively, do not delve deeply into the topic of AT for learners with CP; while they do touch on AT and its role in mitigating barriers, this coverage is rather brief.

Method

Participants

Semi-structured interviews with ten educators from various grades and subjects and six learners at a LSEN school were conducted, and classroom observations were carried out.

Table 1
Educator demographic data

Educator Participant (EP)	Gender	Age	Teaching grade	Employment period in years	Teaching subject
1	Female	29	1	4	Foundation Phase
2	Female	50	1	15	Foundation Phase
3	Male	28	5 and 7 to 9	4	Sesotho and Economic Management Science
4	Female	29	8 to 11	5	Language and Mathematics
5	Male	56	9 and 10	2 and ½	Life Orientation and English
6	Female	66	2	3	Foundation Phase
7	Female	27	7 to 9	4	English and Creative Arts
8	Female	26	10 and 11	1	Consumer Studies and Tourism
9	Male	27	7 to 9	1 and 9 months	Life Skills, Natural Science and Technology
10	Female	59	4 and 7 to 9	9	Life Orientation

There was an even distribution of educators across age, gender, grade taught, subject taught, and years of experience. All learners were diagnosed with CP, are at an LSEN school as mentioned above, and can communicate. The learners were boys ranging in age from 11 to 18. Participant demographics are summarised in Tables 1 and 2. Participants were selected through convenience sampling. Educators were recruited by sending study information to the schools' Occupational Therapist (OT) who shared the information with the staff at the school. Educators then volunteered to take part in the study. Learners were recruited from the referrals of the OT at the LSEN school.

Table 2
Learners' demographic data

Learner Participant (LP)	Gender	Age	Grade
1	Male	18	8
2	Male	17	9
3	Male	16	7
4	Male	17	7
5	Male	11	5
6	Male	15	6

Data collection procedures

Semi-structured interviews

All participants took part in semi-structured interviews. One of these interviews was conducted via Zoom because of the Covid-19 pandemic. The other 15 were conducted at the school. Each interview lasted approximately 40 minutes.

Classroom observations

All participants took part in classroom observations. These observations took place during normal school hours in various classrooms. Each educator presented a 30-minute lesson using technology (as they normally would). Each learner used technology to partake in the various lessons presented by the educators. Strict Covid-19 procedures were followed during the classroom observations.

Data analysis

Content analysis was used as a data analysis and interpretation strategy. This was done with Creswell's Data Analysis Spiral and Atlas.ti, a software program that assists with coding data. Creswell's Data Analysis Spiral aims to find patterns in the data and consists of four steps (Leedy et al., 2019): (1) organising the data and breaking large sections into smaller units, (2) obtaining an overview of the data, (3) developing categories and finding patterns or themes in the data, and (4) synthesis of data.

Trustworthiness

To ensure trustworthiness the first author used direct quotes from respondents, clearly defined sampling methods, and detailed data collection methods, gave precise data gathering methods, analysis, and interpretation of the data, reproduced enough data to decrease her own interpretation, gave a thick description of the context, participants, and research design, and made use of triangulation by comparing the answers to the interview questions from the educators and learners, as well as the observations made in the classrooms.

Ethical concideration

In conducting a study on the use of AT to minimise learning barriers for learners with CP, several ethical considerations had to be taken into account. These considerations ensured the protection of participants' rights, confidentiality, and the promotion of ethical research practices.

Prior to the study, informed consent and assent were obtained from participants and their parents or legal guardians. Participants were fully informed about the study's purpose, procedures, and their rights as participants. Informed consent was voluntary, without any coercion, and participants had the right to withdraw at any time. Confidentiality and anonymity were maintained at all times by anonymising the data.

The ethical applications for the study were submitted to the appropriate institutional review board and ethics committee, as well as the Department of Education.

Results

Barriers experience by learners with CP

These learners experience many physical and cognitive barriers. From the interviews, it is evident that learners also experience other barriers such as difficulties with their vision, the cost of AT devices, inexperience, power outages, and crime, as can be seen in Table 3. Some experience educators as barriers.

Table 3
Barriers and AT for learners with CP

Barriers experienced	AT used by learners
Physical barriers	
Mobility	Wheelchairs Motorised wheelchairs Crutches In-space Wheelchair
Motor skills (writing and typing)	Adapted keyboards Rollerballs Joysticks Buddy buttons Head clickers Scanning Onscreen keyboards Metal keyboard covers Head pointers Adapted chopping boards Adapted knives Adapted cutting boards

Barriers experienced	AT used by learners
Speech and communication	The Grid Speech book
Cognitive barriers	
Cognitive delay	Pictures Videos PowerPoint
Language and reading	Microsoft Office (Microsoft Word and PowerPoint) Immersive reader Spellchecker
Comprehension	Pictures PowerPoint presentations Videos Polls
Memory	Pictures Videos
Severe Intellectual Disability (SID)	All of the above
Other barriers	
Vision difficulties	
Educators	
Cost	
Inexperienced learners	
Power outages	
Crime	

Physical barriers

Learners with CP have poor gross and fine motor skills. This causes challenges with writing, typing, sitting, and eating. EP 1 stated that some learners have little to no function of their hands; this results in the learners not having the finger-pointing function and, as a result, must press buttons with their hand or fist. EP 2 stated that she has learners who are able to use only one hand and other learners who are spastic and have slow hand movements. Learners also experience mobility challenges. This results in difficulties for them with everyday tasks such as walking, running, balancing, and jumping. Participants also indicated that learners have problems with communication and speech. Some learners cannot speak, and others have difficulty with articulation. This causes miscommunication between learners and educators, as well as between and among the learners themselves. EP 6 explained that she does not understand learners because she cannot "catch what learners are saying."

Cognitive barriers

Based on the information provided by the participants, learners experience cognitive delays, language and reading problems, comprehension problems, memory problems, and Severe Intellectual Disability (SID). The cognitive delay is caused by learners being enrolled in school at a later stage rather than in the foundation phase. Some learners struggle with reading, while others experience an inability to read. This is the result of learners not knowing the sounds of the language. Learners also struggle with spelling, which in turn leads to difficulties in reading. Many learners with CP struggle with comprehension. These learners also struggle to understand the content and to grasp basic concepts because of a lack of good background knowledge. EP 7 explained that when she presents a topic about the ocean, most learners do not understand the topic because "some of our kids have never seen the ocean."

According to EP 1 cultural difficulties lead to many cognitive delays and comprehension problems. She further explained that learners are kept at home and attend school only when they are older. Additionally, many learners experience memory problems and struggle to recall basic concepts. This is caused by SID that manifests in slow processing or in no processing skills at all along with memory problems.

Other barriers

Learners with CP may experience other barriers that do not relate to physical or cognitive ones. In some instances, the educator may be the barrier. Educators who do not understand CP or AT will be a barrier to learners' learning in the classroom. EP 9 is of the opinion that "as much as the learners can know devices, everybody is on par, but if an educator doesn't understand how to use their devices, they still have a learning barrier." Further, the cost of AT is another barrier for learners. Learners may have access to AT at school, but some households cannot afford AT at home. These learners cannot complete homework or prepare for assessments at home. Some learners are inexperienced in relation to the use of AT. This leads to learners falling behind in class. According to EP 1, learners often repeat grade 1 because in the first year the school must "get them used to that and sort out access to AT." Power outages are another barrier. Learners depend on AT to function in the educational environment. If the school experiences an interruption in the power supply, learners will not be able to function. Crime is also a barrier for some learners with CP. Many come from poor areas where the crime is high, and their AT devices get stolen.

Effect of barriers on learning

Learners may need concessions and extra time. They may experience a loss of interest in academic endeavours that could lead to failing altogether, and they may fail because of not being able to learn. Educators may feel that they cannot use a variety of teaching strategies and methods.

AT used by learners to reduce the barriers

Although limited research is done on AT to support specifically learners with CP, it was evident during the interviews that there are several forms of AT available to support learners with CP, as can be seen in Table 3. These can be divided into five categories: to assist with writing and typing, for communication, for mobility, to assist with learning, and other AT.

AT to assist with writing and typing

Many devices are available that may help learners with typing. Learners may use a big keyboard where the keys are much larger than the standard keyboard, a rollerball, joysticks, and budybuttons. Some learners with Spastic CP make use of a metal cover that ensures only one button is pressed at a time and not the surrounding buttons. Other learners make use of a mouse that is fitted to the floor. EP 9 explained that his learner uses such a mouse; she uses her feet to navigate and her tongue to type. Some learners with severe disabilities may use a head clicker or head pointer attached to a joystick. EP 1 explained that this clicker attaches to a joystick to ease navigation and instead of using a mouse to click, this learner will use her head to do so. Some programs are also available to assist with typing such as a scanner program that scans the alphabet until a learner clicks on a key, or an on-screen keyboard. EP 2 explained that her learners use a head pointer to type and use the scanning program.

AT to assist with communication

Many learners with CP require assistance with communication. Many learners are non-verbal or struggle with articulation and speech. “The Grid” is a program that assists most learners with communication. It consists of different grid sets with words and symbols that represent everyday language. The learner forms sentences by clicking on the words or pictures. Learners without computers and tablets can use a printed out version and point to the desired word or picture. EP 1 also explained that a particular user cannot take her computer home because of the costs involved and because of the risk of having it stolen, and, as a result, uses a printed-out version to communicate at home.

AT to assist with mobility

Almost all learners with CP make use of some form of AT for mobility. The most common AT devices for mobility are wheelchairs and motorised wheelchairs. EP 1, 5, 8, and 9 mentioned that most of their learners use wheelchairs to move around. Some learners will also make use of crutches or walking aids such as walkers. A few learners, who are diagnosed with full-body paralysis, make use of a Tilt-In-Space Wheelchair. These types of AT assist learners with moving around.

AT to assist with learning

There are many programs that learners use to assist them. EP 1 explained that many young learners make use of “Dina”, a program to practise mouse control and “Nessy Fingers”, a program to assist with typing. These programs assist learners in gaining the skills needed to

use AT effectively. Older learners will make use of a spellchecker to aid them with writing, basic Microsoft programs to type, read, and create icons and pictures to aid their memory and comprehension.

Other AT

Many learners struggle with practical subjects because of not being able to perform practical activities, such as Consumer Studies. EP 8 explained that her learners have many types of AT in her classroom because she teaches Consumer Studies. In this subject, learners use special chopping boards, non-slip mats, and special knives. The chopping boards are adapted by having a nail added to them. This enables the learners to place the food on the nail and cut it according to specifications. The knives have special, non-slip handles or curved handles to aid chopping. Non-slip mats are used under bowls especially when mixing and stirring to prevent them from moving around.

AT used by educators to support learners with CP

Educators can integrate many types of AT into their classrooms to aid learners with CP. These can be divided into three categories: hardware, visual and auditory tools, and other tools.

Hardware

The hardware includes laptops, overhead projectors, and smartboards. All participants reported that they use smartboards in their classrooms and that they use their laptops and smartboards every day. The hardware is used to display the software that assists learners with CP. Smartboards and laptops ensure mostly neater handwriting and bigger font size for educators. EP 2 explained that with a smartboard her writing is clearer, she can increase the size and she can use a diagram. EP 5 also explained that he uses a font that is "easily read by people who've got dyslexia" and all learners with vision problems will find it easier to read. It also saves time when drawing diagrams and doing practical work such as mathematics.

Visual and auditory tools

Educators make use mostly of auditory and visual tools to aid learners in mastering topics. These auditory and visual tools include videos, songs, pictures, slideshows, and the projection of the textbooks, all of which aid learners in the understanding of concepts. These tools aid in memory, reading, gaining a better understanding of concepts, and building background knowledge. EP 2 explained that she uses visuals of the stories that the class reads. She also uses "phonetic songs" and "alphabet songs" to aid learners with their memory. EP 3 makes use of Microsoft PowerPoint, videos, and pictures to aid in teaching and learning. According to him, "It's much easier to present the pictures or maybe the videos which makes it easier for them, rather than expecting them to read." EP 7 uses visual and auditory tools to aid learners in gaining a better understanding of concepts. She explained that if her lesson is on the ocean, she will connect to the internet "where they can physically see [that] this is the ocean. This is the sound you'd hear."

Other tools

Many educators use other tools such as polls, programs that enable one to write on PDF documents, and computer games to teach or practise concepts. EP 6 makes use of a program called "Zodo." She explained that with this program, her learners can edit Department of Basic Education books on their computers. This aids learners with memory, handwriting, and reading.

Effect of barriers on learning

Learning barriers can have a negative effect on teaching and learning. Many themes emerged from the data analysis in relation to the effect of barriers on learning. These are discussed below.

Extra time and concessions

Several educator participants indicated that their learners need extra time to complete tasks and concessions to complete examinations. Some learner participants made the same point. Many learners struggle with reading or comprehending what they have read. According to EP 2, her learners need "extra time and special attention" to overcome their reading difficulties. EP 3 believes that his learners take time to comprehend questions in the examinations. This leads to learners not finishing on time. The concessions are inadequate in most cases and learners fail because of not finishing their examinations or tasks in time.

A loss of interest

Many learners experience a loss of interest in academics, caused by the difficulties that they experience. These learners do not enjoy schoolwork, so they do not want to read, write, and participate in lessons. EP 4 stated that her learners do not enjoy typing and doing schoolwork because "it takes long." This leads learners to want to do other things during class time.

Failing

Many learners must repeat grades because of these barriers. EP 1 explained that learners normally finish grade one in two years. During the first year, she focuses on finding AT and teaching the learners how to use AT devices. During the second year, she focuses on the content. EP 7 mentioned that many learners "slip through the cracks" because they fail given their barriers. Continual failing leads to learners dropping out altogether.

Teaching strategies

Educators may feel that they cannot use a variety of teaching strategies and methods. Most educators use one teaching strategy that accommodates most learners such as repetition, short exercises, and explaining simply. EP 6 pointed out that learners tend to make mistakes if the exercises are too long. Further, many strategies are impossible for learners using wheelchairs and crutches. EP 8 stated that she makes use of only one teaching strategy which is direct instruction, instead of using different teaching strategies because "you can't have role play or

it's not that you can't, it just takes more time, role play, playing games, educational games that become a challenge for the [learners using] wheelchairs or crutches."

Pedagogy and AT

Many educators incorporate AT into their pedagogy. AT assists educators with the planning of lessons to accommodate all learners. EP 1 mentioned that AT improves efficiency. She explained that with technology educators do not have to "plan six different activities" and "everyone is doing the same thing albeit at different paces." It also helps with explanations and creating background knowledge for learners, because educators can make use of pictures and videos. EP 2 explained that before presenting content, she can plan the content and type everything. She explained that creating slideshows is easier than "the traditional way of writing on the board." EP 6 explained that with the use of AT, she can teach more efficiently. EP 6 also explained that she can plan and incorporate more lessons and skills into her daily work.

The interviews indicated that AT used by educators can be divided into hardware and software. Hardware such as laptops and smartboards are used along with software that incorporates visual and auditory tools such as videos, songs, pictures, Microsoft PowerPoint, and other tools such as programs that ease learning and teaching. These tools aid educators in presenting the lessons and enable them to add examples or highlight important information.

Content and AT devices

Educators incorporated AT into the content to aid learners. Educators mostly make use of auditory and visual tools to aid learners in mastering the content of a topic. EP 1 explained that she makes use of "The Grid" to aid learners with the content. She explained that "during a comprehension, the answers can be put in and then they can choose one." These auditory and visual tools include videos, pictures, and slideshows that aid learners in the understanding of concepts and in overcoming the barrier of a lack of background knowledge. EP 2 explained that while presenting content, she can add information or highlight important sections. EP 3 explained that AT makes it easier to present content and EP 7 said that because her learners cannot use their hands and lack background knowledge, she makes use of videos and pictures to explain the content. This leads to a better understanding of it.

Effectiveness of AT in special needs education

AT can be effective in minimising barriers for learners with CP. AT minimises barriers such as problems with vision, mobility, spelling and punctuation, and motor skill challenges. Five participants felt that AT is effective. According to EP 1, AT devices "completely impact their learning." She also explained that AT can be effective only if the educator and learner work together. EP 2 stated that AT is "very effective" in her classroom. EP 4 explained that AT is effective because it reduces the challenges that learners experience, "especially those who have visual problems." EP 3 stated that his AT helps him with everything that he needs to do.

Despite these advantages, three participants felt that AT is effective but does not address the barriers completely. Two participants felt that AT does not effectively address the barriers and more should be done for learners with CP to ensure that this happens. Barriers such as vocalisation and communication are not fully addressed. Learners with AT may still fail if they do not have the background knowledge and cannot grasp basic concepts. AT may also create barriers when the learners and educators are not working together or when learners use functions without grasping the concepts, for example, the grammar and spell-checking function in a language test.

Nonetheless, learners would not be able to study and perform everyday tasks without AT. It is evident that the school and its learners are dependent on AT since learners with CP need it to function.

Discussion

Barriers and AT used to reduce the barriers

In Table 3, the barriers and the AT devices used are depicted. The main barriers arising from the data can be divided into three categories: physical barriers, cognitive barriers, and other barriers.

The main physical barriers are mobility, motor skills, and speech and communication. Participants in this study struggled with mobility and need the support of AT to be mobile. This statement was affirmed by CerebralPalsy (2020) and Landsberg, et al. (2019) when they stated that learners with CP often experience difficulties in everyday tasks such as walking, running, balancing, and jumping. Landsberg, et al. (2019) and CerebralPalsy (2020) also supported this statement by explaining that learners with CP experience impaired gross and fine motor functioning. Scharf (2016) is of the opinion that learners with CP experience impaired communication because these learners struggle with articulation and slurred or slow speech.

The main cognitive barriers are cognitive delay, problems with language and reading, comprehension and memory, and SID. Landsberg et al. (2019) explained that SID is a significant cognitive impairment that affects individuals across many domains of functioning. It is characterised by significantly below-average intellectual functioning, along with substantial limitations in adaptive behaviour. Van Rooijen et al. (2016) and Cerebral Palsy Guidance (2020) explained that learners experience problems with numeracy and arithmetic, reading skills, working memory, non-verbal understanding, short attention span, learning and comprehension problems, executive functioning, problem-solving, and hyperactivity.

The other barriers that emerged from the data are vision difficulties, problems with educators, cost, the lack of expereince of learners, power outages, and crime. These barriers are not addressed in the literature on CP and AT.

Pedagogy and AT devices

Educators can integrate much AT hardware and software into their pedagogy to aid learners with CP. The hardware includes laptops, overhead projectors, and smartboards. The hardware is used to display the software that assists learners with CP. The software includes YouTube, videos, songs, pictures, and PowerPoint presentations. Raja (2016) shared the same sentiment by explaining that educators can supply resources in an electronic format, differentiate the learning and teaching material, use assistive software such as magnification and text to speech, use smart devices, and record lectures. Cerebral Palsy Foundation (2019) also emphasised that the use of larger fonts and text can be beneficial.

Content and AT

Educators mostly make use of auditory and visual tools to aid learners in mastering a topic. These auditory and visual tools include videos, pictures, and slideshows that aid learners in the understanding of concepts. Raja (2016) also explained that educators can provide support with the organisation of the content and memory with calendars, categorisation and organisation applications, and memory aids.

Effect of barriers on learning

Many themes emerged from the data analysis in relation to the effect on learners of the barriers to learning. These barriers include the need for concessions and extra time, a loss of interest in academics, the use of various teaching strategies, and failing. Whitney et al. (2019) are of the opinion that learners with CP may experience bullying that leads to low self-esteem. Cerebral Palsy Guidance (2020) affirmed this statement by explaining that bullying may further lead to a learner with CP not being able to concentrate during class, having lower grades, or simply dropping out of school.

Effectiveness of AT in special needs education

Several patterns emerged from the data in relation to the effectiveness of AT in reducing learning barriers. Five participants reported that AT devices are effective in minimising learning barriers for learners with CP. Cerebral Palsy Guidance (2020) also reported that AT provides an equal opportunity for learners with disabilities to learn.

Three participants reported that AT is somewhat effective and two participants mentioned that AT does not effectively address the barriers. The Department of Basic Education (2004) stated in the Paper on e-Education, that every educator, manager, and learner must be computer literate and use technology in innovative ways to teach and learn by 2013. This goal has not been realised fully. Mnisi (2015) acknowledges that this is a concern for the Department of Education. According to Neves (2020), there exists a "deep inequality" in access to connectivity, hardware and even "stability in households to make online learning possible", especially in low-income areas.

As Du Plessis (2014) noted, rural schools especially do not have the basic infrastructure, including electricity for assistive devices. As a result, there is little opportunity to integrate assistive devices into these schools. According to Mnisi (2015), the Department of Basic Education still considers the White Paper 7 and the Action plan of 2014 to 2025 as relevant and it should be implemented in South African schools. Some private schools have access to AT but some not all.

Limitations

There are a few limitations to this study. First, it included a small number of educators and learners, and all learners were male. This limits the generalisability of the findings. Second, because of the Covid-19 pandemic, only one lesson was observed. This may lead to the Hawthorne effect, where participants change their behaviour because they are being observed (Leedy et al., 2019). Third, the study was conducted at one school. This limited possible generalisation that can be made to other schools.

Implications of the study

There is limited research available on specifically CP and AT. Most studies focus on a definition of CP, such as the study done by Gulati and Sondhi (2018), causes and types such as the study done by Ferrari (2010), and treatment or physical disabilities as a whole such as studies done by Rahamin (2004) and Kouroupetroglou (2013). The few studies that address barriers to learning for learners with CP do not address the problem in any depth, such as the study of Hasselbring and Glaser (2000) that focused broadly on technology use for learners with special needs. This study attempts to bridge this gap by explaining what CP is, the possible barriers it causes, and how AT can be used to minimise the teaching and learning barriers that learners with CP experience.

Recommendations for schools with CP learners

There are two major recommendations for schools with learners with CP and AT. First, educators should be adequately trained on the basics of CP and how to use AT for teaching and learning. This will ensure that educators incorporate the correct types of AT and that they will know how to use them. Second, learners should be educated on the uses of AT from a young age. This will ensure that they use their AT devices to support their learning and grant them the opportunity to focus on academics and not on learning to use the devices.

Recommendations for future research

More research into AT to support learners with CP is needed, specifically on AT and what can be done to adequately accommodate all learners with CP. This study focused on which barriers learners are experiencing and how AT can minimise these barriers, but as indicated, these types of AT are not enough.

Research on training programs for educators in relation to AT devices and the use thereof is needed. It is not enough that the learners know how to use AT. Educators should also support learners to use these devices. Without proper training, educators will not be able to support learners adequately.

Additionally, more research is required to examine the expertise educators possess in helping and supporting students with CP. Educators need to play an effective role in the integration of AT in lessons to support learners with CP. It is not enough to just integrate AT into the lesson when it does not have functional value in minimising the barriers that learners with CP experience. Without a thorough understanding of CP, educators will not be able to integrate AT meaningfully and effectively into lessons.

This study focused on all learning barriers faced by a group of learners with CP. The barriers that learners with various kinds of CP face require further study. This can result in a clearer understanding of the obstacles and educational requirements of every learner. Additionally, CP is a condition that is always changing and developing, necessitating ongoing research.

Conclusion

AT makes learning and teaching possible for learners with CP. This study was not only about AT integration and CP, but also about the barriers experienced by learners with CP and educators teaching learners with CP and which AT devices can minimise these barriers. Learners with CP experience many physical and cognitive barriers in the classroom. From the interviews, it is evident that learners also experience other barriers such as vision difficulties, educators as barriers, the cost of AT, inexperience, power outages, and crime. This can have a negative impact on learning since it leads to the need for concessions, a loss of interest in academics, limited teaching strategies, and failure. Many types of AT can be used by educators and learners to minimise these barriers. The educators can incorporate AT into their pedagogy and content by making use of smartboards, overhead projectors, videos, pictures, and slideshows. Learners can use AT such as trackballs, touch screens, higher contrast displays, enlarged cursors and text, a keyguard, speech-generating devices, and text-to-speech facilities to assist their learning. In the data analysis and discussion sections, these barriers and the AT used to minimise them were discussed in depth. Recommendations for schools that do have learners with CP and recommendations for future research were also suggested. Future endeavours into this topic may be fruitful for other disabilities and educational environments.

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