Digital Assistive Technologies to support remote working by people with disabilities: A scoping Review

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Executive Summary

Background: The issue

In the spring of 2020 many companies sent their employees home to work remotely in an effort to combat the spread of COVID-19. Without forethought or planning, an entire workforce was mobilized using digital assistive technologies to support remote working. Prior to this, these same companies had often claimed an "undue hardship" when asked to make these same accommodations for people with disabilities. Over a year later and much has been learned about the use of digital assistive technology to support remote workers. More importantly, for the first time, people with disabilities can come to the same table in their search for employment. Therefore, the focus of this report is a scoping review undertaken to answer the question: ***How does digital adaptive technology address barriers to labor market participation for people with disabilities?***

Objectives

As a result this study was conceived with four primary objectives: 1) Summarizing key concepts and terminology and provide criteria for future reporting; 2) Inventory of all available digital assistive technologies; 3) Evaluation and synthesis of available evidence related to effectiveness and utility of available technologies; and 4) Provision of recommendations for future research and development.

Results

This scoping review was able to complete Objectives 1 and 4. The summary of key concepts and terminology is provided for in Appendix Two and the criteria for future reporting is included within the section on 'Classifications of assistive technologies'. The inventory of all available assistive technologies is underway and a public facing accessible online database will be launched in the fall of 2021. To meet Objective 3 this scoping review report will be summarized in written reports for presentation to knowledge users and for peer reviewed publication. An abstract on this study has already been accepted for presentation at the Northern Health Research Conference in the fall of 2021. The section on 'Implications (for policy, practice or research)' provides recommendations for future research and development.

Key Messages

There are ten key messages arising from this scoping review:
1. There is a need for specific training programs in the use of assistive technologies by people with disabilities.
2. Organisations should explore the use of assistive technologies to further support their workforce.

3. Evidence is still needed regarding the use of assistive technologies in the workplace and specifically in the home for remote working.
4. Significant and unique barriers have to be identified and addressed.
5. Organisations need to comply with existing policies.
6. More research is needed into the issue of unmet needs by people with disabilities.
7. Research and development into assistive technologies needs to be invested in.
8. Workplace assessments are required in the home setting.
9. Further work in the classification of assistive technologies is required.
10. Large scale studies of digital assistive technologies are needed.

Methodology

Search Methods

Our search methods were heavily guided by an expert advisory committee that we established to inform our study. We undertook traditional searches of the relevant databases of peer reviewed journals. However, these searches produced limited results. Then we identified key papers and searched their bibliographies for additional papers. We identified key journals in the field and searched their indices to identify additional material and finally we undertook a search of the grey literature using search terms recommended to us by our advisory committee (Appendices One, Two and Three).

Selection Criteria

Our selection criteria was initially extremely broad as papers covering the topic were published in many different areas of research. Finally we set upon the following as our inclusion/exclusion criteria. The paper must cover Digital assistive/adaptive technology, Digital assistive/adaptive technology for remote working, Digital assistive/adaptive technology for individuals with a disability, Remote working and disabilities, Computer based technology that can be used for remote working, or Disability and the workplace (accommodations, barriers, improvements etc.). The population was restricted to people with disabilities. The technology had to be digital assistive/adaptive technology. We have included any study type since 2010 in English.

Data Collection & Analysis

The titles and abstracts of articles obtained from the online databases were reviewed and appraised for relevance. If the relevance of a study was still unclear, then the full article was obtained. From the original 212 articles 11 duplicates were immediately removed. A further 75 articles were removed during the review of title/abstracts leaving 126 papers. The full articles were then retrieved and reviewed. An additional 85 articles were removed at this stage resulting in 41 articles forming the basis of this review. Data was abstracted from each of these using a Google Sheets form. A thematic analysis was undertaken and is reported on in the section 'Results: Themes.'

Introduction

The focus of this report is a scoping review undertaken to answer the question: ***How does digital adaptive technology address barriers to labor market participation for people with disabilities?***

Background

The Canadian Survey on Disability, undertaken in 2017, reported that among those with disabilities aged 25 to 64 years who were not employed and not currently in school, two in five (39%) had the potential to work. This represents nearly 645,000 individuals with disabilities who are able to work but are not employed(2).

Given that one in five (22%) of the Canadian population aged 15 years and over – or about 6.2 million individuals – reported one or more disabilities this number is only set to increase(2). Disability is the only minority group that anybody can become part of at any time. Yet the disabled remain underserved and underutilized. Among those aged 25 to 64 years, persons with disabilities were much less likely to be employed (59%) than those without disabilities (80%)(2)

Severity of disability is a predictor of employability, as the level of severity increases, the likelihood of being employed decreases. For example, for individuals aged 25 to 64 years, 76% of those with mild disabilities were employed, whereas only 31% of those with very severe disabilities were employed(2). Within the disabled community the opportunity for using digital assistive technologies to enable their ability to work remotely is widely discussed. However, many employers determine that it's an "undue hardship" to make accommodations allowing employees with disabilities to work remotely or enabled through digital assistive technologies.

In the spring of 2020 the world changed. The COVID pandemic hit and many employers sent their staff home to work. Without forethought or planning, an entire workforce was mobilized using digital assistive technologies to support remote working. It is understood that this wasn't a possibility in certain businesses, leading to layoffs and furloughs. However, for many organizations that were primarily office based, their workforce made the appropriate adjustments and for over a year have continued working remotely enabled by digital assistive technologies. The argument that such accommodation creates an undue hardship can no longer be held valid. Consequently, for the first time in history people with disabilities are able to come to the same table when seeking employment. Therefore, it was time to inventory digital assistive technologies to make it easier for companies to accommodate people with disabilities.

We conducted a scoping review of the potential of remote working for people with disabilities.. Specifically, we were interested in digital assistive technologies aimed at improving the ability of people with disabilities to work remotely. Computer-based technologies were specifically targeted because of the rapid development and diffusion of remote working in the light of

COVID. Since this is an emerging area that covers multiple disciplines, including health care, disability studies, computing science and business/management, the scoping review was undertaken by an integrated transdisciplinary team who identified and inventoried all relevant research. We also thoroughly searched the scientific and grey literature to identify articles describing such technologies.

Objectives

While much has been researched about using digital assistive technology to support learners(3)(4), less is known about their impact in the workplace. Where accommodations are made individuals tend to report dissatisfaction with them (E.g. Haynes et al (5)). Some attention has been paid to designing reasonable accommodations within the workplace (E.g. Pigini et al (6)) but many barriers remain(4,7,8). Despite this, digital assistive technology is still being promoted as being an emerging enabler of people with disabilities in the workplace(9).

To date, a thorough synthesis and summary of all available knowledge in this area had not been conducted. A scoping review was therefore warranted due to the diversity of the literature and emerging nature of the research area(10).

The synthesis allowed us to:
1. Summarize key concepts and terminology and provide criteria for future reporting;
2. Inventory all available digital assistive technology for remote working;
3. Evaluate and synthesize available evidence related to effectiveness and utility of available technology for people with disabilities; and
4. Provide recommendations for future research and development in this area.

Methods

Design

A scoping review is a methodology for rigorously collecting, synthesizing, appraising, and presenting findings from existing research on a topic. The approach is especially relevant when an area is emerging or diverse for the purpose of examining the extent, range, and nature of research activity. It is also useful for determining whether enough literature is available to conduct a formal systematic review or meta-analysis on a topic. Our research area is both emerging and diverse, and it is unlikely that enough articles are available to warrant a systematic review. For these reasons, we chose to conduct a scoping review.

We adopted the scoping review framework proposed by Arksey and O'Malley(11). This framework progresses through 5 stages: 1) Identifying the research question; 2) Identifying

relevant studies; 3) Study selection; 4) Charting the data; and 5) Collating, summarizing, and reporting results. Each stage will be discussed in detail below.

Identifying the research question

Our specific research question was *"What digital assistive technologies, to support remote working, are available to the potential employer and disabled employee?"* This question provided the initial scope for the review and contains several key concepts that guided the search terms used. However, as outlined by Arksey and O'Malley(11), the process of the scoping review was iterative and required us to reflexively adapt the question, search terms, and strategy to ensure that the literature was covered comprehensively. The question was therefore adapted to more appropriately cover the literature reviewed. The final question was *How does digital adaptive technology address barriers to labor market participation for people with disabilities?*

The key concepts in the research question that frames this review and form the inclusion/exclusion criteria include:
Disability - a physical, mental, cognitive, or developmental condition that impairs, interferes with, or limits a person's ability to engage in certain tasks or actions or participate in typical daily activities and interactions
Digital Assistive Technologies – electronic products, equipment, and systems that enhance learning, working, and daily living for persons with disabilities
Workplace – a place (such as a shop, factory, or home) where work is done
Remote Working - a situation in which an employee works mainly from home and communicates with the company by using digital assistive technologies such as virtual meetings

Identifying relevant studies

Online searches of health care, computing science, assistive technology, disability and rehabilitation, augmentative and alternative communication databases were used to identify relevant articles.The initial searches were performed with the assistance of an experienced research librarian at the Northern Ontario School of Medicine who had access to, and a thorough knowledge of all the necessary databases and search engines.

The initial search utilised PubMed and Google Scholar. The search terms used included: disabled persons (MeSH), self help devices (MeSH), assistive technology (keyword), assistive device*(keyword), workplace (MeSH), employment (MeSH). This resulted in just 19 articles.

Consequently, the research librarian repeated the search using PubMed/MEDLINE, CINAHL, PsycINFO, and Google Scholar. Using terms similar to those in the previous search disabled persons (mesh), self help devices (Mesh), work (Mesh), return to work (Mesh), employment (Mesh), "digital assistive technologies", "digital assistive technology", 'remote work", "telecommuting". This resulted in just 25 articles of which many were an overlap with the first search.

Studies were then identified through extensive online searches of relevant databases. Databases searched included: Ovid Medline, Ovid EMBASE, Scopus, CINAHL, Business Source Complete, ABI Inform Global, Social Science Research Network, Web of Science, ACM Digital Library, IEEE Xplore, Computing Reviews, Computing Research Repository, ResearchIndex, and Google Scholar. Ovid Medline and Embase were searched first since these databases contain a thesaurus to search all standard terms related to the search term entered.

Search strategies were adapted to the various databases. Initial keywords included: Disability, Digital assistive technology, Workplace, Remote working.

After articles were identified, we conducted citation searches of the reference list in the relevant articles. A citation search was also conducted on Scopus to identify any subsequent article that had referenced a relevant article.

Next, we conducted a search of the grey literature to locate relevant technologies. This included an Internet search using the key search engine Google.

Consultation with Knowledge Users (1)

We held the first of two advisory committee meetings on the 26th February 2021.

Advisory committee members were identified by conducting research into different organizations, professionals and authors in the assistive technology and disability realm in Canada. Google searches of organizations related to assistive technology in Canada helped identify individuals who are working within the field. These organizations included Canadian Assistive Devices Association, Canadian Assistive Technology, Access BC, Communication Assistance for Youth and Adults, CNIB, Secret Study and TrySight. Authors were identified through browsing journals related to the study. These browsed journals included Assistive Technology, Disability and Rehabilitation and authors of AGEWELL Project 8.2: Aging, Disability & Technology – Understanding and Advancing Canadian Policies for Technology Access.

Through this search we gathered a list of 34 individuals who would be suitable for the committee and reached out to them by email. Going forward those individuals who were available and interested were invited to join the advisory committee. The resulting committee was serendipitously diverse representing academics as well as service providers.

Name	Position	Organisation
David Courtney	Executive Committee	Canadian Assistive Devices Association (Access Abilities)
Steve Barclay	Sales & Administrative	Canadian Assistive Technology

Lois Turner	Program Manager	Communication Assistance for Youth & Adults
Stacey Harpell	Client Services Manager	Communication Assistance for Youth & Adults
Dr. Jeff Jutai	Full Professor	Interdisciplinary School of Health Sciences. University of Ottawa
Mani King	Director: Research, Operations and Business Development	Holland Bloorville Kids Rehabilitation Hospital. Research Operations Team.
Dr. Claudine Auger	Associate Professor	AGEWELL / School of Rehabilitation Université de Montréal
Dr. Peter Smith[1]	Professor Emeritus	Sunderland University, UK

The main outcome of our first advisory committee meeting was that the advisory committee members expanded our search extensively (See Appendices One, Two & Three) providing both additional search terms as well as specific journals, documents and phrases to search within.

Additionally, advisory committee members are professionals and authors in the field who were able to share the most current knowledge and terms when it comes to this subject. We were informed that going forward the phrase "adaptive technology" is being used more widely. Through this dialogue about progressive language they requested that we change the title of our study from assistive technology to adaptive technology to reflect more current thinking regarding this terminology. However, after reviewing the available literature it became evident that the word assistive technology was very prevalent throughout the research. In order to best reflect the literature within the study we have conformed to using the term assistive technology throughout this report. However, we did update our research question to reflect this request.[2]

Extending the search

As formal literature reviews weren't finding much we extended our search and included search terms recommended by our Advisory Committee (Appendix One and Appendix Two) and Grey literature (documents that are not peer reviewed scientific literature). Consequently we searched MEDLINE (PubMed), EMBASE, OMNI, and Google Scholar. The extensive list of keywords and search terms are included in Appendix Three.

Relevant articles from the study teams' own research or libraries were also included. Each digital assistive technology (DAT) that was located was tracked in Google Scholar to determine whether additional studies investigating the tool had been published. In addition, Google was

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[1] Dr. Smith attended the second meeting only.
[2] Identifying the research question (Page 6)

searched to identify possible unpublished studies. This very broad search resulted in 212 articles.

The search included articles in English published since the year 2010 as we felt that technology changes so fast that going back more than a decade would be inappropriate.

Selecting Studies for Analysis

The following were the final set of inclusion/exclusion criteria for the review:
- **Topic of the article**: Article mentions or discusses
  - Digital assistive/adaptive technology
  - Digital assistive/adaptive technology for remote working
  - Digital assistive/adaptive technology for individuals with a disability
  - Remote working and disabilities
  - Computer based technology that can be used for remote working
  - Disability and the workplace (accommodations, barriers, improvements etc.)
- **Population:** People with disability
- **Technology:** digital assistive/adaptive technology
- **Study type**: Any
- **Time Period**: Since 2010
- **Language**: English

The titles and abstracts of articles obtained from the online databases were reviewed and appraised for relevance. Two independent researchers from the team (MI & SB) read each title/abstract and judged whether they were relevant to the research question. When there were disagreements between reviewers, the principal researcher (NTS) offered additional consultation until a decision could be reached. If the relevance of a study was still unclear, then the full article was obtained. After selecting the relevant abstracts and titles, two independent researchers assessed the corresponding full versions of the studies to determine which articles should be included in the full review. If discipline specific questions arose, the reviewers consulted with the principal researcher (NTS).

From the original 212 articles 11 duplicates were immediately removed. A further 75 articles were removed during the review of title/abstracts leaving 126 papers. The full articles were then retrieved and reviewed. An additional 85 articles were removed at this stage resulting in 41 articles forming the basis of this review.
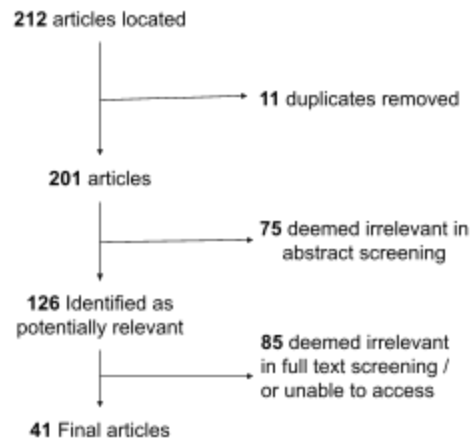
Figure One: Flow chart of article search and selection

We used a Google Sheets database stored on a shared google drive that was securely accessible by team members for all stages of the review. All citations were managed within a shared Zotero[3] (citation management) database. A summary of all 41 papers is included in Appendix Four.

Challenges & Mitigation Strategies

One of the challenges of this study was the availability of empirical evidence. As the study covered a broad array of subjects one library alone did not have all the resources required. As stipendiary faculty with the Northern Ontario School of Medicine as well as being a professor at Algoma University NTS was able to access three different library resources (Algoma, Lakehead, & Laurentian). However, some papers had to be sourced through inter-library loans. If necessary, we also contacted authors directly and asked for copies of papers that proved to be elusive through the library networks.

Data Analysis

Charting the Data

The two undergraduate research assistants (SB & MI), and the PI (NTS), read all identified articles and relevant information was extracted and entered into an electronic data charting form. This included author, year of publication, title of article, journal title, relevancy, actual technology, disability, period of study, feedback, reason, things to be researched, full article, assistive technology and relevancy after reading full article.

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[3] https://www.zotero.org/

Collating, summarizing and reporting results

During this stage we aimed to create an overview of all research in this area. Initially, the PI (NTS) presented a basic numerical summary of the articles located including a summary of the extent, nature, and distribution of the articles. Articles were also summarized according to the type of technologies described or evaluated, research methods used, population studied, and geographic location of the research .Table One (Appendix One) was developed to provide an overall summary of this information and all of the articles located. The PI (NTS) developed matrices where articles were described according to key themes and characteristics of the articles versus discipline including: 1) type of technology; 2) type of disability addressed; 3) type of paper; 4) Country of first author; and 5) year of publication..

We then summarised both the breadth and depth of the literature. Since a variety of study designs and types were included, we did not undertake a critical appraisal of quality. However, we were able to map the diversity observed and inventory the various study designs and methods used. This allowed us to draw conclusions about the nature of research in this area and provide recommendations for future studies.

The overall results of this scoping review will be summarized in written reports for presentation to knowledge users. The document will synthesize all relevant literature on the topic. Thus, we will be able to achieve our four main objectives of: 1) Summarizing key concepts and terminology and provide criteria for future reporting; 2) Inventory of all available digital assistive technologies; 3) Evaluation and synthesis of available evidence related to effectiveness and utility of available technologies; and 4) Provision of recommendations for future research and development.

Results

General description of articles

Of the 41 articles, the vast majority were from North America (24 USA, 3 Canada). Four were from Australia, two from Italy and one each from Pakistan, Bangladesh, Norway, India, Croatia & South Africa, Jordan, and the UK. One was international in scope. Twenty-three articles were published since 2016 and eighteen in the time period 2010-2015 which suggests an increasing interest in the subject domain over time.

Seventeen papers were concerned with "Assistive Technology" generally. Six with AAC (Augmentative and Alternative Communication) specifically, six with workplace accommodations and the rest were evenly spread over Communication Stories, Speech to Sign, Speech to Text, and specific applications.

Most papers were concerned with either assistive technologies to assist with sight issues (n=9) or with multiple disabilities (n=10). Cognitive/intellectual disability (n=4), hearing (n=3) and

communication needs (n=3) were next with the rest being evenly spread over physical mobility, neurological disability, speech disability (n=1 each) and two were concerned with specific disabilities (multiple sclerosis and tetraplegia).

Twelve papers were some form of review or systematic review. Eight were concerned with evaluation and six with barriers/challenges. Three were about classification of assistive technologies and three were case studies. We also included one briefing paper(1) as it formed a perfect foundation for this scoping review.

Table One. Characteristics of included articles (n=41)

	Number (%)
Source of evidence	
Evaluation	8(19.5%)
Barriers/Challenges	7(17%)
Classification of assistive technologies	3(7%)
Case studies	3(7%)
Workplace accommodation	7(17%)
Review	12(29%)
Background paper	1(2%)
Geographic location of lead authors	
North America (USA & Canada)	27(66%)
Australia	4(10%)
Italy	2(5%)
Bangladesh	1(2.5%)
Croatia & South Africa	1(2.5%)
India	1(2.5%)
International (team)	1(2.5%)
Jordan	1(2.5%)
Norway	1(2.5%)
Pakistan	1(2.5%)
UK	1(2.5%)

Year of publication	
2010-2015	18(44%)
2016-2021	23(56%)
Type of technology discussed in the article	
Assistive technology	18(44%)
AAC (Augmentative and Alternative Communication)	6(15%)
Named application	2(5%)
Communication stories	2(5%)
Speech to sign	1(2.5%)
Speech to text	2(5%)
Disability type addressed	
Multiple	10(24%)
Sight	9(22.5%)
Cognitive/intellectual	4(10%)
Hearing	3(7.5%)
Communication	3(7.5%)
Specified condition	2(5%)
Physical	1(2.5%)
Neurological	1(2.5%
Speech disability	1(2.5%)

Inventory of assistive technologies

Background paper

The World Bank Background Paper(1) explores the role of Information and Communication Technology (ICT), rather than explicit assistive technologies in a number of domains. One of which is the workplace. The paper provides an overview of opportunities offered by ICT and the internet to allow full participation by those with disabilities. As we stated earlier (Background) accessible ICT can level the playing field for people with disabilities across all life domains. Table Two drawn from the World Bank Background paper(1) demonstrates just how assistive technology can address barriers due to different disabilities.

Table Two: Barriers to participation by disability type and relevant ICT solutions(1 Page 8)

Disability Category	Examples of barriers in social, economic, and community participation	Examples of accessible technology solutions
Visual Disability Includes total blindness or low vision	- Reading print (e.g., textbooks, instructions, documents) and writing (e.g., signing checks, legal documents) - Accessing visual information in print or audiovisual media (for example, warnings and information in text scrolls on television). - Navigating new surroundings when all signage is in text.	- Text-to-speech rendition and speech/voice output - Braille displays - Screen and text magnification - Voice recognition - Audio description of graphic and visual media - Electronic audio signage - GPS-facilitated navigation - Optical character or image recognition - Changing screen brightness, color contrast
Hearing Disability Total or partial hearing loss	- Hearing lessons, warnings, and other auditory information in person or over audio media such as the radio or television. - Communicating with others including educators, peers and colleagues, clients, first responders, government personnel, and others.	- Closed and open captioning, subtitles for videos, TV programming - SMS, text messaging - Text Telephone or Telecommunication Device for the Deaf (TTY/TDD) which allow text messaging over the phone line - Telecommunications Relay Services which allow text to speech conversions through an operator - Use of vibrations/text alerts instead of audio alerts
Speech Impairments	Communicating with others including educators, peers and colleagues, clients, first responders, government personnel, and others.	- SMS, text messaging - Synthesized voice output, text to speech functionality - Use of virtual picture board and communication solutions
Physical Disability Loss of mobility, dexterity, and control over some body	Entering, navigating, and using buildings, classrooms, and other	- Voice recognition systems - Adapted and virtual

functions	physical spaces. ● Using writing tools such as pens and pencils, keyboards, mouse.	keyboards ● Joysticks and adapted mouse ● Use of eye-gaze and gestures to control devices ● Remote and online access to work, education, and other services
Cognitive Disability Includes a range of conditions which may impact a person's memory, thinking and problem solving, visual, math, reading and language comprehension, ability to pay attention or follow instructions. Examples of underlying conditions are traumatic brain injury, learning disabilities, down syndrome, autism, cerebral palsy.	● Difficulty understanding, remembering, or following instructions. ● Difficult in comprehending textual information. ● May occur together with other limitations such as speech impairments or trouble with hand grip and movements. ● Difficulty in communicating or expressing thoughts and ideas.	● Text-to-speech rendition and speech/voice output ● Touch screen devices ● Mobile apps and online resources that mimic Augmentative and Communication (AAC) devices, electronic picture boards for communication ● Organization and memory aid tools such as online calendars, note taking, alerts ● GPS-facilitated navigation ● Use of multimedia to aid comprehension e.g., videos, graphics
Psychosocial Disability	● Need for flexible schedules ● Difficulty understanding, remembering, or following instructions. ● Inability to react and make appropriate decisions following information or instructions. ● Difficulty in communicating or expressing thoughts and ideas.	● Use of online communication, documentation, work tools to aid with flexible scheduling ● Organization and memory aid tools such as online calendars, note taking, alerts

Despite the prevalence of such technologies the potential costs still deter many employers. However, Raja (1) dedicates a complete section of their paper to Availability and Affordability. In this section they discuss the high costs of ICTs and the resulting lack of affordability for developing nations. However, they also state explicitly that *"Studies that have explored the return on investment of technology accommodations in the workplace overwhelmingly show that the direct and indirect benefits to the employer almost always outweigh the costs of making the*

accommodation."(1) Further recent studies prove that accommodations cost below US$500 in most situations(12,13).

Themes

In an effort to find a way of managing the 41 papers a thematic analysis was undertaken (as seen in Table One). This resulted in seven main themes: Reviews, Evaluation, Case studies, Barriers & challenges, Classification of assistive technologies, Workplace accommodation(s) and a Briefing paper(1). Each of these will now be addressed.

Reviews

To understand how to move forward in the field of assistive technology and supporting individuals living with disabilities it's important to reflect on the existing tools, technology, accommodations and knowledge that already exists. In analyzing what has already been presented in this field it can be seen that assistive technology plays a positive and significant role in improving people's livelihood and work prospects. These noteworthy changes and developments also vary depending on the type of disability or field of interest. There are many different types of needs that need to be addressed by assistive technology such as mental functions, personal mobility, sensory functions, daily living activities, orthotics and prosthetics, communication and skills training, recreation and sports, and housing, work and environmental improvements(14). The use of assistive technology has produced helpful outcomes and has been prominent in aiding individuals with intellectual disabilities employment outcomes(15).

This is a constructive display of how AT can be a large factor in securing jobs for individuals living with disabilities. Similarly, these results have been produced for individuals with cognitive disabilities as well, such as AT cuing systems which help increase independence and assist in the increase of job completion and correctness(16). Independence is an important quality for individuals living with disabilities as without it one may not be able to attain employment or perform certain tasks. Assistive technology has also been proven to be useful for individuals with learning disabilities by producing increased educational outcomes, satisfaction in the learning process and boosting quality of life(17). These skills learned within the learning environment may also be able to be transferred one day into the workplace, ultimately this is giving individuals with learning disabilities the tools they need to succeed. For individuals with neurological disorders, a multitude of technologies have been and continue to be designed to aid in functioning. These technologies work towards improving a set of functional activities which require cognitive skills such as attention, reasoning, memory and self-monitoring(18).

In the field of augmentative and alternative communication many strides have been made and technology discovered to improve the lives of individuals living with complex communication needs. Specific changes and advances have taken place such as the evolution of the population of individuals who live with communication disabilities and require augmentative and alternative communication(19). Alongside this comes the changes to the larger array of communication needs that must be addressed and supported(19). As the population changes so do the

complex issues that people face within their lives. Positively, as these variations have occurred so has the availability of technology and systems to support individuals(19). This includes advances such as new symbol sets, layouts, organizations, selection techniques, and output(19). As the field and need for assistance continues to grow it seems as though the technology continues to keep up with its progressions. As well, frameworks have been identified to help in understanding and fitting individuals to a technology. Assistive technology frameworks such as the Human Activity Assistive Technology model takes a consolidated approach of the interaction between the activity, human, context and the technology, linking the process of selecting an assistive technology solution with the individual doing the activity(20). For augmentative and alternative communication this is a significant approach as complex communication needs can vary from each person and may not always present the same way or require the same interventions. Natural language processing has also been incorporated into augmentative and alternative communication through popular tools such as word prediction(21). As this technology, and these devices, continue to evolve in this area, they become beneficial to not only the user but also to the people engaging in conversation with the individual. This works towards greater inclusivity.

Accommodations and participation have also become a prominent and important aspect of supporting individuals living with disabilities in the workplace. In terms of participation, effective interventions can vary depending on the type of disability. Mental health disabilities interventions such as support and training were effective, for individuals with a physical disability peer mentoring is beneficial and for those with neurological disabilities more of a one-on-one setting was found to be effective(22). All of these variations are a concrete display that participation methods and interventions have to be tailored to suit individuals needs and cannot be a one size fit all scenario. Similarly, accommodations also need to be fit to the individual and appropriate for the tasks required. Assistive technology and specialized equipment are considered accommodations and include things such as ergonomic workstations, communication devices and computer access devices(23). They all play a part in ensuring that an individual can do their job successfully. For people living with physical disabilities workplace accommodations can be categorized in a particular way; accommodations that address physical barriers and enhance workplace and work area accessibility or physical/technological modifications, accommodations that increase workplace flexibility and autonomy of a worker or workplace flexibility accommodations and accommodations that promote workplace inclusion, integration or social accommodations(24). All accommodations are crucial to the workplace for individuals living with any type of disability.

Evaluation

Evaluating assistive technology is an important process in ensuring that it is serving the functions that it is designed and required to do. There are many reasons why evaluating assistive technology is significant. One of the reasons is gaining the perspective of the user's experience can help people better benefit from their assistive technology and avoid circumstances such as individuals abandoning their technology due to low satisfaction(25). This is vital as there needs to be a connection between the individuals using the technology and the

development of the technology in order for it to be truly effective. User satisfaction can be seen as one of the most important aspects of why an evaluation is needed(26). Matrices designed for evaluation are an innovative approach to assessing devices as it explores important factors to the population using the device and then uses a ranking system to determine its satisfaction level or usefulness(26). It is important to conduct evaluations because the devices and products are designed to assist individuals who may not be able to carry out these functions without it. Due to this, when it comes to evaluation tools being used to develop assistive technology, being rooted in the end user's priority will ensure that the technology is being made with the individual's needs and values in mind(25). Different frameworks and processes are used to carry out these evaluations.

One useful measurement of effectiveness is the Usability Scale for Assistive Technology which measures the usability and efficiency of the assistive technology used by individuals with disabilities within their workplace with the assigned work tasks they are required to complete(27). This would allow for any issues that may arise to present themselves and therefore give a more in depth of potential malfunctions in the use of the assistive technology. The framework aims to address the barriers and acknowledge the strengths through the monitoring of the interaction between the individual and their assistive technology device(27). Doing so may provide insight into how the employee uses their technology, how they interact and the outcomes of that interaction whether it is positive or negative. This evaluation framework takes a systematic approach in determining assistive technology usability by taking into account the assistive technology and its support it provides, the skillset of the employee using the device and the degree of the accommodations being provided to each task, ultimately determining the effectiveness and usability of the assistive technology device(27). This is just one evaluation framework that can be useful in understanding if an assistive technology is functioning properly to best serve the client.

Another evaluation method is the User evaluation technique in which the individual evaluating the system receives an introduction to the system and then a short 5-minute training period before evaluating it(28). This was undertaken using a speech-based text correction tool which was designed for individuals experiencing or living with visual impairments.

The purpose of evaluation is to determine the degree that an assistive technology efficaciously encourages participation, remedy impairments and alleviates the limitations that may come with living with a disability(25). Evaluation can also be done within the workplace by organizations, managers and employees. This type of evaluation was done within Italy where a number of companies were evaluated to gage the accessibility levels of information and communication technologies for employees with disabilities(29). Evaluations such as these, can provide an insight into the actual workplace and the perspectives of both manager and employees, going beyond the actual technology itself.

Evaluations can also be undertaken on a specific product or technology to measure its effectiveness, usability and user satisfaction. This can be seen in the evaluation of the Smartphone Screen Reader VoiceOver where the user's experience with the technology was

documented and strengths and weaknesses were identified such as the importance of training and functional improvements that could be made(30). As well as Shuffle speller, where participants engaged in evaluating the device by using it in a controlled environment completing a series of tasks to gain effectiveness(31).

Evaluating a specific product or device can allow for greater understanding between the interaction of the individual and the technology. This was displayed within introducing "communication stories" to workers with alternative communication and their conversation partners, through this assessment major themes were identified such as the apparent impact of sharing Communication Stories on participants, supposed influence of watching Communication Stories on workplace supervisors and job coaches and the general impresses of the Communication Story as a self-advocacy tool for supportive positive workplace connections(32). In this circumstance the device got to be evaluated and assessed by not just the user, but also the individual who would be engaging with the user. Similar to this, Evaluations can also take place as the individual is using the device in real time. This can be seen with using an AML framework within a device such as real time speech to sign translation as it is able to provide contextual data and as well gain user satisfaction through eye tracking(33). This allows for the device or system to be catered to the individual using it, as it grows to understand and learn what works and what does not as the user engages with the device. All forms of evaluation make great contributions to better improving assistive technology in the future. In order to create assistive technology that best suits the needs of individuals with disabilities it's important to take the time to evaluate from all angles to gain the most knowledge.

Case studies

The alarming rate of unemployability among people with disabilities necessitate the presence of assistive technologies and/or compensatory strategies in pursuance of a better and easier integration in the workforce. A 2012 examination of the text presents a similar focus (34) where they conducted two case studies (Michael and Ben) who are visually impaired individuals :('that is, when vision is not satisfactorily corrected by spectacles/lenses'). Michael, a 50-year-old male, who sustained a cerebral thrombosis (stroke) that resulted in right homonymous hemianopia, prior to his stroke, worked as an electrician. However, due to the impact of the stroke on his vision, he could not pursue the same job. Through a number of Vision Australia's services Michael was able to land a long-term employment in the field of business administration. The second individual was Ben, a 25-year-old male, who had low vision due to Stargate's disease which affects central vision. He was a manual laborer. However, the incident warranted the change of profession to a chef after profiting from Vision Australia's Employment services. Exploiting the skills these individuals had was a crucial step in the employment strategy. Interests, previous work and educational history, Medical, psychosocial, and physical/environmental needs and interpersonal skills are also important considerations during the planning process.

The study included a number of assistive technologies that facilitated the integration. First, Michael benefited from screen enlargement software. Also, A task lamp at his workstation

provided added illumination for writing quick notes and viewing the telephone keypad. The edges of the steps of the stairwell to Michael's office area were painted with a contrasting strip to improve their visibility.

Vision substitution strategies can also contribute to the types of compensatory techniques, Ben, For example, needed a variety of "talking" products including talking kitchen scales that measured and announced the weights of ingredients, a talking food thermometer that measured and announced cooking temperatures and a talking timer that announced time. He also used a video or electronic magnifier to easily view and follow recipes. In addition, the study emphasized the importance of the independent and safe travel skills where getting to/from work and moving about/within the workplace is often taken for granted by people who are fully sighted.

Farooq, Aasma and Iftikhar presented a similar focus in their recent study of the text (35) divulging the importance of assistive technologies in the life of people with disabilities and their families. A sample of 200 hearing impaired students was selected in this case study to identify the assistive devices used by hearing impaired students and determine their effectiveness. They found that *"Among different forms of high- and low-tech assistive technologies, hearing aids, cochlear implants, vibrotactiles, loop, infrared and F.M systems are most used by children with hearing impairment."*(35)

After analyzing the data collected, the results were that most of the students (60%) used Hearing aid and a few used Cochlear implant (10%), less than 10% were using Vibrotactiles, Loop system, FM system, Infrared system and 15% were using more than one device. The study conceded that some are more affordable than others and there is a clear difference between those who use high-tech ATs versus low-tech ATs. But the outcome of using either one of them is still significantly positive.

In another case exploring clients who are living with tetraplegia's experiences in using assistive technology for computer access, important information was identified. Many individuals engaging in the study discussed benefits such as completing tasks independently, finding meaning and control in their life, overcoming physical barriers and becoming social (Folan et al., 2015).

Unfortunately these case studies were focused on supporting people with disabilities in the workplace, away from home, which is the focus of this scoping review. However, they are included here to provide insight into what is possible.

Barriers & challenges

There are several barriers and challenges which present themselves when an individual living with a disability is trying to access employment and assistive technology in the workforce. These barriers and challenges are widespread and are seen all throughout the world. They can be centered around both access to the proper technology and accommodations and as well due to the issues that arise in working virtually. Some barriers specific to teleworking include lack of

sufficient training, poor support, and inadequate job counselling for individuals with disabilities (Schopp, 2004). Difficulties in working from may make these positions less frequent or result in an individual having to be in the actual work environment and access other accommodations. Furthermore, obstacles in the work environment may make it so individuals who are seeking assistive technology may not be able to have access to significant devices or tools which they need in order to function or carry out different tasks including work. A significant barrier includes the cost of these assistive devices, most notably relatively "high tech" solutions such as computer technology and robotics(36).

Another barrier is the market in which assistive technology is developed for and the way in which it can become restrictive and limiting in its transparency of the devices effectiveness. Assistive technology is regularly developed for a smaller market therefore it can become isolated from the larger realm of technology markets, due to this issues with the technology often are only discovered once they are in actual use(36). Eligibility requirements can also have a significant impact on access to Assistive Technology. This can take place when programmes are offering funding but an individual must meet certain criteria, if one does not meet the criteria they will not gain access to the assistive technology(37).

These issues can be heightened in places such as Canada where legislation and policy can dictate decision making regarding assistive technology services. In Canada there is no federal universal legislation which pertains to assistive technology funding and services therefore the responsibilities fall onto the provincial level(37). This can add difficulty as there is different legislation within each province. As well, government programs are often viewed as a last case scenario therefore an individual seeking assistive technology must go through avenues such as private and workers insurance before accessing government funded programmes(37).

Additionally to barriers within accessing and using technology itself, there are also social barriers as well. Issues such as stigma, misconceptions, stereotyping and lack of appropriate accommodations can impact individuals living with disabilities ability to do their work effectively or even gain access to suitable employment(36). Further, these barriers can take form in a legal sense as well. In places such as the United States, disability laws have been structured on an anti-subordination approach which restricts individuals in retaining rights to those that are legally defined within that class of people and can prove such belonging(38). This may leave out a whole group of people who are trying to access assistance but may have not gone through a formal process or assessment of some kind to classify as having a disability. Additionally, under the disability laws factors such as "undue burden" make it possible for organizations or companies to not provide requested or required accommodations if it is deemed not financially or practically reasonable(38). This leaves what is considered necessary to perform a job task up for debate and can be very harmful to workers who are living with a disability and require an accommodation to perform their job.

This could have a large impact on the individual and their comfort and confidence within the workplace environment. Other barriers for individuals living with a disability accessing work which were discussed included factors such as lower skill levels and job applicability, expenses

of assistive technology, government role with disability issues and non compliance with policies, confusion amongst definitions of disabilities and suitable accommodations, fear of disclosure and perceptions from others, negative organisational attitudes towards the disability issue and poor attitudes of individuals with disabilities(36).

These can be significant barriers for someone which will increase the difficulty and challenges they experience in the process of being able to obtain and maintain employment. Specifically individuals with visual impairments face barriers within the workplace both using the assistive technology and being able to work with others. Collaboratively, assistive devices such as screen readers have issues accessing websites and being descriptive on social media websites(39). This could make it difficult to work with another individual on a project or within the workplace. Furthermore, when using the actual devices complications can arise that cause difficulty. Some of these challenges include factors such as when a visually impaired individual is using different screen readers across platforms and technical issues arise making it difficult for the screen reader itself to be universally accessible(39). These can be significant barriers for someone which will increase the difficulty and challenges they experience in the process of being able to obtain and maintain employment. Specifically individuals with visual impairments face barriers within the workplace both using the assistive technology and being able to work with others. Collaboratively, assistive devices such as screen readers have issues accessing websites and being descriptive on social media websites(39). This could make it difficult to work with another individual on a project or within the workplace.

Furthermore, when using the actual devices complications can arise that cause difficulty. Some of these challenges include factors such as when a visually impaired individual is using different screen readers across platforms and technical issues arise making it difficult for the screen reader itself to be universally accessible (39). This all can be related to larger issues which pose challenges for users with disabilities trying to access and use assistive devices. As the world moves forward with technological advances there are a lot of positive changes being made but there remain aspects that continue to pose potential difficulties in areas such as augmentative and alternative communication devices.Countries can learn from the experiences of others. For example, The USA could learn a lot from the EU in the provision of telework for people with disabilities(40)

Challenges that need to be addressed are factors such as keeping a focus on communication not just the technology itself, developing innovative approaches to the assessment and intervention of the AAC, ensuring easy access to AAC, and to maximize the solutions for AAC to support a larger variety of individuals(41). Lastly, there are challenges surrounding the knowledge between research and technology development. Some of these challenges include marginalization of individuals, focus on research-driven developments in technology, lack of technology developers such as researchers, engineers and technical developers and the gap between the research and everyday practices(19). As the challenges and issues individuals face become more complex, the technology must be able to adapt at the same time. If this does not happen then it creates a divide and does not suit all individuals who may be in need of assistive technology.

Classification of assistive technologies

Assistive technologies and products are useful in helping individuals with disabilities in many aspects within their lives. Classifying assistive technologies into different categories allows for a better understanding of the technology itself and what it is designed to do. Products and technology can often be categorized as medical, assistive or universally designed(42). These three categories help distinguish the products and technology from one another. Qualifiers can be used to stipulate the level of severity when it comes to the impairment and quantifiers can express the domains and physical environments of use(42).

Each category of technology and product has a different function for use. Medical products and technology are designed to assist in replacing body functions or structures and are a suitable option for individuals with full or severe impairments, making them deemed to be medically necessary(42). This technology could be important in assisting people who have health issues or impairments where their physical body is not functioning at normal capacity. Assistive products and technology are designed to restore, enhance or compensate functioning or irregularities and are suitable for individuals who have a severe to moderate impairment(42). For individuals living with disabilities these assistive devices can provide independence and assist in daily functioning, making it easier to take part in things such as work. Universally designed products and technology are suitable for all impairments, movement limitations or partaking limits due to physical environmental factors(42). This makes it possible for all individuals to access these products and technology.

Other classifications of assistive devices can be categorized based upon their function on or within the body and whom they are used by. Intrinsic health state assistive technology devices are implanted and they are significant to an individual's functioning due their replacement of a body function or structure(43). This can assist people living with disabilities by providing them with the device that will improve their quality of life. These types of assistive technology devices remain with the individual at all times in all environments and they become a part of their daily living(43). Parallel to these devices are the Extrinsic health state assistive technology devices which are not implanted but remain a crucial part of an individual's functioning by reinstating, supplementing or recompensing for body functions or structures that could be impaired(43). Although these devices are not permanently connected to the individual they play a vital role in assisting them in their lives.

Other classifications include both disability and cross disability specific health related state assistive technology devices. Disability specific are utilized by particular groups and enhance functioning through the restoration, augmentation or compensation of bodily functions or structures that have been impaired(43). This may pertain to a certain group who may be living with the same type of disability who would benefit from the same or similar devices. Cross disability has a similar classification to disability specific but is designed for individuals who may have multiple types of disabilities or belong to populations that are marginalized(43).

The classifications of devices make it easier to comprehend and understand what and who assistive technology is made for. Additionally, access technologies are often used for individuals with complex communication needs or severe motor impairments and can be devices or methods such as movement sensing devices, BCI, eye tracking and switch scanning(44). The different classifications of devices allow for a more concrete description and understanding of what devices do, who they may be designed for and how they potentially work.

Workplace accommodations

Workplace accommodations are different measures that can be put into place in order to assist individuals living with disabilities in their work tasks, environment and day to day functioning. Reasonable accommodations are crucial for individuals living with disabilities to carry out essential job functions(23). This gives individuals the resources they need to be able to be involved and eligible in the workforce. These accommodations can often be categorized in ways such as assistive technology and specialized equipment, variations in the work environment, adapted job requirements, changes in workplace policies and human assistance(23).

Reasonable accommodations can refer to arrangements such as accessibility in the work environment, technical redesign of the work space, assistive devices and technology to help with tasks, reorganization of the function and process of the work being done and personal assistance(6). Implementing these different factors into the workplace can make it easier and more manageable for someone to do the work that is required of them. As well it can make the work space a more inclusive environment. Specific examples of accommodations include footrests, ergonomic chairs, modified keyboards, augmentative and alternative communication mouth sticks, arm splints, large print and written information, changes in workplace policy, changes in hiring or interview procedures, alternative work protocols and human assistance in the workplace(23). All of these accommodations are designed to make a task easier and reduce barriers for individuals living with disabilities engaging in work. To ensure successfulness in administering reasonable accommodations there should be a cohesive balance of four interventions including ensuring accessibility, creating an enabling environment, interventions in place for reduction or containment of disability and interventions for minimizing risks (6). These interventions will help ensure that all measures are being put in place to address any potential problems that could present themselves. As well it gives individuals needing accommodations options when it comes to how they would like to access assistance. It is said that this can be done through individualized assessments where working tasks, environment, risks and accommodations are assessed(6). Doing so provides a comprehensive outlook on the benefits on implementing accommodations and why it is necessary within the workplace for individuals with disabilities. Accommodation solutions can be categorized as universal; which means that are common to other works but help because of an individuals specific limitation, adaptive; which means changes made to the environment, help or assistive; aid being provided by other human beings or assistive technology; using a device(5). Some of these accommodations can be solutions that were already existing in the work environment or that can be specific to a certain disability or task, it is all depending on what job is required and the person's ability level.

Accommodations such as mobile assistive technology can provide blind workers with efficient and innovative ways to complete their jobs and create independence in the workplace(45). For this specific disability, assistive technology is suitable and useful in aiding the worker. Another useful workplace accommodation for individuals with visual impairments include the combination between mobile and enabling IT (ME-IT), which has been proven to provide the individual with new capabilities such as reading text on the fly, understanding the visual properties of people and things in the workplace, getting used to the physical work environment, acknowledging objects in one's work environment and locating things in the work environment(46). This makes it easier for the person to function within their work environment both mentally and physically. This may vary depending on what line of work someone is in as each job does require different skills and functions to perform. For example, communication stories are a specific tool designed for individuals with complex communication needs which engages the user and their communication partner and can be used in the workplace(47). The communication stories can be developed on the individual's personal Idevice, compiled through pictures and videos, that can be shared with others, such as a boss or co-worker, to make workplace communication more accessible(47).

Other forms of accommodations include things such as job restructuring, supported employment, customized employment and vocational rehabilitation for workers who have injury or who have previously been injured(24). These options focus more on the way in which expectations can be managed differently to suit the individual and their needs. As well this can be done through workplaces and their staff being supportive of the individual working with a disability(24). Specifically this could look like offering the training and resources needed for the individual to feel confident and comfortable in doing their work. Programs such as PROMOTE, a 40 hour per week, 4 week training program, have individuals attending lectures, completing exercises and doing projects to give individuals with visual impairments the proper training and skills to prepare them for the workplace(48). This is a very proactive approach in accommodating individuals with disabilities in the workplace as it ensures they are feeling prepared before they even enter the workforce. Much of these accommodations are set within a workplace environment. However, they could readily be applied in the home to facilitate remote working.

Consultation with Knowledge Users (2)

As stated above,[4] we identified our advisory committee members by conducting research into assistive technology contributors such as professionals in the field, authors and organizations within Canada. We held two advisory committee meetings, one which took place in February 2021 and the other in July 2012. At our first meeting we explained the study to our advisors and gained new perspectives and knowledge going forward with the research. Through this we were able to attain valuable insight that helped us broaden our research tactics to gain a more in-depth variety of papers. Databases, journals and key search words were brainstormed and shared helping us discover new research avenues.

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[4] Consultation with Knowledge Users (1)

During our meeting in July we summarized and reported the results of our research to the advisory committee members by sharing our draft report. We gained insight and recommendation regarding future policy and practices as well as direction for future research in this area.

Before our second meeting we additionally identified two Knowledge Users: Dr. Peter Smith and Laura Smith. Dr. Smith participated in the July meeting and both he and Laura commented on the final draft report. Dr. Smith is a parapelgic and Laura is blind.

Implications (for policy, practice or research)

Discussion

While the thematic analysis enabled us to get a handle on the papers our Advisory Committee really liked the classification that the World Bank used in their Briefing Report(1) and consequently for the purpose of discussion we are using the three categories identified in Figure Two: Completing work tasks, Communications and interactions, and Schedule and process flexibility.

Completing work tasks

This category encompasses document processing, using the web, and accessing information which can be readily addressed through the provision and use of electronic documentation (rather than paper), the use of text-to-speech, voice recognition, magnification, Braille displays, optical character recognition, and other accessibility features. Many of which cost less than US$500(12,13).

Communications and interactions

Communicating with clients and colleagues form the basis of this category. Desktop and mobile instant chat platforms and real-time displays facilitate communication for people with hearing and speech impairments. Text and video telephones can facilitate internal and external phone calls via the use of an interpreter. Live captions can be offered with webcasts and video conferences.

Schedule and process flexibility

The ability to accommodate needs for breaks and schedule medical provider visits speaks to the schedule and process flexibility needed. Remote work platforms allow employees schedule flexibility. Mobile devices facilitate anytime, anywhere work and employees can work from physically accessible and convenient locations such as their own home.
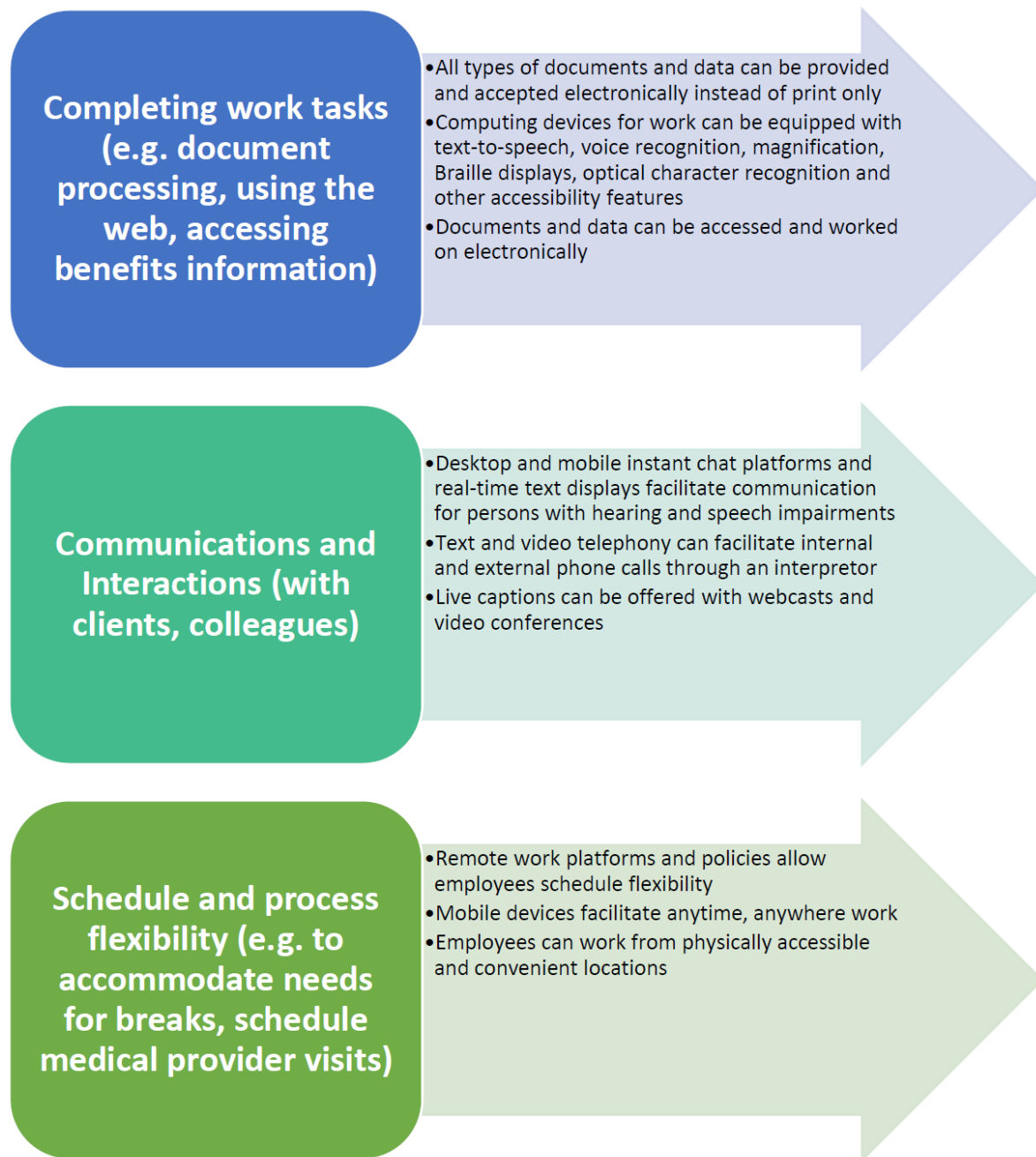
Completing work tasks (e.g. document processing, using the web, accessing benefits information)

- All types of documents and data can be provided and accepted electronically instead of print only
- Computing devices for work can be equipped with text-to-speech, voice recognition, magnification, Braille displays, optical character recognition and other accessibility features
- Documents and data can be accessed and worked on electronically

Communications and Interactions (with clients, colleagues)

- Desktop and mobile instant chat platforms and real-time text displays facilitate communication for persons with hearing and speech impairments
- Text and video telephony can facilitate internal and external phone calls through an interpretor
- Live captions can be offered with webcasts and video conferences

Schedule and process flexibility (e.g. to accommodate needs for breaks, schedule medical provider visits)

- Remote work platforms and policies allow employees schedule flexibility
- Mobile devices facilitate anytime, anywhere work
- Employees can work from physically accessible and convenient locations

Figure Two: How ICT addresses barriers to labor market participation for persons with disabilities (1 Page 13)

Policy, Practice & Research Implications

Sundar's 2017 study found that of 433 different types of accommodations made, 40% were related to assistive technology, 9% to policy changes and just 5% to human assistance(23). This is suggestive that the role of assistive technologies is a trend that continues to increase with time. Consequently, as a result of this scoping review there are ten recommendations for policy,

practice and research in the area of digital assistive technologies for remote working by people with disabilities:

1. **There is a need for specific training programs in the use of assistive technologies by people with disabilities**. As an example, a targeted training program, ProMOTE, demonstrated that a small investment (the provision of a 4 week training course) resulted in over half the participants becoming employed as a direct outcome from the program(48). Additionally, there is a need to incorporate assistive technology tools into vocational training(16).

2. **Organisations should explore the use of assistive technologies to further support their workforce.** Assistive technologies have been proven successful at improving work performance for people with disabilities by improving their self-confidence, autonomy, independence and quality of life. Morash-Macneil et al undertook a systematic review of 10 papers concerning the use of Assistive Technology for Individuals with Intellectual Disability in the workplace and demonstrated that assistive technologies are successful in improving work performance with *"respect to productivity, navigation, time management, and task completion."*(15)*.* Additionally, there is some evidence that assistive technologies tend to reduce the burden of caretakers and therapists. That they improve self-confidence and help people with disabilities to achieve greater autonomy, independence, and quality of life(5,18,26).

3. **Evidence is still needed regarding the use of assistive technologies in the workplace and specifically in the home for remote working.** Sauer et al's systematic review and Padkapeyeva et al's synthesis demonstrated that there is very little evidence supporting the use of assistive technologies(22,24) for people with physical or cognitive disabilities(16). It is notable that in our review we only found a single paper concerned with assistive technologies being used in the remote workplace (home) by people with disabilities(40)..

4. **Significant and unique barriers have to be identified and addressed.** Improvements from the use of assistive technologies come with significant and unique barriers that have to be overcome(19,27,39,44).

5. **Organisations need to comply with existing policies.** Some companies, despite participating in a Code created to encourage the employment of people with disabilities in South Africa, were found to employ very small numbers of people with disabilities and didn't focus on them when developing policies and practices(36).

6. **More research is needed into the issue of unmet needs by people with disabilities**. There is an increasing awareness of unmet needs(5) but little is being done to address them(37).

7. **Research and development into assistive technologies needs to be invested in.** Assistive technologies are not a one size fits all proposition. They must be chosen carefully and customised to the individual(17). In general they could be much better disseminated(29) and their research and development needs to make the most of effective communication between all key stakeholders including people with disabilities themselves(25,41).

8. **Workplace assessments are required in the home setting.** Workplace assessments should include ergonomics alongside physical, cognitive, and organisational concerns(49) and risk assessments(6). Augmentative and alternative communication (AAC) appears to be leading the way in such research and development(20,21,47,50)

9. **Further work in the classification of assistive technologies is required.** In order to optimize the use of assistive technologies classifications would be helpful. Various approaches have been suggested including task-based(14) , multidisciplinary(42,43)

10. **Large scale studies of digital assistive technologies are needed**. Specific technologies are being researched, such as devices to assist with hearing impairment(35), visual impairment(46), tetraplegia(51) but with very low numbers of participants. For example Khan's study of a speech based text correction tool had just five participants(28), Smaradottir et al's evaluation User Evaluation of the Smartphone Screen Reader VoiceOver with Visually Disabled Participants had just six participants(30). Improving to a degree was Peters et al's study which had thirty-seven participants(31) and Wentz and Lazar's study of the usability of email applications by blind users(52). More commonly studies have less than 10 participants (32–34,45)

Conclusions

As stated earlier, the Canadian Survey on Disability, undertaken in 2017, reported that among those with disabilities aged 25 to 64 years who were not employed and not currently in school, two in five had the potential to work(2). Within the disabled community the opportunity for using digital assistive technologies to enable remote working is widely discussed. However, historically many employers have determined that it's an "undue hardship" to make such accommodations.

However, in the spring of 2020 the world changed. With the impact of the COVID pandemic many organizations sent their employees home to work remotely without any prior planning or forethought. At this time, many employees continue to work from home enabled by digital assistive technologies. Consequently, for the first time people with disabilities can come to the same table in search of employment.

Therefore, it is time to inventory digital assistive technologies to make it easier for companies to accommodate the disabled. This inventory will be undertaken as the next phase of this study and will be released as a public-facing online accessible database in the fall of 2021.

In conclusion, the use of assistive technologies in the remote workplace is under-researched and under-developed. Much work needs to be undertaken to really demonstrate the effectiveness and cost/benefit analysis of employers' provision of such technologies for their employees. Notably, given the focus of our original research question we found next to no evidence for the use of assistive technologies in the home for remote working. While there is certainly evidence that such technologies are beneficial in the home or in an office based workplace, research into their application in the home-based work environment is significantly lacking.

Knowledge Mobilization Activities

This scoping review had four main objectives of: 1) Summarizing key concepts and terminology and provide criteria for future reporting; 2) Inventory of all available digital assistive technologies; 3) Evaluation and synthesis of available evidence related to effectiveness and utility of available technologies; and 4) Provision of recommendations for future research and development. Fundamentally, this study aims to improve social inclusion of people with disabilities within the workforce.

This report fulfils objectives 1, 3 and 4. Objective 2 will be met through the development of a public facing online database that will match assistive technologies with different types of disabilities making it easier for employer and employee to identify the specific assistive technologies that will meet their needs. The work for this database is currently underway and will be launched in the fall of 2021 at INSERT WEB ADDRESS.

Following submission of this report and accompanying Evidence Brief to the Social Sciences and Humanities Research Council and the Government of Canada's Future Skills program the report will be rewritten into several research papers and submitted for academic publication. An abstract of the study has already been accepted for poster presentation at the Northern Health Research Conference in the fall of 2021.

Additionally, when Algoma University put out a press release about this study being funded it was picked up by the media as detailed in Appendix Five. We will follow this up with a subsequent press release, in due course, reporting on the results of this study.

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Appendix One

Additional search recommendations

Received from Advisory Committee meetings held on the 26th February 2021.

- Clarify how we define work to better understand research direction
- Explore range of tasks that would be done at work
- Hybrid work vs remote work
- Telehealth modalities (define concepts of the work done up to date)
- ATIA digital Siri, google etc. voice activated and environmental controls
- AT journal
- Include journals in search strategies
- Full range of disabilities
- Assistive technology journal
- Disability and rehabilitation journal
- Disability and rehab assistive technology journal
- People with lupus, arthritis, MS
- Consider different forms or categories of disabilities
- ESDC uOttawa fitness to work for persons with disabilities
- Ethical and legal issues
- Adaptive technology
- Search terms may want to include Complex Communication Needs (CCN),
- Augmentative Alternative Communication journal
- articles that discuss covid on participation
- Participation or exclusion (mention of disabilities)
- Wong et al (2021) systematic review:
- https://link.springer.com/article/10.1007/s10926 020 09954 3
- https://www.nfb.org/images/nfb/publications/jbir/jbir15/jbir050202.html
- https://kuscholarworks.ku.edu/bitstream/handle/1808/14588/Muller_ku_0099M_13290_
- DATA_1.pdf;sequence=1
- the link is to a 2014 dissertation: A Look at Employment for Adults Who Use
- Augmentative and Alternative Communication
- https://eric.ed.gov/?id=EJ526009
- Mouth device for wheelchair
- Otter (attachment to teleconferencing) capture meeting in real time, keeps it in notes setting for those who can't access can view or read transcription
- Health literacy
- Closed captions
- Visibility
- AAC for communication
- Communication functions for individuals
- Communication assistance

- Speech language pathology
- ASHA journal
- Alternative communication
- ALS
- Barriers to communication
- Communication and writing aids service

Appendix Two

Email from Dr. Jeffrey Jutai

Subsequent to the Advisory Committee meetings held on the 26th February 2021.

RE: Search strategy:
1. Search in journals that typically include articles on assistive technology, such as Assistive Technology and Disability & Rehabilitation (include Dis & Rehab: Assistive Technology, and also the journals Occupational Medicine and Work.
2. Search in disability (and chronic condition) specific journal such as Arthritis Care Research and Multiple Sclerosis

- The systematic review by Wong et al (2021):
- https://link.springer.com/article/10.1007/s10926 020 09954 3 cites research studies concerned with allowing employees who have a disability to work from home or work from a remote location (partially or fully):
- Al Dhanhani AM, Gignac MA, Beaton DE, Su J, Fortin PR. Job accommodations availability and utilization among people with lupus: an examination of workplace activity limitations and work context factors. Arthritis Care Res. 2015;67(11):1536–1544.
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- Benedict RH, Rodgers JD, Emmert N, Kininger R, Weinstock Guttman B. Negative work events and accommodations in employed multiple sclerosis patients. Mult Scler. 2014;20(1):116–119.
- Gignac MA, Cao X, McAlpine J. Availability, need for, and use of work accommodations and benefits: are they related to employment outcomes in people with arthritis? Arthritis Care Res (Hoboken). 2015;67(6):855–864.
- Varekamp I, van Dijk FJ. Workplace problems and solutions for employees with chronic diseases. Occup Med (Oxford). 2010;60(4):287–293.
- RE: person who have intellectual and developmental disability, consult Dr. Virginie Cobigo at uOttawa (Virginie.Cobigo@uottawa.ca) who directs the OPEN social enterprise and consults for ESDC (Employment and Social Development Canada on assessment of fitness to work for persons with intellectual and development disability.
- You might want to read articles by Paul T. Jaeger on the accessibility of the internet (websites) for persons with a disability and consider the implications for working remotely.
- You might want to consider ethical and legal issues: e.g. book by O'Reilly, Arthur (2007). The Right to Decent Work of Persons with Disabilities.
- Also, Lang R et al (2011). Implementing the United Nations Convention on the rights of persons with disabilities: principles, implications, limitations and driving the

implementation of the UN Convention on the Rights of Persons with Disabilities: Principles, implications, practices and limits. Alter, 5(3).

Appendix Three

Keywords & Search terms used

Digital Assistive Technologies, Disabled, Disability, Workplace, Remote working, Assistive Technology, Assistive Devices, Information Technology, Digital Technology, Digital Electronics, Teleworking, Work, Communication aids for disabled, Disability studies, Persons with hearing impairments, Disabled persons, Hearing aid, Electrical assistive technology, Electrical assistive devices, Assistive devices, Visually impaired, Hearing impaired, Physical disability, Intellectual disability, Deaf, Blind, Mute, People with disabilities, People living with disabilities, Disabled person, Developmental disabilities, People living with developmental disabilities, Able bodied, Office, Workforce, Job, career, Work environment, Work from home, Building, Company, Organization, Foundation, Distant work, Distant working, Isolated work, Isolated working, Visual Impairment, Auditory, Non verbal communication, Non verbal, Text to speech, Talking spell checker, Text magnification, Subtitles, Captions, Closed captions, Learning assistive technology, Assistive learning device, Assistive technology, Assistive learning systems, Secluded working, Secluded work, workplace accommodation, Employment, Personal Assistive Services (PAS), Accessibility, Human centered computing, Rehabilitation, Assistive technology Solutions, American with disability act (ADA), Tools, Cognitive disability, Vocational DATs, AT use in workforce, Available DATs, Mobile assistive technologies (MAT), Blind workers (BW), Social inclusion, Person environment fit (P E fit), Mild disabilities, Sensory deficiency, Motor disability, DAT provision, WHO Assistive Products List, Employment exclusion, Global Research, Innovation and Education on Assistive Technology (GREAT) Summit, Global Collaboration on Assistive Technology (GATE) program, and Employment barriers.

Appendix Four

Summary of papers

Table Two: Summary of papers included in the Scoping Review

Type of Technology	Purpose	Description	Target recipient / group	Limitations
Computer skills training program (ProMOTE)	Preparation for the workplace	(Leo et al, 2017)(14)ProMOTE developed by NIB is a a training program designed to help visually impaired people in the workspace.(40 hour per week , 4 weeks training)	Visually impaired	
Augmentative and Alternative Communication (AAC)	Communication for paralysis	(Elsahar et al, 2018)(20)"TALK" uses distinct inhalation and exhalation breathing signals together with a low-cost micro-controller board to encode messages through Morse codes -"Dasher" is a text-entry tool available on several operating systems. It uses input from a mouse (or other means or belt) to manipulate a cursor on a screen to steer towards alphabetical letters and start writing	Both are for paralysis sufferers and individuals in locked-in syndrome.	DASHER : the inhalation and exhalation movements used for the expansion and contraction of the belt could be restrictive. TALK: the need to input letters to form words infers slow conversational rates
Speech Generating Devices (SGD)	Improve communication, enhance quality of life, increase opportunity, ensure appropriate	(Light & McNaughton, 2013)(53) AutoCom is a display of letters on the screen of a laptop but with no modification to the original nonelectronic communication boards Quote :*" Essentially we are running apps reflecting designs from the 1980s/1990s on cutting edge 21st century hardware"* AAC improvements	Complex Communication Needs	More research is required to understand and develop new AAC devices that better suit the user --All these SGDs require a better user-focused approach other than fitting the disabled with devices

	AAC systems are being used, improve AAC devices	-Use of white background in grid displays instead of color to improve performance and communication -Vertical layout instead of horizontal or diagonal to better suit the AAC user -Visual scene displays instead of grid displays as they offer more advantages to the AAC user		available, because of the different skills each has.
AAC (Access technologies)	Develop new access technologies that are user friendly, accessible and efficient	(Fager et al, 2019)(44) Wearable sensor system - 3D movement sensing technology that learns the users movements eliminating the need for precise positioning Matrix speller - BCI system using alphabetic grid RSVP Keyboard - BCI system using a rapid serial visual representation of individual letters to improve accurate letter selection Shuffle Speller - BCI system using a shuffle method of letters based on probability Berlin BCI - BCI system presenting letters in a circular motion Eye tracking and switch scanning device - User focuses with their eyes to target specific word or letter and then activates switch to then scan words or letter Supplemented Speech Recognition System - Speech recognition system that is customized to the users individual speech capabilities using word prediction, language models, large vocabulary speech recognition algorithms and first letter supplementations Smart Predict App- AAC application resembling a spelling device that allows users access to traditional AAC keyboard but as well have access to communication partner app that assists in communication	Neurological Conditions	More research required

AAC	Alternative communication	(Higinbotham et a, 2012)(21) Natural language processing - computer algothrithyms focused on human language Word predictions - Speech recognition -	Augmentative and alternative communication, complex communication needs	
AAC	Make AAC more accessible and progressive, easier to attain and more sustainable for clients	(Light & McNaughton, 2012)(50) Mobile technologies- Touch screen phones Ipads Software applications for phones	Complex communication needs	More research, not guaranteed to be effective with each clients specific need
AAC	Modernize AAC through the use of Ipads	(McNaughton & Light, 2013)(41) Ipad - use of Ipad instead of traditional AAC devices to modernize, increase social acceptance and awareness, empower users, increase AAC technology, improve functionality and connection and promote development and research of AAC	Developmental disabilities, acquired neurogenic disorders and degenerative neurological conditions	
Communication Stories	Support communication between employee and employer, help individuals feel confident and	(Müller et al, 2018)(32) Communication Stories - A self administered tool used for individuals with intellectual disabilities/autism to teach others how they communicate by -Providing communication partner with information and modifications to better communicate -actively involving the individual in intervention -increase awareness and knowledge of individuals needs to their employer	Intellectual disabilities/Autism	

	independent in the workplace, assistance for both individual with disability and communication partner	-using AT to share communication story and decrease stigma of AT		
Communication Stories	Assist individual in explaining how they communicate with others, help communication partners understand, supports communication in the workplace	(Pouliot et al, 2017)(47) Communication stories - customized stories created by user to explain how they communicate which can be used with communication partners to share information through their IDevice	Intellectual disabilities and Autism spectrum disorder	
Specific named application (Shuffle speller)	Assists individual with typing	(Peters et al, 2018)(31) Shuffle speller - a customizable algorithm that is adaptable to a users abilities to improve their typing	Severe speech and physical impairment, locked in syndrome, visual impairments	
Speech to sign	Allows individuals	(Otoom & Alzubaidi, 2018)(33) Prototype assistive device - real time speech to sign	Hearing impaired	

	who are hearing impaired to access information online	translation using voice recognition converted into voice stream, translation of text into an ASL sign stream and a sign language animation avatar		
Speech to text	Enables individuals with visual impairments to use speech for writing and editing	(Khan et al, 2015)(28) Speech based text correction tool - A speech to text tool using both recognition and correction modules allowing individuals to write and edit their work using voice commands	Visually impaired	
Speech to text	Assists individuals with visual impairments to use touch screen devices	(Smaradottir et al, 2018)(30) Voice over - A integrated screen reader enabling individuals to interact with the device using gestures and giving speech feedback (in Apple products)	Visually impaired	
Assistive technology Using USAT framework, they reviewed the following ATs through 5 case studies: -mouth stick -Pull out keyboard	Assist individuals with various neuromuscular and sensory impairments.	(Arthanat et al, 2016)(27) JAWS is a screen reader software for text-to-speech feature on a computer. Zoom text program is used for for screen magnification.	Individuals with disabilities	Employers are not ready to provide high tech ATs. Participants do not have an update about the recent updates in the market. Some of the ATs are underdeveloped and need to be upgraded.

-Wheelchair -Left handed mouse -JAWS -Zoom text program				
Assistive Technology	Improve access to AT	(Jakovljevic & Buckley, 2011)(36) Screen readers & Speakerphones	Individuals with disabilities	Little discussion of actual AT technology? (Might not be relevant)
Assistive Technology	Assist with communication, allow user to have autonomy	(Gupta et al, 2018)(18) Moss talk - BangaSpeak - SentenceShaper - NaturallySpeaking - C-Speak Aphasia - Aphasia Scipts - TouchSpeak -	Neurological disorders	Focus on treatment (is this applicable to work)????
Assistive Technology		(Perelmutter et al, 2017)(17) Text to speech - Speech to text - Word processing (Spell and grammar check) - Multimedia and hyper text - Smart pens - Ipad based writing instruction -	Adolescents and adults with learning disabilities	
Assistive Technology there is :rehab robots	It is a statistical analysis of the current (2020) ATs used by the disabled community in	(Beradi et al, 2020)(37)	Individuals with disabilities	The restriction on the performance in the daily activities may not necessitate the use of AT devices. Therefore the statistics might be biased. Moreover, First Nations reserves were not

	canada, with indicating just the type of the AT not specific ones. But mostly talking about assistive health technologies			included in this research, nor were individuals under the age of 15 years. The data used in the research are from the CSD conducted in 2012–2013;
Assistive Technology Blueroof Independence module (BIM) DynaVox V:	Help the disabled(those who have vicual impairment or a communication disability.) be independent .	(Muncert et al, 2011)(26) **DynaVox V** - is a Augmentative and alternative communication that permits the users of internet access being email and text messaging and other applications like speech output and e-book reader (services for all ages for more information :https://www.spectronics.com.au/product/25007 **Nemo Magni** - it s portable device designed to help people with low vision read and write.for more information : https://www.enhancedvision.com/downloads/users-manual/discontinued/Nemo%20User%20Manual.pdf **Pen elite -** allows users to scan , store and transfer up to 1000 pages of printed text to a laptop or any other device using USB or an app (phones) along with a text to speech function https://www.bhphotovideo.com/c/product/505219-REG/Wizcom_Technologies_QLE1000_QuickLink_Pen_Elite_Pen_Scanner.html **SmartTalk -** designed to aid communication through the real-voice playback , it can also Record and playback 48 messages of standard	Warriors in transition, veterans, individuals with physical and mental disabilities and adults age 65 and older. But can help mostly anyone with vicual impairment or a communication disability. Nemo Magni , Pen Elite, SmartView= visual impairment DynaVox V, Smart Talk= communication impairment	Found this website too in the process https://www.toptechtidbits.com/ The adaptability is a major limitation eg for Nemo magni and smartView Some of the products are costly and not portable.

		length of 10s for moreinformation : https://www.specialneedscomputers.ca/index.php?l=product_detail&p=199(26) **SmartView -** it magnifies to help the disabled see text and the environemnt around		
Assistive Technology	Use of computer, potential return to work	(Folan et al, 2015)(51) **Dragon Voice Activation** - is a software that runs on Microsoft/windows and macOS that facilitates access to other softwares in the operating system **QuadJoy -** is a device that uses sip and puff technology to enable the access , control and connection to information on a computer. **Mousegrid -** is a voice activated software in laptops to change to place of the pointer on the screen for those with a motor disability **Trackball Mouse:** are primarily used to move the cursor on the screen. Like mice, computer trackball devices also include buttons, which can serve as left-click and right-click buttons, and may also be used to enter other commands	Tetreplegia, spinal cord injury	Not time efficient.
ME - IT	Assist individuals in performing work tasks and assistance in their workplace environment	(Heath & Babu, 2020)(46) 'Seeing AI' = is an application developed by microsoft intended to help blind and visually imaired people to recognize objects with a QR code on them. Like menus ME-IT -	Visual impairments	AppleVis.com is another site found in the process
Assistive Technology		(Bauer & Elsasser, 2012)(42) Hearing aids - no specific ATs identified	Individuals with disabilities	

		Screen Magnifiers - no specific ATs identified		
Assistive Devices		(Farooq et al, 2015)(35) **the low-tech assistive technologies:** (Hearing aid, Closed captioning, Amplifiers, Signaling devices, Vibrotactiles, Real time captioning, Alerting devices, Infrared system, TDD/TTY) **high-tech devices** : (Loop system, FM system, Cochlear Implant, Computer aided note taking, Screen flash for computers)	Hearing impairments	
(Not technology)	Prepare individuals with visual impairments before entering the workforce to have the skills to perform their job	(Parker, 2020)(48) ProMOTE curriculum	Visual impairment	
Assistive technology	Support individuals with intellectual disabilities while working	(Morash-Macneil et al, 2018)(15) - Axium X30 handheld computer—picture perfect software - Microsoft Pocket PC 2003 second edition software - Video iPod—Pinnacle Studio 10 (2005) Software	Intellectual disability	

		- G-sensor system installed on smartphone - Vibrating watch—calendar clock with time and date, vibration alarm apps - iPod touch—functional planning system app - iPad and iPod touch—first then visual schedule app - iPhone—Layar mobile app and Google maps - Google maps app on mobile devices and AR navigation app		
Assistive technology	Improve performance and skills, increase independence	(Sauer et al, 2010)(16) Picture cues, Picture Prompts, Auditory prompts	Cognitive disabilities	
(Not technology) Background paper		(Raja, 2016)(1) Background paper		
Ergonomic changes to the micro worksite And Assistive technologies	Determining the adequate ATs to the disabled based on a risk assessment which will avoid damaging his or her	(Pigini et al, 2010)(6) **the MATCH system:** is a tool which facilitates focused employment for persons with disability and provide a sepecific interventions that may be excluded for able-bodied workers . **ATs used in the research :**Bluetooth headphone/mic,electric wheelchair ,foot-operated trackball; mouth stick for the keyboard; voice recognition; personalised configuration of theWindows desktop including accessibility tools, Sensor-switches	Physical impairement	The lack of awareness about some working tasks that may expose the worker to efforts that gradually damage his or her physical condition further in the long run.

	physical condition further	interface(145,00 euros), Sunbreaker curtain(100,00 euros),Sound absorbent boards(400,00 euros),Free standing partition wall (250,00 euros), Adjustable ergonomic table (350,00 euros) **environmental accomodation:** The lighting system, re-designing the workstation (furniture and ergonomic changes)		
Assistive technology	Support and create sustainable and effective outcomes for individuals with low vision in the workplace	(Ferronatoa & Ukovic, 2014)(34) Screen magnification, screen reader software, "talking" products	Low vision	
Assistive technology	Support individuals with disabilities	(Tao et al, 2020)(25)Mobility Aids, mHealth, Telehealth, Upper Limb Prosthesis, Wheeled Mobility Device, Cochlear Implant, Wheelchair, eHealth, Manual Wheelchair, Lower Limb Prosthesis, General AT, Hearing aid	Cognitive, perceptual, physical limitations	
Assistive technology, assistive devices	Increase work participation	(Smith et al, 2017)(22) Apple Ipod Touch PDA, Video modeling, Visual Work Systems, VideoTote, Portable electronic AT, Video prompting, Audio prompting, Video and Audio prompting	Various disabilities	
Assistive technology	Support people with	(Bauer & Elsaesser, 2012)(42) Medical technology, Assistive technology, Universal technology	Various disabilities	

	disabilities, impairments			
Communication technologies	Provide inclusivity, workplace accommodations	(Gastaldi, 2015)(29) High resolution displays, screen magnifying software, braille displays, auditory feedback aids, special input devices, voice recognition software, ergonomic accessories, telecommunication devices, special keyboards, touch screens, voice recognition software, joysticks, trackballs	Various disabilities	
Mobile assistive technology	Promote social inclusion, positive job performance and employers perceptions	(Babu & Heath, 2017)(45) **VoiceOver**(AppleVis.com,) MATs along with RFID technology, - **KNFB Reader :**affords capturing and converting printed text to verbal form. -**Digit-Eyes:**creating and reading custom QR codes as a means of embedding accessible notes in the work environment. **the AbilityOne program :**	Visual impairment/blind	Tasks can be error-prone and labour-intensive even when they are accomplished.
Assistive technology/special ized equipment		(Sundar, 2017)(23) TTY or a dedicated sign language interpreter.as headsets or wheelchairs, followed by ramps, automatic doors, and ergonomic chairs,arm supports,communication devices, and computer access devices	Various disabilities	-Strategies such as adjusted schedules; job restructuring and personal assistance were observed less frequently. -the limitation of this study is that only studies conducted in the U.S. were included and caution must be used while

				interpreting results in an international arena.
Assistive technology for visual impairment	Increase accessibility and collaboration in the workplace	(Wahidin et al, 2018)(39) computer enlarging sofware,accessible websites, Screen Reader (Windows,linux, built-in screen readers in phones android and IOS), (braille embosser,braille printerbraille manual typewritera braille watch, a braille display, and a braille notetaker.),Electronic Braille:Braille can be used for various types of applications, from low-tech (e.g. braille typewriters) to high-tech (e.g. braille displays)., VoiceOver (iOS),Eyeglasses, CCTV, Enlarging Software (Windows),Training and tech support,Window-Eyes,ORCA and Emacspeak,JAWS, -**OCR (Optical Character Reader) :**converts printed materials, scanned documents, and image-based PDF files to text documents. -**Audio Player and Recording :**for taking notes or recording a meeting. - **Talking GPS :**to navigate and help them to travel. - **Long White Cane :** helps in detecting obstacles when they are walking.	Visual impairment	-screen readers also have difficulty accessing websites and describing image-rich content on social media sites. -limitations of screen readers in accessing graphs, images, certain layouts, styles, and formats within office documents. -Remote access systems that are poorly supported. -many developers do not follow Web Content Accessibility Guidelines where only 39% of new websites conformed to WCAG 2.0. -Participants reported numerous issues related to keeping their ATs up-to-date. -Participants described the importance of educating colleagues to make them understand the limitations of ATs.

Email and web based applications for individuals who are blind	Address barriers	(Wentz & Lazar, 2011)(52) Microsoft outlook express, Microsoft outlook office 2007, Mozilla thunderbird/Sunbird, Gmail, Hotmail, Outlook web access2007, Yahoo mail classic JAWS 10(screen reader software), Data logging software (REFOG Keylogger),stopwatch, a spell check feature , web-based email applications,	Visual impairment/blind	-Email application features such as the ability to create folders, move messages to folders,manage contacts, and use calendaring are hard tasks for the disabled. -the lack of a logical tab order results in the user losing navigational focus. -web-based applications need more improvement in their features for the disabled. Applications should be examined closely for their usability when they are navigated with a keyboard alone.
Assistive technology "ergonomics workstation assessment conducted for an administrative worker"	Creating workstations that are accessible and functional for individuals with visual impairments	(Long, 2011)(49) Desktop video magnifier, Zoom text, JAWS screen reader, document scanner, Optical character recognition software, document reader/voice note taker, dual channel headset, hand held video magnifier, software for mobile phone wireless computer mouse,Colour coding assistive devices and their respective cables,an articulated arm to mount the monitor,a stand for the telephone	Visual impairment	

Workplace accommodations (Assistive technology)	Identify workplace accommodations that can be used to individuals deaf or hard of hearing	(Haynes & Linden, 2012)(5) Alternate formats (captioning), Electronic communication (text messaging), Signal system (pagers), Sound transmission system, Telephone aid,captioning, FM systems, Infrared systems,co-worker help, "Flexible or adjusted work schedules", PALD which means personal assistive listening device	Deaf or hard of hearing	The most common unmet needs were effective communication in groups and lack of co-worker support. -lack of understanding or knowledge about the effects of hearing loss. -Difficulty with background noise especially in some work environments. -people sometimes are not aware of AT that help or may not feel that their hearing loss is sufficient to warrant an AT -"Flexible or adjusted work schedules" are unlikely to be used
Workplace accommodations (Assistive technology)	Identify workplace accommodations that can be used to individuals with physical disabilities	(Padkapayeva, 2017)(24) Wheel chair(s),Seeing eye dog(s),Cane(s),Crutch(es),Flexible hour(s),Modified task(s),Ergonomic adjustments, **environmental accomodation** : installation of ramps, railings, and automatic doors, changes to floor surfaces, fit-ting doors with ramp handles as opposed to levers or knobs, implementing Braille signage, and equipping elevators with voice-activated controls. a specific training or hiring program designed to recruit persons with disabilities,	Physical disabilities	-insufficient training, lack of knowledge about accommodation options, and inappropriate selection of equipment or technology -lack of aware-ness and ignorance regarding disabilities

		lip reading, sign language,and computer-assisted translators for those with hearing impairments. screen readers Assistive technology, Adapted computers, Assistive software for computers and mobile phones, telephone aids, adapted equipment, tools and personal protective equipment, assistive technology services, workplace technology		
AAC Devices	Increase and support communication	(Light & McNaughton, 2019)(19) Augmented reality, digital image processing, Brain-computer interface, sensing technologies and wireless connectivity, artificial intelligence and machine learning	Complex communication needs	
Assistive technology		(Bauer et al, 2011)(43) Intrinsic HS ATD, Extrinsic HS ATD, Health related state ATD, Disability specific HRS ATD, Cross disability HRS ATD	Various disabilities	
Remote working/telework	Inclusive working, reducing barriers	(Schopp, 2004)(40) Telework, online work,	Various disabilities	

Appendix Five

Press Release: February 2021

CTV News: Interview with Dr. Donna Rogers and Dr. Nicola Shaw

https://northernontario.ctvnews.ca/algoma-university-professor-receives-prestigious-grant-to-support-her-research-1.5305869

Sault Online:

https://saultonline.com/2021/02/dr-nicola-shaw-awarded-social-sciences-and-humanities-research-council-grant/

Sault Star:

1. Printed a brief on Friday
2. https://www.saultstar.com/news/local-news/algoma-u-prof-gets-research-funding

CBC:

https://www.cbc.ca/listen/live-radio/1-84-up-north/clip/15825459-algoma-university-researcher-points-covid-19-remote-workplaces-equity

Sault This Week:

https://www.saultthisweek.com/news/local-news/google-meet-inspires-successful-application-for-research-grant