

**The Impact of Marginalization and Intersectionality on Post-Secondary Students
with Disabilities' Use of Assistive Technology: A Scoping Review of the Literature**

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Executive summary

Background: the issue

Approximately 18%-34% of Canadian college and university students have disabilities, emphasizing the importance of exploring assistive technology's (AT) impact on academic success (Canadian University Survey Consortium, 2020, 2021; Fichten et al., 2018). AT, including smartphone apps and virtual assistants, is vital for supporting students with disabilities, given the significant influence of education on employment and salary outcomes of individuals with disabilities (McDiarmid, 2023).

Traditional assessments can marginalize students with disabilities, even with accommodations like extended time (Nieminen, 2022). Some students report positive growth by efficiently using AT to overcome challenges, while others avoid disclosing disabilities due to stigma and hesitancy to access services (Nel et al., 2022). Stigma associated with devices further influences AT selection (Piculo dos Santos et al., 2022).

Intersectionality compounds feelings of stigma and marginalization. For example, Miller et al. (2021) report that LGBTQ+ college students with disabilities made little use of accommodations and experienced a greater degree of environmental rather than personal micro-aggressions. Shaw et al. (2012) examined the intersection of race, age and gender with disability and found clusters of characteristics that put certain groups at a higher risk of harassment; across groups women reported more harassment than men, with the most harassment reported by Hispanic and American Indian women with behavioral disorders. Kaye et al. (2008) found that Black Americans used fewer AT devices than non-minorities and are especially less likely to use what they described as “high-tech” devices, as are those of Latino ethnicity.

Objectives

The main objective of this project was to scope the literature on technology use by post-secondary students with different disabilities with the intent of capturing how issues of privilege, marginalization and intersectionality impact their use of AT. Specifically, we intended to examine the following questions:

1. Are there intersections of marginalized identity among students with disabilities that uniquely affect and are uniquely affected by using AT?
2. To what extent do developers of technologies report engaging people with disabilities in design and development (i.e., in participatory research)?
3. What gaps or unaddressed issues exist in the literature on these themes?
4. Are there design features that could mitigate feelings of marginalization?
5. Do specific types of AT privilege certain classes of users more than others?

Methods

Research questions were addressed by means of a systematic scoping review of the available relevant research literature (Arksey & O'Malley, 2005). To identify relevant documents, we searched across multiple bibliographic databases in French and English, as well as employing other means (web searches of Google & Google Scholar, scanning recent issues of key journals, and citation searching) to locate relevant materials.

Coders, in alternating teams of two, independently implemented both stages of study selection by regularly meeting to compare their respective decisions and, when

needed, discuss, and resolve disagreements. These final included studies were then coded for study features and extraction of themes.

Results

The searches produced a total of 1,241 records for screening, which were added to an existing database of 305 records in a collection gathered for a prior review of AI-based virtual assistants for post-secondary students with disabilities (see Fichten et al., 2021), which brought the total to 1,546 records. After removing duplicates, a collection of 1,135 records was left to undergo abstract screening for relevance, followed by the review of full-text documents identified through the initial screening. 137 of these records were retrieved for full-text review, from which only 12 were selected for final inclusion in our analysis. These final included studies were then coded for study features, namely: 1) Major themes (intersectionality, marginalization, privilege, stigma), 2) Methodology, 3) Identity dimensions, 4) Type(s) of disability, 5) Type(s) of technology, 6) Subject matter/discipline.

Key Messages

AT can reinforce and magnify feelings of marginalization but carefully implemented it can be liberating and provide more independence. In navigating this delicate balance, the careful integration of AT into various aspects of daily life becomes crucial, emphasizing its capacity to enhance the overall well-being of those it aims to assist. The challenges posed by a disability can be specific, but other intersecting factors can create more challenging contexts for individual users. These unique contexts underscore the importance of recognizing and addressing the diverse layers of adversity. Understanding the intersectionality of factors such as socioeconomic status, cultural background, and geographical location is pivotal in developing comprehensive support systems. By acknowledging and navigating these complex dynamics, and adopting principles of Universal Design for Learning (UDL), society can work towards creating inclusive environments that cater to the specific needs of diverse individuals with disabilities, fostering a more equitable and accessible world.

Given the increasing use of smartphone and other mobile applications as well as of general use technologies by the close to 50% of students who may be accessing AT directly on their own without going to university services (Fichten et al, 2018), the determining factors in selection, effectiveness of use, as well as satisfaction with their use, is an area that merits more attention from researchers and practitioners alike. This seems a significant gap in the literature to be addressed by future researchers.

In general, there is an unfortunate paucity of studies reporting development of tools involving students with disabilities in the design of AT or in participatory action research. Such collaborations may ensure that biases are not perpetuated or reinforced. Additionally, few publications empirically analyze the impact of the intersection of disability with other identity factors on use of AT. Arriving at meaningful, long-term solutions requires a direct, purposeful, ongoing partnership with the end users. The paucity of usable studies in this review reveals a systemic disconnect between researchers and post-secondary students across Canada. Until this gap is bridged, understanding and effective action will remain elusive.

Full Report

Background

Between 18% and 34% of Canadian college and university students have a disability (Canadian University Survey Consortium, 2020, 2021; Fichten et al., 2018). In a recent study, our team found that 26% of social science students self-reported a disability such as a visual, hearing, communication or mobility impairment, a learning disability such as dyslexia, an attention deficit hyperactivity disorder, or limitation in the use of their hands and arms (Fichten et al., 2019). It is important to understand how their use of assistive technology (AT), whether that involves smartphone apps, screen readers, virtual assistants, or other assorted technology and software, can help students with disabilities succeed in their studies and, ultimately, in their lives. This is because university and college degrees significantly influence the employability and salary that people with disabilities can obtain (McDiarmid, 2023).

For many years, our team has studied various AT for students with disabilities from a variety of angles, trying to determine which are most effective but also which are actually used by students (Fichten et al., 2020, 2022). We have conducted a study of browser extensions (e.g., safe browser extensions for Google Chrome) used by post-secondary students with disabilities (Fichten et al., 2022), as well as a brief scoping review of the literature on artificial intelligence (AI) driven apps to promote learning among post-secondary students with disabilities (Fichten et al., 2021). Even as we study the performance of these virtual tools and their utility for students with disabilities, we must be aware of how these technologies can also bring new challenges to students' identity and, in some cases, lead to feelings of greater marginalization if not properly designed (Cheuk, 2021). Further, technology development is often initiated by non-disabled practitioners with epistemic privilege (Winters et al., 2020), and without much input from the intended users; this can then lead to unintentional biases and ethical considerations (Findlater et al., 2019). Winters et al. (2020) have called for more participatory action research and emancipatory methodologies to ensure that AT does not exacerbate systems of privilege and marginalization of learners.

Modern Conceptions of Assistive Technology

Increasingly, AT is becoming less the special province of university access services but placed literally in the pocket of users through smartphone applications. While there are numerous lists of smartphone features and apps (Leyden, 2018), the literature on the use of AI-based smartphone apps and virtual assistants to help students with academic work and to improve their motivation and performance is sparse (Fichten et al., 2021). In addition, while AI-based virtual assistants (e.g., Alexa, Siri, Google Assistant, Bixby) can help schedule study routines, make recommendations for work and wellness breaks, offer reminders, and provide information and definitions in real time, there is little known about how these can help postsecondary students with disabilities improve attention and concentration, or more effectively complete schoolwork (juxtaposed with myriad real life demands of work, family, etc.). For example, students with learning disabilities and motor impairments can use dictation apps (voice-to-text) to work on assignments and use voice commands to research topics. Students with print impairments, while listening to their textbook, may encounter a word or subject they aren't familiar with and can verbally ask the virtual assistant for help. Similarly, students

with visual impairments can use AI-based smartphone apps such as Seeing AI to identify people and objects and to read text after taking a photo of a page and performing optical character recognition (Findlater, 2019; Kelley, 2021; Microsoft, 2019; Wong et al., 2019). In addition, students with hearing impairments can use speech-to-text AI-based apps such as AVA to communicate in groups (Matney, 2016), and there have been initiatives to teach Alexa to respond to sign language (Singh, 2018). For students with speech impairments (e.g., cerebral palsy, hearing impairments), who often have problems with dictation and voice-to-text apps, Google has developed Project Euphonia (Fisher, 2019; Synced, 2019). The potential is vast, but informed use of these tools is scant and insufficient attention has been paid to students' attitudinal outcomes and how use of these tools may impact their self-esteem and identity (Lang et al., 2015; Lannan, 2019).

Many students with disabilities do not disclose them (Grimes et al., 2021) and are hesitant to sign up for services (Fichten et al., 2018). The stigma associated with some devices can also be a determining factor in the selection of specific AT (Piculo dos Santos et al., 2022). Feelings of stigma and marginalization can be compounded when disability intersects with other marginalized social categorizations (Ripat & Woodgate, 2011). For example, Miller et al. (2021) report that LGBTQ+ college students with disabilities made little use of accommodations and experienced a greater degree of environmental rather than personal micro-aggressions. Shaw et al. (2012) examined the intersection of race, age and gender with disability and found clusters of characteristics that put certain groups at a higher risk of harassment; across groups women reported more harassment than men, with the most harassment reported by Hispanic and American Indian women with behavioral disorders. Kaye et al. (2008) found that Black Americans used fewer AT devices than non-minorities and are especially less likely to use what they described as "high-tech" devices, as are those of Latino ethnicity. Students with psychological disabilities are especially stigmatized and often dismissed by faculty (Kain et al., 2019; Riffel & Chen, 2020), and learners in French have poorer access to technologies that can assist them than do those who are educated in English (e.g., Arcuri et al., 2022).

Students with disabilities report a variety of barriers to their education in college, ranging from teachers who speak too quickly, to difficulty writing notes while also maintaining focus on a professor's presentation, as well as general difficulty seeing/hearing the teacher or other students (Fuller et al., 2004), as well as challenges accessing university services (Hong, 2015; Marshak et al., 2010). Other issues include inaccessible file formats and lack of transcriptions or audio options for media (Bostic, 2022), as well as inability or difficulty participating in fieldwork (Hall et al., 2002), in the direct production of knowledge as researchers (Lillywhite & Wolbring, 2019) as well as placement in work-based learning (Thompson & Brewster, 2022). Students with disabilities can be marginalized by traditional assessments, even when additional accommodations (usually in extended time provided) are available (Nieminen, 2022). Of course, feelings of marginalization from disability are not uniform, with some research also pointing out that students report positive feelings of personal growth by successfully overcoming challenges (including by means of efficiently employing AT) and using them as a source of motivation (Nel et al., 2022).

Objectives

The main objective of this project was to scope and analyze the literature on technology use by post-secondary students with different disabilities with the intent of capturing how issues of privilege, marginalization and intersectionality impact their use of AT (including screen readers, virtual assistants, AI-based applications, etc.) that are supposed to help them navigate their education.

Specifically, we intended to examine the following questions:

1. Are there intersections of marginalized identity among students with disabilities that uniquely affect and are uniquely affected by using AT?
2. To what extent do developers of technologies report engaging people with disabilities in design and development (i.e., in participatory research)?
3. What gaps or unaddressed issues exist in the literature on these themes?
4. Are there design features that could mitigate feelings of marginalization?
5. Do specific types of AT privilege certain classes of users more than others?

Methods

The above-stated research questions were addressed by means of a systematic scoping review of the available relevant research literature (Arksey & O'Malley, 2005).

Search Strategy

To identify relevant documents, searches were conducted by the first author, who is an Information Specialist (Master of Library and Information Sciences) with over a decade of experience working on systematic reviews. He searched across multiple bibliographic databases in the subject literature (i.e., ERIC, Education Source), related disciplines like Psychology (PsycINFO), Sociology (i.e., Sociological Abstracts, SocINDEX) and major interdisciplinary databases (i.e., Academic Search Complete, Web of Science, ProQuest Central), Google Scholar French, and Érudit. These searches employed key terms, and where appropriate database-specific controlled vocabulary, to locate publications on the topic. Searches were limited to English and French publications between 2010 and 2023 (to focus on current and topical technologies). A sample search would look like the following:

(disabilit* OR disabl* OR "special need*" OR impair*) AND (marginal* OR stigma* OR minorit* OR positionalit* OR identity OR intersection* OR othering OR exclusion OR inclusion OR isolation OR underclass OR stereotype OR discrimination OR LGBTQ+ OR Gender OR Race OR Black OR "African American" OR Ethnic* OR anomie OR anxiety) AND ("assistive software" OR "assistive technolog*" OR "artificial intelligence" OR "machine learning" OR "intelligent tutor" OR "smart tutor" OR "virtual assistant" OR "smart assistant" OR "adaptive technolog*" OR "browser extension" OR "Google Assistant" OR Alexa) AND ("adult education" OR "higher education" OR Postsecondary

OR University OR College OR Undergraduate OR Tertiary) NOT (retardation OR "intellectual disabilit*") Date Limit: 2010 onward Language: English, French

These database searches were supplemented by searches of Google Scholar for additional formal publications, and of regular Google for grey literature (Schöpfel, 2011). We also scanned recent issues of the journals *Critical Disability Discourses*, *Disability Studies Quarterly* and the *Canadian Journal of Disability Studies* for relevant publications. A total of 1,241 results were obtained by these searches, which were added to an existing database of 305 records in a collection gathered for a prior review of AI-based virtual assistants for post-secondary students with disabilities (see Fichten et al., 2021), which brought the total to 1,546 records. After removing duplicates, a collection of 1,135 records was left to undergo abstract screening for relevance, followed by the review of full-text documents identified through the initial screening.

Inclusion / Exclusion Criteria

Considered for inclusion were various types of research papers with the potential of informing one or several research questions as stated above. Therefore, the exclusion (reasons for discarding any given document from further consideration along with some additional restrictions imposed by the project timeframe and available resources) were formulated as follows:

- The study did not address a disabled or impaired population.
- The population was not post-secondary students studying in a formal institution of higher education.
- The study did not address either a) intersectionality of identity characteristics, or b) a specific marginalized community.
- The study was focused on intellectual disability.
- The study did not address the use of AT (it did not need to be the primary focus but had to play a significant role, and outcomes could vary – whether it was impact on achievement, willingness to use technology, feelings of stigma, etc.);
- The study was not conducted in North America; we decided early on to limit ourselves geographically to focus on informing educational practice most relevant to the Canadian context, as the proposal and team resources were not designed to analyze the multitude of international contexts.

Review Procedures

Coders, working in alternating teams of two, independently implemented both stages of study selection by regularly meeting to compare their respective decisions and, when needed, discuss and resolve disagreements.

After screening all abstracts, we were left with a set of 137 publications. The inter-coder agreement rate at this stage of the review was Cohen's kappa = 0.64. As three-point scale – from “confidently reject” to “confidently retrieve full-text document” with the middle point of “doubtful in favor of retrieval” – was used at the abstract screening stage, the inter-rater agreement could be also expressed as Pearson's coefficient of correlation: $r = .52, p < .01$.

Teams of two coders again reviewed the full PDF articles for all 137 and coded them for relevance, using the same inclusion/exclusion criteria previously employed for

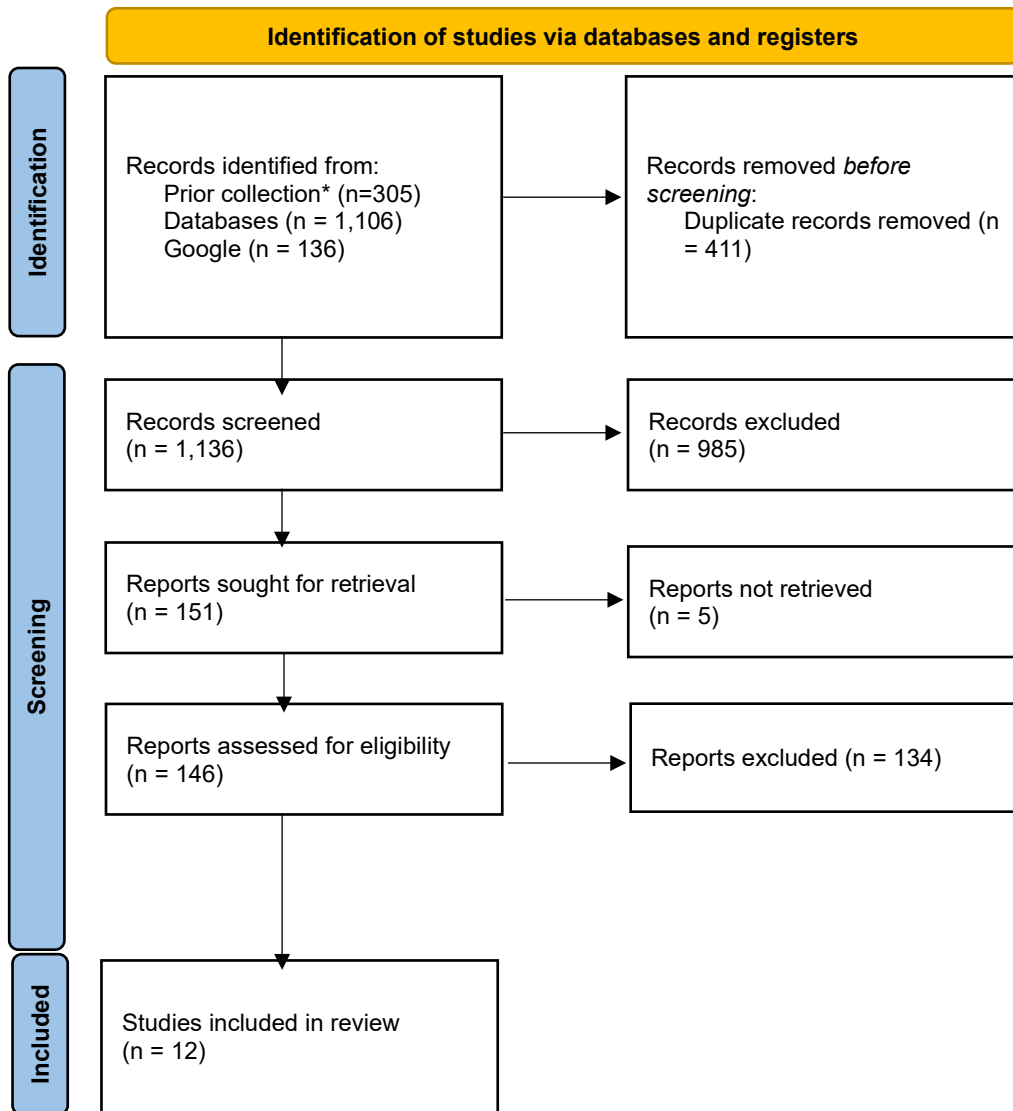
screening the abstracts. This produced a final collection of 12 studies retained for the final substantive coding and analyses. The interrater agreement rate for full-text review was Cohen's kappa = 0.60 (or $r = .59, p < .01$).

These final included studies were then coded for study features, namely:

1. Major themes (intersectionality, marginalization, privilege, stigma)
2. Methodology
3. Identity dimensions
4. Type(s) of disability
5. Type(s) of technology
6. Subject matter/academic discipline

The PRISMA diagram below depicts the progression of the review up to the point of analyses and summaries.

PRISMA diagram



*For more information about this collection please see Fichten et al. (2021).

Results

As stated earlier, results that passed all exclusion criteria were few. Many pertained to adult population with disabilities generally and not to students in higher education (for example Ward-Sutton et al., 2020 performed a systematic review of barriers to use of AT among African Americans with disabilities but did not address higher education or students). Others addressed the intersection of disability with other identity characteristics, but also without focus on higher education students (e.g., Kaye et al., 2008; Ripat et al., 2011), or focused on how the intersectionality impacted their use of university services (special support services, the library, etc.) but not how this impacted their use of AT specifically (e.g., Parsons et al., 2021). Still others were rejected for taking place outside of North America but may otherwise have been included. For

instance, Manase (2023) used a narrative inquiry design to explore the experiences of 15 university students at a university in South Africa and concluded that “students’ marginalisation through undiversified learning modes and poorly presented learning content that force students to adapt unconventional ways of managing learning” (p. 6).

Studies did not have to explicitly mention intersectionality, but if they included factors such as gender or race in their analysis they were kept for review (e.g., Forbes, 2019); if they simply reported a gender breakdown in their participant description but did not otherwise report results using this variable they were ultimately excluded (e.g., Nelson & Reynolds, 2015). In several instances, the researchers performed interviews with participants and relevant themes emerged in the interviews, these were included even if the researchers themselves did not necessarily focus on these factors (Pacheco, 2014).

The results were heterogeneous in the type of research they originated from; three are dissertations, two book chapters, one conference paper, and five are journal articles. They are mostly the product of different researchers, with only Malcolm and Roll (2017, 2019); as well as co-authors on Simpson et al., (2022) appearing more than once. The results are mainly qualitative in nature (n=5), with two providing a mixed methods paradigm that included a quantitative survey tool alongside interviews as the data collection tools. There were two review articles, with one of those being a systematic review, and two were descriptive or opinion articles. Surveys were the most common method specified, appearing in 5 studies, then interviews (3), retrospective analyses (2), and then 1 example each of journal entries, autoethnography, systematic review, case study, and phenomenological study.

In terms of the major themes that we coded for, there were 8 studies that addressed intersectionality, 3 publications discussed elements of marginalization and/or privilege either in the population addressed in the study, or within the AT itself, and 6 studies had themes of stigma associated with disability. Please see below for a further discussion of themes.

Gender was the most frequently considered identity factor, appearing in 7 of the 12 included studies. Race was reflected in 3, with an additional 2 that had a focus on ethnicity/cultural background (e.g., recent immigrants). Other factors of identity that appear in the collection are socio-economic status (1) and age (2).

Most studies did not only look at students with a specific disability but considered a range of disabilities; however, Forbes (2019) and Kazimzade et al. (2019) each studied students with visual disabilities. In studies where multiple participants were interviewed there was diversity in their disability types. For example, in Jain et al. (2020) each of the authors described their own disability – hearing impairment, visual impairment, and quadriplegia respectively.

Table 1 below summarizes the disabilities addressed in the studies included in our final analysis, either in descriptions of study participants or simply as examples of the types of disability supported by a university’s access services. In this review we grouped disabilities based on the categorization previously used by the authors (Fichten et al., 2022).

Table 1. Disabilities mentioned within the included studies.

Visual impairment	10
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Limited mobility	10
Learning disability	6
Hearing impairment	4
Autism	3
ADHD	2
Limited use of hands	1
Mental health difficulties	2
Brain injury	2

Categories of assistive technology featured in the included studies are presented in Table 2 with their respective frequencies.

Table 2. Assistive technology types mentioned within the included studies.

Text-to-speech	12
Smartphone apps	4
Notetaker	3
Audio recording	3
Virtual assistants	2
Captions	2
Sensory aids	2
Courseware	2
Alternative keyboard	2
Facial recognition	1
Eye tracking	1
Facilitated communication	1
Personal electronic response system	1
Magnification	1
Tactile support	1
Laptops	1
Motorized wheelchair	1
Scanners	1
Literacy software	1

While an attempt was made to code the studies by subject matter or academic discipline addressed, most studies took a broad approach to university access or experience at the institution (e.g., Kazimzade et al., 2019), either not mentioning subject matter or with participants spanning programs (e.g., Forbes, 2009, where participants report studying Computer Science, Education, Foreign Language and Music). There were some exceptions, with Jain et al. (2020) recounting their experiences as graduate students in Computer Science, and Malcolm et al. (2019) including whether a student was enrolled

in a STEM program in their analysis. However overall, there was insufficient reporting on this dimension.

Before elaborating on the themes that emerged from our scoping review, we first provide an overview and summary of the 12 included studies.

Summary of studies

Carroll-Miranda (2014) completed a qualitative phenomenological study for her dissertation, guided by critical theory and disability studies, exploring the inclusion experiences of six students with disabilities in higher education, focusing on the role of AT. Semi-structured interviews were conducted, and evolving participant portraits were created to highlight their voices and experiences, emphasizing their interactions with ‘social oppressions’. The interpretative phenomenological analysis revealed interconnected issues in the inclusion process, including access, AT, barriers, and pro-activity. The study found that while AT facilitates participation, accessing it involves complexities. Participants used AT to resist exclusion, and the study identified societal reactions to disability as a major barrier affecting their daily experiences in university. The importance of AT extends beyond physical devices, emphasizing its role as a process and not simply a fix. The author describes various lessons she took from her experience working with her participants, including that not all described their inclusion experiences from a negative perspective, but instead “how they embraced their experiences as opportunities of learning, as well as opportunities towards social transformations where every member in society is part of this transformation, including them (p. 324).”

Foley and Ferri (2012) provide a journal article where they explore the ways in which AT can contribute to feelings of marginalization in students with disabilities. Technology can create unexpected forms of social exclusion for people with disabilities, reflecting ableist and normative values of independence and competence. The authors critique trends in digital design where socially constructed features from the analog world are migrated to the digital environment. Drawing on the work of Ellis and Kent (2011), Foley and Ferri note that as socially networked sites, including those used in online education (e.g., courseware like Blackboard and Moodle) become an ever-growing part of daily life, so too does the cost of exclusion from these contexts reverberate. They remark that such systems “have been developed with little functional understanding of disability (p. 196).” The focus of the authors was primarily on online learning broadly, with mention of popular brands like the courseware already mentioned, as well as iPhones, YouTube, Kindle, etc. While they provide examples of disability (e.g., mobility and visual impairment) the article is not focused on student populations with any specific impairments.

Forbes (2019) in her dissertation used a qualitative approach, employing a questionnaire, interviews, and journal entries to investigate how virtual assistants impact higher education for individuals with visual impairments. The study focused on virtual assistant features, purposes, user experiences, and their role in alleviating disability-related stress through the use of features such as alarms, reminders, calendars, search engines. Findings showed that virtual assistants reduce barriers and stress, improving accessibility for visually impaired individuals in both online and face-to-face education. Technology

enhances independence, autonomy, and social integration while reducing limitations. The study noted participant diversity in age, sex (three male, four female students), education level, and ethnicity (however all participants reported being of the same general ethnicity). These factors were not, however, employed in the analysis, perhaps, because they did not exert any additional effects on AT use.

Griffen and Tevis (2014) published a qualitative case study (journal article), where they discuss the shift from high school to college, when students with disabilities encounter a pivotal moment. They lament that their presence is frequently overlooked in conversations about underserved groups in higher education, especially within the framework of intersectionality. The case study, where three students were interviewed (all female, two White and one Black) aimed to fill this gap by adopting a “strengths-based” perspective. The students reported a mix of mobility and visual impairments. The study explores how college students, typically marginalized, leverage the strengths inherent in their socially constructed identities as a dynamic force to unlock pathways to academic success. Independence emerged as a strong theme across participants; students want “to feel more comfortable about communication and independently problem-solving disability-related challenges (p. 247).” The research suggests that students leveraged the strengths from their intersecting identities to adopt a proactive attitude and to achieve academic success, overcoming the limitations of the ‘deficit view’ of disability to embrace the full range of their socially constructed identities.

Jain et al. (2020) provide a three-person autoethnography among students originally from India in this conference paper. They offer an account of their graduate school experiences as individuals with disabilities, emphasizing situations where requested accommodations failed, prompting the use of alternative coping strategies. Each author reports a different disability – hearing, visual and mobility (quadriplegia). The authors describe stigma, and internal conflicts with self-identity that specifically impacted their likelihood or desire to request accommodations. While feelings of insecurity and fear of bothering a professor may be universal, they describe the experience of moving to different geographic locations (e.g., from India to the United States) exacerbating these feelings. All three had to acclimatize to new social and culture norms, which introduce additional conflict to their self-identities. The experience led to a "rediscovery of our perceptions, opinions, and needs surrounding our disability" (p. 4). Discussing AT, they articulate three misassumptions they each encountered: 1) technology can remove every access barrier; 2) technology can always work; and 3) technology for one person works for every person.

Kazimzade et al. (2019) offer a detailed book chapter with a strong focus on the intersection of gender and race (conceptualized as cultural inclusion) and likelihood of using AT. The chapter delves into the historical context of adaptive learning technologies and AT, emphasizing the dimension of impairment/disability in inclusion. The authors argue that it is crucial to integrate cultural inclusion into adaptive educational technologies to ensure the inclusion of diverse student groups; this facilitates participation and prevents "generation of knowledge making associations that leads to stereotypes in gender or ethnicity, to break undesirable, unfair associations, as well as to

allow participating of heterogeneous groups in education (p. 68)." Kazimzade et al. are especially interested by emerging practices that integrate accessibility and inclusion with Artificial Intelligence, examining cultural dimensions and discussing the origins of biases in technology, with a consideration of gender and ethnicity. The conclusion highlights the necessity for heightened awareness of biases in creating learning systems and training algorithms for the successful integration of AI and inclusive learning technologies in the future.

Malcolm and Roll (2017) in their journal article investigated the impact of AT services on college students with disabilities. They provide examples of disability from across the spectrum but group them into categories (learning disability, mobility deficit/pain, mental/behavioral disorder, CNS damage, visual deficit, and mood disorder), and also do not focus on any particular form of AT, listing many diverse tools (e.g., audio recording, text-to-speech, screen readers, etc.). The retrospective study used anonymized data from 455 college students referred by the campus disability support office to Colorado State University's Assistive Technology Resource Center (ATRC) from 2011 to 2015 for technology-related assistance. Intake interviews at ATRC identified academic challenges due to their disabilities. In addition, pre- and post-intervention ratings (taken near the start and end of the semester) using the Canadian Occupational Performance Measure (COPM) showed overall improvement, particularly for students with mood disorders. COPM scores improved for both genders and across class levels (e.g., Freshmen, Sophomore). The study suggests that a student's diagnosis may influence AT service outcomes and perceptions of usability, while gender and class level did not seem to have a significant impact on the results.

Malcolm and Roll (2019) in a follow up journal article, assessed the impact of AT services on college students with less-apparent disabilities (learning disability, autism spectrum disorder, ADHD, other cognitive/behavioral), using their COPM instrument. They defined several categories of AT accommodations, namely: AT for notetaking, audio recordings, modified display, text & audio readings, AT for writing, text recognition, AT for time management, and single word display). Significant improvements were found in self-ratings of academic performance and satisfaction. Gender, class-level, and initial self-perceived abilities influenced engagement with AT services, highlighting their relevance for student success. The authors note that men experienced less improvement than women in their average performance rating, which "implicates a need for further research to ascertain unique characteristics and needs with which male students present when seeking AT supports and services" (p. 178).

McNicholl et al. (2019) conducted a systematic review in a journal article that discusses stigma as a barrier to AT use, without any specific focus in disability or technology type. There is no consideration of other intersecting identity factors. AT enhances confidence, autonomy, and motivation. The positive perception of AT by others, seeing it as a tool for empowerment rather than just alleviating disability burdens, fosters inclusion and a sense of belonging in higher education. This positive view of AT reduces stigma and changes perceptions, underscoring the need to normalize its use to realize its potential benefits for

everyone and promote inclusion, suggesting a need for further research to explore these benefits and the factors influencing stigma reduction.

Pacheco (2014), in her dissertation, studied the choice of students with disabilities to pursue STEM careers. The study involved interviews with 18 STEM professionals and graduate students with sensory and orthopedic disabilities. The focus was on identifying sources of self-efficacy and understanding the role of AT in their STEM choices and journeys. AT types considered included text-to-speech, sensory aids, and digital recorders, with VoiceOver and JAWS (Job Access With Speech) specifically mentioned. Key findings indicate that individuals with sensory and orthopedic disabilities approach sources of self-efficacy differently compared to white males without disabilities in STEM, resembling patterns seen in other underrepresented minorities in STEM. Social persuasions emerged as a crucial factor, with participants emphasizing its impact on the development of self-efficacy beliefs. Although intersectionality is not focused on in much detail, one participant (Lina) comments in her interview about different expectations for women: "I think for the culture and all that a lot of it is, 'Oh, there aren't very many women and women really aren't into technology, ... well, you kind of have to work a little harder kind of thing [being female], which for me, actually, I had to work even more hard to go over the issues of accessing information..." (p. 109). Pacheco concludes by suggesting a need for further investigation into the intersection of disability, sex and ethnicity in STEM choice.

Simpson et al. (2022) in a journal article provide a retrospective analysis of secondary data from a university AT center. No specific type of disability is the focus, and a variety are mentioned (e.g., ADHD, autism, learning disability, visual impairment, etc.), nor do they clearly define the types of AT under consideration (they describe main areas of focus being reading, writing, note-taking, studying, and time management). The study investigates AT utilization among postsecondary students with disabilities (SWD), as well as its impact on GPA, and one of their aims was to "determine if final cumulative GPA can be predicted by AT service utilization, first-generation status, disability category, gender, race/ethnicity, socioeconomic status, and major (p. 8)." A key finding was that first-generation students with disabilities were more likely to seek AT services than their continuing-generation peers, but they still received lower GPA than their continuing-generation cohorts. The authors theorize that they are more likely to come from a low-income socioeconomic background and need to work more during school, and that they may find it more difficult to adapt to new educational environments and face additional stigma and discrimination.

Whitley-Grassi et al. (2021) is a book chapter that discusses equity as an important aspect of Universal Design for Learning (UDL) as applied to a case study from a New York college. Although they do not explicitly discuss the intersection of disability with other identity factors, they stress the importance that tools should allow learners enhanced freedom of choice and encourage flexibility to avoid a "you have this diagnosis, use this tool" approach. The authors discuss Disability 3.0, that embraces the social model of disability to provide as unrestrictive service model possible, leveraging online and blended learning. For the authors, Disability 3.0 is a progression or evolution in the

conceptualization of disability, building upon earlier models or theories such as the medical model (Disability 1.0) and the social model (Disability 2.0). It examines student support services in modern contexts of educational technologies and their place in online and blended learning. The authors state that UDL guidelines (CAST, 2018) are key to the development of this new model because it attempts to open up the curriculum to be fully inclusive before any disabled students encounter it.

Major Themes

There was broad agreement about moving away from the medical definition of disability to a socially constructed one, that does not isolate disability as a factor of identity or see it as something to be ‘fixed’. Carroll-Miranda (2014) notes that participants used AT as a means of resistance to avoid exclusion and that descriptions of experiences were consciously not negative but forward-thinking and hopeful. Likewise, Griffen and Tevis (2014) suggest that students use their intersecting identities to achieve academic success. By focusing on the need to overcome the so-called ‘deficit view’ of disability, students find motivation to embrace the full range of their socially constructed identities, with AT supporting independence (see also Forbes, 2019). McNicholl et al. (2019) discuss the stigma that can be a barrier to AT use, but also that AT can be a tool for empowerment. That said, technology is not a cure-all, and as Foley and Ferri (2012) discuss, it can reflect ableist and normative values if not carefully designed.

Cultural acceptance, varying norms, and needing to adjust to new circumstances, emerged as themes – not only in terms of how disability is viewed in different communities but also how much stigma is attached to AT. Jain et al. (2020) discuss how all three authors had to acclimatize to new social and cultural norms after immigrating, and the internal conflicts that arose in their self-identity. Kazimzade et al. (2019) argue that cultural inclusion must be centered in AT design to ensure that AT appropriately addresses not only disability but considers how it does so with respect to different student cultural groups, ensuring that biases are not reinforced, for example by artificial intelligence algorithms.

The intersection of gender and disability was addressed in several studies but with no clear unified message emerging. Malcolm and Roll (2017) investigated how gender impacted perceptions of AT services and found no impact of gender on results. However, in a 2019 study Malcolm and Roll again investigated gender’s impact, this time on self-ratings of academic performance following AT services and found that it was men who experienced less improvement than women. Forbes (2019) included gender in her analysis of the impact of virtual assistants on students in higher education, but concluded it had no impact on results. Pacheco (2014) investigated the role AT plays in the choice of graduate students to pursue careers in STEM and calls for more research into the intersection of disability, sex, and ethnicity in STEM choices. One of the participants in her study noted that there are stereotypes for women working in and with technology that add to the challenge, and that she had to work harder to access information.

We had hoped to find examples of participatory action research, where students with disabilities were engaged and consulted on the development of AT, but no such study ended up in our final set of included publications. Studies often used university offices and service providers as a focus of their inquiry (e.g., Malcolm & Roll, 2017, 2019; Simpson et al., 2022). This appears to be a significant gap in the literature,

especially as many students bring their own AT with them to higher education (for example as apps on their smartphones) and may not necessarily consult with a university's official offices.

Universal Design for Learning (UDL), discussed in Whitley-Grassi et al. (2021) seems to promote a good way forward, ensuring that concern for disabled users be built into the design of online and digital resources. Foley and Ferri (2012) though critiquing UDL for “suggest[ing] the possibility of universal access, even when products that have gone through a UDL design process might not be universally accessible in practice” the authors in the end make the argument that “similar to universal design, accessible and inclusive technology would build in accessibility from the start rather than try to retrofit after the fact or make accommodations” (p. 199). There was broad agreement across the literature that socially constructed features from the analog world should not simply be migrated to the digital environment.

Conclusions and implications

AT can reinforce and magnify feelings of marginalization. However, carefully implemented, it can be liberating and provide more independence. The challenges posed by a disability can be specific, but other intersecting factors such as the specific disability, the number of students' disabilities, socio-economic status, race, etc. and context (e.g., STEM) can create more challenging contexts for individual users. These unique contexts underscore the importance of recognizing and addressing the diverse layers of adversity that individuals with disabilities may face. Developers of specific AT tools, as well as university accessibility specialists should keep in mind that students from different cultural and socio-economic backgrounds may face unique challenges and obstacles.

Understanding the intersectionality of factors such as socioeconomic status, cultural background, and geographical location is pivotal in developing comprehensive support systems. By acknowledging and navigating these complex dynamics, society can work towards creating inclusive environments that cater to the specific needs of diverse individuals with disabilities, fostering a more equitable and accessible world for everyone. Recognition of the different AT needs of individuals with the same disability is an important factor. This recognition is vital for developing targeted interventions that address both cultural and disability-related barriers, ultimately fostering a more inclusive environment. A continued shift towards Universal Design for Learning in online education and AT development should be prioritized to ensure equitable access to higher education for all students. Moreover, although our focus was on AT, the current trend toward students with disabilities using the built-in accessibility of general use technologies such as Microsoft products, Adobe Acrobat, Zoom, Google Docs, etc. need to be considered in the future. These technologies, used by everyone, can diminish feelings of exclusion and stigma.

In general, there is an unfortunate paucity of studies reporting development of tools involving students with disabilities in the design of AT or in participatory action research. Such collaborations may ensure that biases are not perpetuated or reinforced. Additionally, few publications empirically analyze the impact of the intersection of disability with other identity factors on use of AT. There is a tendency to treat both disability and technology broadly rather than look closely at the impact of a specific type

of AT (for example virtual assistants, screen readers) for students with particular types of disability. In addition, many studies are based on students who had registered for access services from their college. Given the increasing use of smartphone and other mobile applications as well as of general use technologies by the close to 50% of students who may be accessing AT directly on their own without going to university services (Fichten et al, 2018), the determining factors in selection, effectiveness of use, as well as satisfaction with their use, is an area that also merits more attention from researchers and practitioners alike. This seems a significant gap in the literature to be addressed by future researchers.

There has been a marked shift in conceptions of disability away from a medical definition of challenges that must be compensated for or overcome, to a more socially determined definition that sees disability as one factor of an individual's identity. As noted by Griffen and Tevis (2014), students can leverage the strengths from their intersecting identities to achieve academic success, overcoming the limitations of the 'deficit view' of disability to embrace the full range of their socially constructed identities.

Although there is a growing amount of research on including disability in considerations of intersectionality, few addressed how it impacts post-secondary students and their use of assistive technology specifically, and rarely addressing specific disability or technology types.

A shift towards a more Universal Design for Learning (UDL) for AT and online education services that builds in support for disability among the factors considered should be encouraged. There is a need to make sure AT accounts for equity for those who have other marginalized identities that are not always considered in their development especially as artificial intelligence and programmed algorithms take on an expanding role in AT. Developers should consider that students with disabilities and with other marginalized identities may face additional challenges, either from their own cultural communities who may have varying degrees of acceptance and comfort with disability but also with AT, or from normative systems produced by the dominant group identity.

Knowledge mobilization activities

Our plan for sharing and disseminating findings is manifold and intended for various audiences. The following deliverables will be prepared in paper-based and/or online formats. Our results will speak to: 1) instructional designers and project teams that regularly look for better ways to improve educational technology to assist students with disabilities; 2) instructors, access technologists and adapted services counsellors who work with students with disabilities; 3) students with disabilities trying to assess the utility and effectiveness of AI-based assistive technologies; 4) administrators in higher education whose job it is to develop better instructional approaches and devise long-term plans to improve teaching and learning – to inform all these categories of researchers and educators about the best relevant practices and outstanding issues.

We will use traditional avenues (e.g., Zoom webinars, articles in online and paper-based publications aimed at instructional designers (e.g., *Campus Technology*), scholarly journals (e.g., *Journal of Enabling Technologies*), and social media. We will also hold presentations at faculty-related conferences (e.g., SALTISE 2024) and give interviews to radio and print media where possible. The investigation will result in the creation of a set

of best practice guidelines that will also be widely disseminated online through the Adaptech Research Network and the website of the Centre for the Study of Learning and Performance.

Dr. Catherine Fichten's (psychologist) Adaptech Research Network team, which consists of students, faculty, access service providers and access technologists, several with disabilities, will disseminate information about the study to its stakeholders and membership by discussing it at regular meetings and highlighting it on its Adaptech Research Network web site (<https://adaptech.org/>). Dr. Fichten will take the lead in national knowledge transfer; she and co-applicant Dr. Havel (counsellor) have ties to the National Educational Association of Disabled Students (NEADS). Co-applicant Havel also has ties to several Quebec groupings of both French and English language disability service providers as well as to the Canadian Association of College and University Student Services and their email discussion forum (cadsppe-l@listserv.uottawa.ca). Fichten will also work with Adaptech Research Network students to disseminate the results to student groups at Dawson College, Athabasca University, McGill University, Concordia University, and Université de Montréal. Dr. Alice Havel will also help with dissemination on the Francophone side of Quebec CEGEPs and disability service providers. Dr. Eva Libman and Dr. Sally Bailes (psychologists) from McGill and the Jewish General Hospital will be responsible for dissemination at McGill and at the Jewish General Hospital. Educational technologist Dr. Richard Schmid will disseminate information derived from the project at Concordia University. Schmid is a Professor in the Department of Education (Concordia University) and a founding member of the Centre for the Study of Learning and Performance (CSLP) where he leads the Systematic Review Team. He has conducted research on the application of learning strategies, like concept mapping, to instruction in higher education and conducted and published a major meta-analysis on pedagogical strategies supported by technologies in post-secondary education and the cognitive and affective factors they influence. Findings from Schmid's review projects are regularly presented to audiences at practitioner-oriented conferences (e.g., CNIÉ—Canadian Network for Innovation in Education, Sloan-C Conference on Online Learning Networks), as well as research-based conferences (e.g., AERA—American Educational Research Association; AECT—Association for Educational Communication and Technology).

All team members, including student research assistants, will participate in the knowledge translation activities and in developing learning materials (e.g., infographics, factsheets, etc.). A web-based *Knowledge Link* summarizing our findings in a clear, accessible form will be produced by the CSLP. It is a plain language summary of the research geared to educators, policy and decision makers, summarizing the key findings with implications for policy and practice. In addition to presenting this summary on its own website, locally we aim to feature our work in collaboration with Concordia's Centre for Teaching and Learning (CTL, <http://www.concordia.ca/offices/ctl.html>). Working with CTL, we hope to integrate the research results into learning modules for disability service providers and educators. These learning modules will be openly accessible on the web. Findings will also be shared with CEAP, the CSLP's satellite at Université du Québec à Montréal (UQAM) through a bilingual workshop later in 2024.

The team also is considering pursuing an SSHRC Connection Grant to organize a colloquium that will bring instructional designers (and students pursuing the discipline)

together with post-secondary students with disabilities to discuss our findings and deliberate on more informed and equitable paths forward in the field of assistive technology. Arriving at meaningful, long-term solutions requires a direct, purposeful, ongoing partnership with the end users. The paucity of usable studies in this review reveals a systemic disconnect between researchers and post-secondary students across Canada. Until this gap is bridged, understanding and effective action will remain elusive.

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