



Assistive Equipment and Technology for Students with Disabilities: Final Report

March 2017

Submitted to:

**Ministry of Advanced Education
PO Box 9162 STN PROV GOVT
Victoria, BC V8W 9H3**

SRDC Board of Directors

Richard A. Wagner
Partner, Norton Rose Fulbright LLP

Gordon Berlin
President, MDRC

Tim Brodhead
Former President and CEO of
The J.W. McConnell Family Foundation

Maria David-Evans
IPAC Immediate Past President and
Former Deputy Minister, Government of Alberta

Robert Flynn, Ph.D.
Emeritus professor, School of Psychology,
University of Ottawa

Pierre-Gerlier Forest, Ph.D., FCAHS
Director and Palmer Chair
School of Public Policy
University of Calgary

Suzanne Herbert
Former Deputy Minister, Government of Ontario

Guy Lacroix, Ph.D.
Professor of Economics, Université Laval

Renée F. Lyons, Ph.D.
Professor Emeritus, Dalhousie University
Founding Chair and Scientific Director Emeritus,
Bridgepoint Collaboratory for Research and Innovation,
University of Toronto

James R. Mitchell, Ph.D.
Founding partner, Sussex Circle

SRDC President and CEO

Jean-Pierre Voyer

The Social Research and Demonstration Corporation (SRDC)

is a non-profit research organization, created specifically to develop, field test, and rigorously evaluate new programs. SRDC's two-part mission is to help policy-makers and practitioners identify policies and programs that improve the well-being of all Canadians, with a special concern for the effects on the disadvantaged, and to raise the standards of evidence that are used in assessing these policies.

Since its establishment in December 1991, SRDC has completed over 300 projects and studies for various federal and provincial departments, municipalities, as well as other public and non-profit organizations. SRDC has offices located in Ottawa and Vancouver, and satellite offices in Calgary and Montreal.

For information on SRDC publications, contact

Social Research and Demonstration Corporation
55 Murray Street, Suite 400
Ottawa, Ontario K1N 5M3
613-237-4311 | 1-866-896-7732
info@srdc.org | www.srdc.org

Vancouver Office
789 West Pender Street, Suite 440
Vancouver, British Columbia V6C 1H2
604-601-4070

Calgary Contact
587-890-8425

Montreal Office
4126 Saint-Denis Street, Suite 302
Montreal, Quebec H2W 2M5
514-948-5317 ext. 234

Published in 2018 by the Social Research and
Demonstration Corporation

Table of contents

Executive Summary	1
1. Introduction	10
1.1 Background	10
1.2 Context	11
1.3 About this report	11
2 Methodology	13
2.1 Research questions	13
2.2 Overview of data sources	14
2.3 AT inventory	15
2.4 Literature / information source review	15
2.5 Online survey	16
2.6 Key informant interviews	18
2.7 Ethical considerations	19
3. Results	21
3.1 Overview of Assistive Technology	21
3.2 Assessment processes and practices used by practitioners and organizations for identifying suitable AT to meet students' needs	29
3.3 Application of Assistive Technology as part of the Universal Design for Learning in post-secondary education curriculum delivery	43
3.4 Effectiveness of Assistive Technologies for addressing disability-related barriers to post-secondary education	49
3.5 Assessment of potential effectiveness of new and emerging technologies	71
3.6 Trends	72
4. Overview and conclusions	77
4.1 Findings	77
4.2 Remaining knowledge gaps	78
4.3 Recommendations	79

Appendix A: AT inventory overview	81
Appendix B: AT service delivery process	82
Appendix C: Additional resources	86
References	88
Glossary	93

List of tables

Table 1	Overview of areas of inquiry and corresponding data sources	14
Table 2	How well do the following statements describe your institution's approach to AT?	22
Table 3	Has your province or territory developed any instructions, guidelines, or checklists to help disability support staff at post-secondary institutions assess...? (n=15)	33
Table 4	How likely is it that the following instructions, guidelines, or checklists will be developed in the future in your province/territory?	34
Table 5	Do you follow guidelines to assess the suitability of AT devices for...? (n=99)	34

List of figures

Figure ES1	What AT devices are available at your institution to assist students with disabilities? (Survey of PSE support providers, n=99)	4
Figure 1	Province/territory of post-secondary support staff survey sample (n=99)	17
Figure 2	Number of full- and part-time students registered at institution (n=99)	17
Figure 3	Number of students with disabilities registered at institution (n=99)	18
Figure 4	What AT devices are available at your institution to assist students with disabilities? (n=99)	24
Figure 5	Types of eLearning environment and equipment available and accessible to students with disabilities at your institution (n=99)	25
Figure 6	Common steps in a AT service delivery model	30
Figure 7	Do you or other disability support staff at your institution...?	32
Figure 8	For assessments, do you use guidelines...?	35
Figure 9	Top three most important criteria that influence staff AT assessments and recommendations (n=99)	38
Figure 10	Frameworks guiding AT assessment	41
Figure 11	Categories of AT assessments	41
Figure 12	Are the principles of UDL implemented in your institution? (n=99)	46
Figure 13	Please indicate if accessibility is incorporated in the design of the following at your institution (n=99)	48
Figure 14	How familiar are the following groups with the availability and use of AT at your institution? (n=98)	49
Figure 15	How effective are these AT devices, when they are available, in removing barriers to post-secondary education for students with physical disability?	54

Figure 16	How effective are these AT devices, when they are available, in removing barriers to post-secondary education for students with sensory disability?	55
Figure 17	How effective are these AT devices, when they are available, in removing barriers to post-secondary education for students with communication disability?	56
Figure 18	How effective are these AT devices, when they are available, in removing barriers to post-secondary education for students with cognitive disability?	57
Figure 19	How effective are these eLearning environments and equipment, when they are available, in removing barriers to post-secondary education for students with physical disability?	58
Figure 20	How effective are these eLearning environments and equipment, when they are available, in removing barriers to post-secondary education for students with sensory disability?	59
Figure 21	How effective are these eLearning environments and equipment, when they are available, in removing barriers to post-secondary education for students with communication disability?	60
Figure 22	How effective are these eLearning environments and equipment, when they are available, in removing barriers to post-secondary education for students with cognitive disability?	61
Figure 23	Do you or other disability support staff provide training, instruction or guidelines to faculty members on how to...?	64
Figure 24	Are there official policies and guidelines for faculty and staff on how to ensure access to electronic and information technologies for students with disabilities? (n=99)	69
Figure 25	Have you or other disability support staff at your institution...?	75
Figure 26	Compared to five years ago...	76
Figure 27	Thinking about the next five years, do you think...?	76
Figure 28	Assistive Technology evaluation process	83

Executive Summary

The Social Research and Demonstration Corporation (SRDC), working with Neil Squire Society, has undertaken a study of assistive equipment and technology for postsecondary students with disabilities. The three aims of the study were: to inform assistive technology (AT)-related decision-making for Canadian post-secondary institutions and jurisdictions; to provide guidance for individuals with disabilities, post-secondary staff, and policy makers around the selection of appropriate AT to address disability-related education barriers, and; to assist Canadian jurisdictions in forming policy and practice for the delivery of funding, notably the Grant for Services and Equipment for Students with Permanent Disabilities.

This final report draws together findings from a comprehensive literature and information source review, the compilation of an AT inventory and four components of pan-Canadian fieldwork. SRDC surveyed 99 post-secondary institutions' disability service providers and 15 provincial and territorial civil servants directing support programs. SRDC also worked with NSS to conduct more detailed in-depth interviews with 22 post-secondary support staff and 21 post-secondary students with disabilities.

The projects' findings are presented under the five originally-designated headings for the investigation, followed by a summary of remaining knowledge gaps and a set of recommendations.

Assessment processes/practices used to identify suitable AT applications

In general, despite a thorough exploration to locate peer-reviewed research for each research topic, SRDC/NSS found very little rigorous evidence on AT at the postsecondary level. In this case, we found very limited prior evidence on assessments processes to identify and match AT to postsecondary students' requirements. One Canadian study found that specialized assessment processes to match AT to students' needs were not standardized or regulated in Canada. There were several different types of service delivery model (including universal design for learning) with implications for the assessment process. Across the different models, the procedural steps were broadly similar, perhaps best exemplified in a review of AT service delivery models in 21 European countries (Stack et al., 2009; Federici et al., 2014). Typically, procedures run from initiation through assessment, recommendation, selection and procurement to usage (including training), a sequence that seems broadly applicable to Canadian institutions also.

Exploration in phase two with students and staff found later steps in this intended sequence received less attention and that the overall assessment process to identify suitable AT for Canadian post-secondary students with disabilities was very individualized. In their descriptions, students and staff typically described a similar sequence (i.e., a meeting with staff to review documentation and identify needs, identification of possible AT solutions, followed by steps to obtain the technology). Support staff reported considering students' needs, preferences, and past experiences with technology on a case-by-case basis so as to understand the student's "whole story." They also tended to rely a great deal on their own knowledge and experiences with AT. Most based their recommendations to students on the data gathered about the individual, his or her environment and tasks. Many fewer collected data later to determine the effectiveness of AT. Similarly, among

the fifteen respondents to the survey of provincial/territorial representatives, fewer than half (n=6) indicated they knew their province or territory had collected province/territory-wide data to monitor the use of AT devices at post-secondary institutions.

The level of satisfaction with assessments among the students interviewed was mixed. A slight majority were satisfied with the process overall. Reasons for less satisfaction included: lengthy wait times to get an appointment or to obtain the technology and, more importantly, the selected AT did not meet their needs or was not a good fit for them. While students were typically satisfied with their AT, they offered a number of suggestions to help improve their access to and use of AT:

- Access to a wider range of AT as well as access to AT they considered more responsive across a wider variety of user needs;
- Better or more user-friendly programs and devices (specific suggestions varied from student to student, according to their disabilities and needs, but included items such as reading, writing, and math programs and web browser navigation tools);
- Better ability to access AT software on smart phones;
- Centralized access to AT advice and support.

Most schools reported providing training on the specific AT selected. Over half of the 22 students interviewed indicated that they had received training from their post-secondary institution on how to use their AT, either at their current school or at a previous one. Most were satisfied with the training although there were exceptions. Those who had no training either already knew how to use the AT or they figured out how to use it on their own. For some, this approach was sufficient. For others, the lack of training proved very challenging representing a pitfall to in their postsecondary experience.

Trends/potential for application of AT as part of the universal design for learning (UDL)

“Universal design” (UD) – the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design – can be applied to *learning* as UDL: an educational framework that guides the development of flexible learning environments that can accommodate individual learning differences. UDL is a *proactive* approach focused on ensuring access to all participants with a broad range of characteristics and thus contrasts with more *reactive* accommodation that requires students to disclose disabilities, provide documentation, and request AT or other supports that may or may not be approved.

The literature implies a positive relationship between AT and UDL whereby UDL facilitates the integration of AT to address disability-related barriers. Some students will continue to need AT even in learning environments that are well equipped with UDL materials and methods. Nonetheless, UDL should help facilitate the use of AT that responds to individual needs.

All respondents to the survey of post-secondary support staff viewed UDL as either very (88 per cent) or somewhat important (12 per cent). When asked whether the principles of UDL had been

implemented at their school, responses were fairly evenly split between yes (42 per cent) and no (43 per cent) with the remaining 14 per cent unsure. One institution included in the interviews had an official mandate to understand UDL principles. It had developed a UDL primer, delivered a three-day UDL institute to faculty, addressed UDL during new faculty orientation, and provided tips and information on how UDL could look in the classroom. However, most interviewees reported implementation at their institution was happening sporadically or in pockets (e.g., among certain faculty) or that only “weak” attempts had been made. That said, most staff interviewees felt at least some progress had been made in the past five years, such as:

- Better awareness, understanding, and appreciation of UDL;
- Recruitment of campus UDL champions and specialists;
- Faculty training on UDL principles;
- Adoption of UDL principles for updates to existing courses and development of new ones;
- Broader availability of so-called AT for the entire student body (e.g., text-to-speech and speech-to-text software);
- Better accessibility of course materials (e.g., alternate formats, online platforms, digital materials);
- More course delivery options (e.g., online);
- Some change in practice (e.g., recognition of different learning styles and different means of assessment for each).

Some interviewed students mentioned the need to recognize the benefits of AT for all students, not just those with disabilities and recommended mainstream adoption of AT simply as “technology,” not a distinct category of technology only for persons with disabilities. However, staff interviewees reported mixed levels of optimism that UDL principles would be incorporated within the next five years. Some felt the status quo would be maintained for some time to come or, at best, change would happen slowly.

An inventory of available AT to address disability-related barriers to education

An AT inventory has been compiled based on the expertise of NSS, using a number of sources. The inventory includes items that have frequently been used and recommended in educational contexts, items that are frequently sold by various AT manufacturers, and those identified in the literature review. SRDC/NSS have provided the inventory as an Excel database separate from this report, with searchable categories. The resource has the potential to be transformed into another format to facilitate use by practitioners, students, and the general public.

The fieldwork did not add materially to the inventory. Students with disabilities in Canadian colleges and universities use some form of AT to facilitate their learning. In line with the literature, those providing access to supports at institutions reported in the survey that the AT most

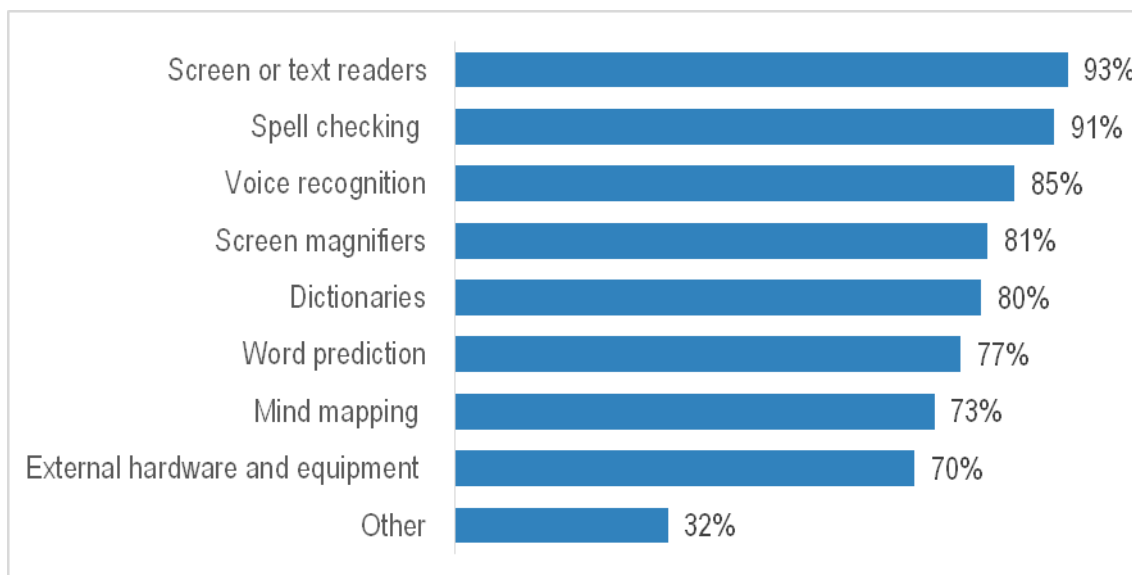
commonly used was designed to support reading and writing, along with brainstorming/mind mapping software (Figure ES1). Most frequent for reading was text-to-speech/optical character recognition/speech synthesis (e.g., Kurzweil 3000™ and Text Help software™), while for writing it was speech/voice recognition (e.g., Dragon Naturally Speaking™) and word prediction (e.g., Text Help™; Outlining/Mind Mapping Software).

Students interviewed most commonly indicated they used a range of AT for reading, writing, listening, and note-taking activities, in particular:

- Reading – text reader/e-reader, text-to-voice software, optical character recognition, closed captioning, screen magnifier, alternate format materials;
- Writing – adapted keyboard, screen or hand-held magnifier, voice-to-text software, mind-mapping and outlining software, content generation tool, software to check written work;
- Listening – hearing aid, recorder/recording applications (“apps”) to play back later;
- Note-taking – recorder/recording apps, audio note-taker, note-taking app, smart markers/pens (as well as AT to assist with the listening and writing aspect of note-taking).

Students less commonly reported using AT for things like planning, organizing, memorizing, and focusing. When they did use AT for these tasks, they typically identified software or apps (e.g., for mind mapping). Some students indicated an interest in AT for these activities but said they were not aware of AT that would help them.

Figure ES1 What AT devices are available at your institution to assist students with disabilities? (Survey of PSE support providers, n=99)



Assessment of effectiveness of distinct categories of AT for addressing disability-related barriers to education

Our search of the peer reviewed literature showed that the evidence on the effectiveness of AT is scarce. A general problem is that recent research has not kept up with the explosive growth in technology. Some authors have pointed out that AT is often deemed to have a positive impact on educational performance merely by virtue of having a practical application. Indeed, one review found that a large percentage of studies used anecdotal evidence (e.g., with the use of AT an individual was able to perform a task they were not able to before) without evaluating effectiveness, such as comparing two assistive devices. This type of evidence is not sufficient for all types of AT nor for selecting from a suite of available devices.

The majority of disability support staff survey respondents indicated that various types of AT available were effective in removing barriers for students with a **physical disability**, a **sensory disability**, a **communication disability** or a **cognitive disability**.¹ The top rated items identified as very or somewhat effective by over 90 per cent of respondents were:

- For those with a physical disability – voice recognition, screen or text readers and external hardware/equipment;
- For those with a sensory disability – screen magnifiers, screen/text readers and voice recognition;
- For those with a communication disability – spell checkers, screen/text readers and word prediction;
- For those with a cognitive disability – spell checkers, mind mapping tools and word prediction.

Most types of eLearning tools and resources were also reported effective in terms of removing barriers for students with diverse disabilities.

¹ These terms were defined in the survey as follows:

- Physical disability – a condition that limits one or more basic physical activity.
- Sensory disability – a condition affecting one of the five senses, typically vision, hearing, or touch.
- Communication disability – an impairment to the capacity to use expressive and/or receptive language in one or more of the following areas: speech, conveying information, and understanding information.
- Cognitive disability – an impairment that affects an individual's ability to access, process, or remember information.

Among the students interviewed, there was consensus that their AT had had a positive impact on their post-secondary experience (some quotes are included below). Depending on the nature of their disabilities and the type of AT they used, they felt they had generally seen improvements in tasks such as their reading, writing, listening, and/or note-taking abilities along with memorization, focusing, planning and organizing – allowing them to work more efficiently and resulting in better quality assignments and better grades. Some had found more independence (e.g., by no longer relying on human supports like interpreters). Even a student who had abandoned her AT felt that knowing it was there had increased her confidence. For some, post-secondary education would not have been possible without AT.

“Without access to assistive technology, I either wouldn’t be participating, or I’d be struggling a lot more. I would say it facilitates it, and it’s an essential part of my participation for sure.”

“If I didn’t have it, I would probably be a B student rather than an A student.”

“It changed everything. You know, I almost quit my PhD several times when I was in the process of trying to sort it out...it is so much difficult effort to do this work without assistive technology.”

“The success of my academic career is dependent upon assistive technology.”

“Not having access to disability technology can literally prevent someone from achieving any type of goal or dream in their life.”

“To get an education and be competitive in this world, we need to have the technology available to us to do that.”

(Student interviewees)

Post-secondary disability support staff interviewees indicated that in general they used informal means to assess the effectiveness of AT in removing barriers to post-secondary education, usually relying on anecdotal feedback from students. In many cases staff interviewees indicated that they would have preferred a more systematic or formal means for assessment but were restricted by a lack of time and resources. Yet most were fairly satisfied overall with the process.

When staff were asked if there was a need to standardize the assessment process on a provincial or national level, comments were mixed. Some felt it would be difficult because of the variation in students’ disabilities and needs. Even most of those who could see some benefit to such an approach highlighted the need for flexibility and would prefer guidelines to fixed rules.

Assessment of potential effectiveness of new/emerging technologies

Technological advancements are bringing new products and applications to the market on a continuous basis. As the available evidence tends to lag behind the pace of innovation, some experts have argued that these new innovations can become considered as reasonable tools provided they are based on other evidence-based practices, techniques and procedures.

Post-secondary support staff interviewees indicated that finding the time to stay abreast of ever-changing AT was a major challenge to their work. They commonly heard about and/or assessed new and emerging AT through three sources: (1) listservs, online information and webinars, and

conferences, or (2) through communication with colleagues, peers, professional associations, private companies, or (3) organizations like the CNIB, ATBC, Neil Squire Society, and the High Tech Centre Unit in California. Other suggestions for improving processes to assess new and emerging AT included the following:

- Opportunity to communicate directly with AT developers (rather than only with company support lines) – e.g., focus groups/product testing or advice from developers on what one should consider when assessing the technology;
- A provincial – or ideally a national – research body to keep all post-secondary institutions up to date and make recommendations around new and emerging technology;
- Centralized website or community of practice accessible;
- Tools (e.g., a checklist) for evaluating new software or devices;
- Funding for professional development related to the identification and assessment of new and emerging technology and/or to hire additional staff to help keep up to date AT.

Gaps in knowledge

The literature review identified gaps in knowledge around how to best utilize AT that responses to SRDC/NSS surveys and interviews did not necessarily fill (although responses obtained during the fieldwork were able to shed more light in some areas). The remaining gaps in knowledge include:

- There is a persistent gap in knowledge on the **relative effectiveness of AT devices**, and a paucity of high quality research on the efficacy of specific AT of appropriate combinations of approaches such as specific pairings of AT with learning strategies.
- More work is still needed to better understand the **factors influencing acceptance or abandonment of AT**. In-depth longitudinal research could explore the interaction between the characteristics of AT users and their academic task demands to pinpoint flaws in the process that lead to AT mismatch. SRDC/NSS obtained relatively little additional insight from its collection of point-in-time accounts from a handful of cases with abandonment.
- **Optimal training and professional development** – SRDC’s survey identified the types of professional development currently provided and sought, as well as failings in existing training provision. For example, not many provinces coordinate training leading to ad hoc development of AT expertise. On campus provision of AT training to faculty to support exam-taking is almost universal, while training on use of accessible instructional technologies is much less widespread.
- Understanding **applications of AT within UDL** and **trends in AT applications** represent moving targets for knowledge-building. The survey shed light on the most prevalent trends on Canadian campuses and included 44 per cent who were optimistic that the principles of UDL would be adopted across all institutions within five years.

Recommendations

Recommendations for increasing the accessibility of post-secondary education for students with disabilities through changes to AT are derived from the literature review (especially a recent study by Fichten et al. of Canadian AT and emerging trends) and from analysis of the fieldwork data by SRDC/NSS. Most are directed to post-secondary institutions although several point to more cross-jurisdictional support and collaboration:

- Increase the use of universal design principles, in particular, to ensure the accessibility of digital technologies. Train faculty how to use technology in an accessible way in their teaching, educate on UD principles and provide ongoing support with adoption.
- Require vendors to demonstrate (“show me how”) that their products are accessible to users with disabilities. If the institution purchases an inaccessible product, it should require vendors to provide a timeframe for when an accessible version of a product will be available.
- Institutions should explicitly describe their commitment to digital inclusion in policies that govern the use of technology in teaching and learning.
- Institutions should deliver training on the use of frequently used AT to helpdesk and other IT staff who interact with the student body and provide them with awareness training on accessibility. By doing this, day-to-day technical trouble-shooting can shift from the access technologists and the offices providing disability related services to the mainstream helpdesk.
- Minimizing wait times for appointments, funding, and actual AT. These delays can have a negative impact on students (who fall behind while waiting for AT to arrive). Ideally systems should be structured to provide AT to students before their classes start.
- Addressing funding barriers. The Canada Study Grant for persons with permanent disabilities does not require pre-payment for AT. Nonetheless the scope of the project included all post-secondary students with a disability. Among those with other funding sources, cost recovery can be slow meaning many students have to pay money up front and wait for reimbursement – that some find very difficult to manage. There is a large challenge also for those students facing high AT costs who find they are ineligible for funding.
- Re-think student training. Most students in our sample were satisfied with their training, but not all. Some provided concrete suggestions, such as providing training prior to start of classes, making available options for online training. Inadequate training is cited as one of the prime reasons for abandonment.
- Facilitate more follow-up on AT utility with students. Although students and staff seem satisfied with the processes, in some cases staff are really unaware of whether students are using AT successfully. Again this can be related to abandonment.
- Resource allocations need to keep pace with demand and the costs of technology requirements. Many institutions have limited resources (time, money, staff) for AT.

- Assessment guidelines. Interviewees would prefer guidelines to absolute standards, thus a recommendation is to consider developing sets of guidelines. These could be specific for existing needs and more generic for new/emerging technology.
- New and emerging technology. This is a big challenge for many staff interviewed. There is scope for establishing a clearinghouse to compile and share information on available and optimal AT solutions in a timely manner. There is a lot of duplication currently as all institutions strive to varying degrees to stay up to date on their own.

Conclusion

There are two overarching themes in the study findings. The first is that, overall, the existing system of provision of AT is making a big difference to the learning experience of students in Canada. Students said that, at a minimum, they would not be able to do as well in post-secondary education without AT. For some, post-secondary education would be impossible without the AT they could access. Post-secondary disability support staff thought AT trends were moving in the right direction. More than 80 per cent both saw barriers for students being more effectively addressed than five years ago and felt educators' awareness of issues had increased. For the future, staff strongly tended towards seeing more standardization in practices related to AT at the institution (75 per cent) and federal (55 per cent) levels in the next five years.

The second, counterbalancing theme is that there are still challenges, including (especially) long wait times to get appointments with disability staff and to receive AT. Some students also struggle with paying initial up-front costs for their AT and their learning would be facilitated by faster access to the funding. There is room to accelerate the pace of access to education among students with disabilities by facilitating cross-jurisdictional learning on promising practices in areas such as training in AT use and guidelines for assessment of the utility of existing and emerging AT.

1. Introduction

1.1 Background

In an era where public agencies are under increasing scrutiny to demonstrate the use of evidence-based practices with measurable outcomes and to maintain accountability for funds dispersed, accurate and up-to-date understanding of all services and supports is essential. To that end, British Columbia's Ministry of Advanced Education – mandated to provide leadership and direction for post-secondary education and training in the province (British Columbia Ministry of Advanced Education, 2015) – has commissioned research on assistive technology (hereafter AT) for post-secondary students with disabilities across the country. The findings are expected to:

- Inform AT-related decision-making for Canadian post-secondary institutions and jurisdictions experiencing challenges related to rapid changes in the AT field and effective provision of appropriate/ applicable AT for addressing disability-related barriers to education;
- Provide guidance for individuals with disabilities, post-secondary staff, and policy makers around the selection of appropriate AT to address disability-related education barriers;
- Assist Canadian jurisdictions in forming policy and practice for the delivery of funding, notably the Grant for Services and Equipment for Students with Permanent Disabilities.

On behalf of the provincial governments of British Columbia (BC), Nova Scotia (NS), and Prince Edward Island (PEI), this work was conducted by the Social Research and Demonstration Corporation (SRDC), a non-profit social policy research organization, in partnership with the Neil Squire Society (NSS), a non-profit society specializing in the use of assistive technologies for people living with disabilities. The work is intended to result in better understanding of the applicability and effectiveness of AT within the context of facilitating access to education for students with disabilities for both policy makers and practitioners in Canada.

This final report describes the findings from the first and second phases of the project. Phase 1 involved a comprehensive literature and information source review and the compilation of an AT inventory. Phase 2 involved online stakeholder surveys, and key informant interviews, subsequent analysis and the development of recommendations. The scope of the work covered the following five areas of inquiry:

- (A1) Overview of assessment processes/practices used by practitioners, organizations, and/or jurisdictions for identifying suitable AT applications to meet student needs
- (A2) Overview of trends/potential for application of AT as part of the universal design for learning in post-secondary education curriculum delivery
- (A3) Inventory of available AT for students with visible and/or invisible disabilities and applicability for addressing disability-related barriers to education (including relative costs and ability to facilitate distance learning)

- (A4) Assessment of effectiveness of distinct categories of AT for addressing disability-related barriers to education (including best/promising practices in AT applications)
- (A5) Assessment of potential effectiveness of new/emerging technologies.

1.2 Context

In Canada, about 14 per cent of the population (approximately 3.8 million people) reports having a disability (Employment and Social Development Canada, 2015). Numerous disparities related to health, employment, income, and other areas have been documented for people with disabilities (Iezzoni, 2011). However, access to education, particularly higher education, can be an equalizer, linked, for example, to better employment options and higher earnings that can place people with disabilities more on par with other Canadians. Yet many barriers to education continue to exist for this population, including those related to attitudes, accessibility, and finances that can make it difficult to access or finish education (e.g., 16 per cent of youth with disabilities leave their studies for disability-related issues) (Human Resources and Skills Development Canada, 2009).

Accommodations for students with disabilities can help facilitate their academic success, and assistive technologies comprise an important area of student accommodation and support (see Glossary at the end of this report for definitions). Better awareness of disability issues, along with better tools to address them, has led to more students accessing accommodations, particularly in the area of AT. Advances in technology have also resulted in increased access to education through distance learning and led to changes in curriculum delivery. For example, Universal Design for Learning (UDL) is one framework that increasingly guides the development of flexible learning environments for students with individual learning differences in post-secondary settings. Applications of AT within the UDL framework have the potential to make the curriculum more accessible to students with a wide variety of disabilities (Burgstahler, 2003; Simoncelli & Hinson, 2010).

This project gathers information on the ways in which existing features of the learning environments both facilitate and impede access for students with disabilities, as well as on the role AT plays in those environments. This allows us to better describe the current context from the perspective of students with different disabilities, including the types of supports that are and are not available for students. The importance of AT for students and any challenges in accessing it are reviewed and recommendations developed for future policy.

1.3 About this report

This final report summarizes the results from phases 1 and 2 of the project. First, we outline the methodological approach to our study, and the procedures for gathering the wide range of data involved. We then report on the findings, beginning with an outline of key terms related to AT in the context of education. Next, we provide an overview of processes and practices for identifying and delivering suitable AT applications, and discuss existing service delivery models utilized in Canada. The subsequent section focuses on AT applicability as part of UDL, a leading framework for curriculum delivery. Our focus then shifts to an assessment of the evidence on the effectiveness of AT for addressing disability-related barriers to education, and a discussion of best and promising

practices in AT applications. Next, we comment on existing trends with respect to AT applications in post-secondary settings. Finally, we end with conclusions and recommendations.

2 Methodology

2.1 Research questions

Research questions for the study were developed in an iterative process that included stakeholder consultations and a review of the literature. They are listed below under each area of inquiry.

(A1) Overview of assessment processes/practices used by practitioners, organizations, and/or jurisdictions for identifying suitable AT applications to meet student needs

- What are the existing processes and practices to identify and deliver suitable AT applications to meet student needs?
- What evidence is available on the effectiveness of these processes and practices?

(A2) Overview of trends/potential for application of AT as part of UDL in post-secondary education curriculum delivery

- What is UDL and how does it facilitate access for students with disabilities?
- What are the existing best/ promising practices regarding the application of AT as part of UDL in post-secondary education curriculum delivery?

(A3) Inventory of available AT for students with visible and/or invisible disabilities and applicability for addressing disability-related barriers to education

- What is the available AT for students? What is the relative cost of AT devices?
- What is the applicability of the AT for addressing barriers to post-secondary education and for facilitating distance learning by disability type?
- What are the current trends in applications of AT?

(A4) Assessment of effectiveness of distinct categories of AT for addressing disability-related barriers to education

- What is the evidence on effective applications of AT?
- What are the ways in which effectiveness of AT is typically assessed?
- What are the best/ promising practices for AT applications in post-secondary education?

(A5) Assessment of potential effectiveness of new/emerging technologies

- What are the ways in which effectiveness of AT is typically assessed in post-secondary education as new/ emerging AT comes to the market?

2.2 Overview of data sources

The study will utilise a variety of data sources, including literature and information source reviews, stakeholder surveys, and key informant interviews. The overview of the data sources in reference to the areas of inquiry is summarised in Table 1 below.

Table 1 Overview of areas of inquiry and corresponding data sources

Area of Inquiry	Literature/ Information Source Review	Online Survey		Key Informant Interviews	
		Post- secondary disability support staff (n=99)	Provincial/ territorial staff (n=15)	Students with disabilities (n=21)	Post- secondary staff (n=22)
I. Overview of assessment processes/practices used by practitioners, organizations, and/or jurisdictions for identifying suitable AT applications to meet student needs	✓	✓	✓	✓	✓
II. Overview of trends/potential for application of AT as part of the universal design for learning in post-secondary education curriculum delivery	✓	✓			✓
III. Inventory of available AT for students with visible and/or invisible disabilities and applicability for addressing disability-related barriers to education (including relative costs and ability to facilitate distance learning)	✓	✓	✓		✓
IV. Assessment of potential effectiveness of new/emerging technologies	✓				✓
V. Assessment of effectiveness of distinct categories of AT for addressing disability-related barriers to education (including best/promising practices in AT applications)	✓			✓	✓

2.3 AT inventory

The AT inventory was compiled based on the expertise of the Neil Squire Society, using a number of sources. The inventory includes items that have frequently been used and recommended in educational contexts, items that are frequently sold by various AT manufacturers, and those identified in the literature review.

The inventory has been developed as an Excel database, with searchable categories (see Appendix A: for field descriptions). However, it has the potential to be transformed into another format to facilitate use by practitioners, students, and the general public. The inventory was developed from the initial literature review and environmental scan with a view to supplementing with additional items identified in the survey and stakeholder interviews in phase 2 of the project. The initial inventory was, however, sufficiently comprehensive that no new items emerged from the fieldwork.

2.4 Literature / information source review

In order to identify relevant articles and reports for this project, multiple searches of the peer-reviewed and grey literature were conducted. Due to the rapid changes in technology, the review examined information produced within the last five years (2010 – to the present). Searches were limited to materials published in English and French (specific to Canada). The literature search took a national focus, and was supplemented with international information.

In terms of the peer reviewed literature, a comprehensive search was conducted of PubMed, ERIC and CINAHL databases, using combinations of the following keywords: (search 1) assistive devices, assistive technology, student, post-secondary, education, and disability, and (search 2) assistive devices, assistive technology, and universal design.

The first search yielded 83 results in PubMed, 277 in ERIC and 133 in CINAHL. The second search yielded 9 hits in PubMed, 21 in ERIC, and 18 in CINAHL. All abstracts were reviewed for relevance based on the following criteria and scope: (a) Assistive technology use outside the post-secondary context (e.g., K-12 schools, home, workplace, or community); (b) Assistive items other than technology (e.g., ergonomic furniture, seating, desks); and (c) Assistive services (e.g., sign language interpreters, tutors, academic coaches). In addition, results obtained in CINAHL were filtered to ages 19-64 with relevant major subject headings. All duplicates were removed.

Based on the above criteria and after removing duplicates, 8 articles were found in PubMed, 47 in ERIC, and 9 in CINAHL. The references from the articles selected for this review were also examined and supplemented with Google Scholar searches. In this way, 18 additional articles were added, for a total of 82 peer reviewed articles.

In terms of the grey literature, we used advanced Google searches for the above keywords as well as additional terms (e.g., AT best practices, service delivery models, services, assessments). We also reviewed information through direct access to specific communities of practice (CoP) and websites. These included, but were not limited to:

- (a) National and international government departments and agencies (e.g., Assistive Technology BC; Ontario Assistive Devices Program, BuyAccessible.gov);
- (b) Non-governmental organizations (e.g., National Educational Association of Disabled Students, Quality Indicators for Assistive Technology Community, Rehabilitation Engineering and Assistive Technology Society of North America);
- (c) Post-secondary institutions and organizations (e.g., Association of University Centres on Disabilities, Adaptech Research Network, University of Washington DO-IT Center); and
- (d) Communities of Practice (e.g., IT Accessibility Constituent Group, Disability Federation of Ireland AT for Inclusion CoP, Supporting Families of Individuals with Developmental and Intellectual Disabilities CoP).

While a variety of keywords were used to identify as many articles and reports as possible, we have found that many different terms are used in the literature for information relevant to this study. Given the differences in terminology – and the fast pace of technological changes used to address the relevant subject matter – this review may not be exhaustive.

2.5 Online survey

Between November 2016 and January 2017, SRDC administered online surveys in English and French to two key groups: (a) service providers who support students with disabilities at post-secondary institutions, and (b) provincial and territorial government representatives engaged in directing supports to students with disabilities and interviews with post-secondary students.

Post-secondary disability service providers

The survey of disability support providers took a census approach whereby SRDC sent email invitations to virtually all identified post-secondary institutions in the country. Contact information was compiled using online information publicly available through the National Educational Association of Disabled Students (NEADS) and institutional websites.

The online questionnaire queried respondents about aspects of their institution, overall approach to AT, assessment processes, types and perceived effectiveness of available AT and eLearning supports, universal design issues, and AT trends.

A total of 99 out of 280 invitees responded for a response rate of 35 per cent. Respondents represented all provinces and two territories. Approximately half (51 per cent) represented community colleges or *Collèges d'enseignement général et professionnel* (CEGEPs), while 43 per cent represented universities, and 3 per cent each represented technical/vocational schools or other types of institutions.² The majority (80 per cent) indicated their office was the sole provider of

² Other types of PSE institution were identified as: a combination of a college and technical/vocational institute, a combination of a college and university, and a service providing AT and related resources and support to post-secondary institutions.

services and supports to students with disabilities at their institution.³ Additional details on the institutions represented in the sample are provided in Figures 1 to 3.

Figure 1 Province/territory of post-secondary support staff survey sample (n=99)

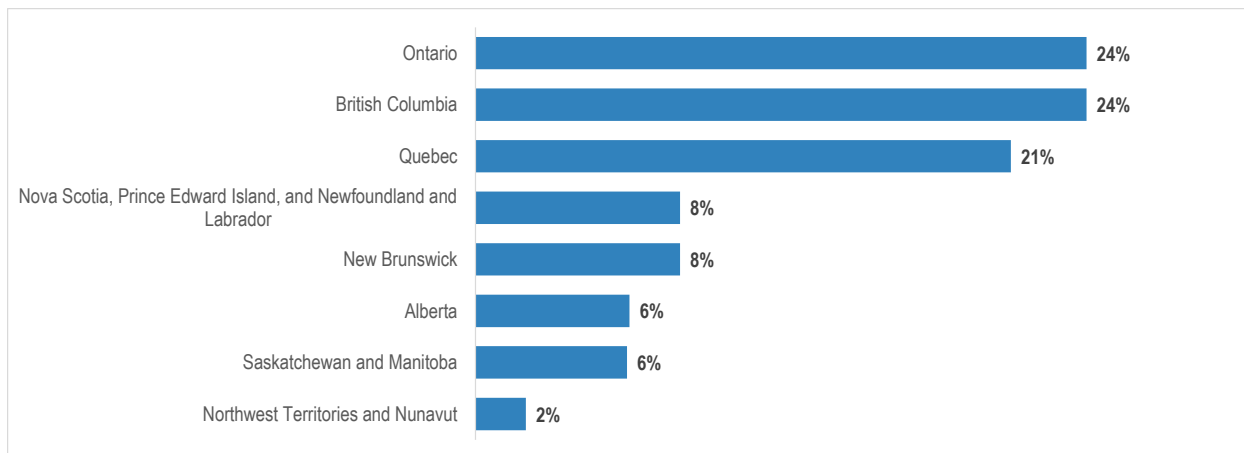
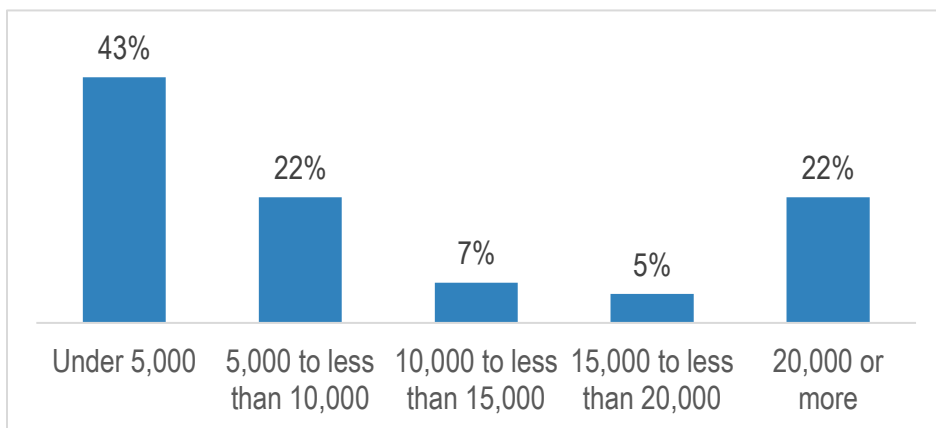
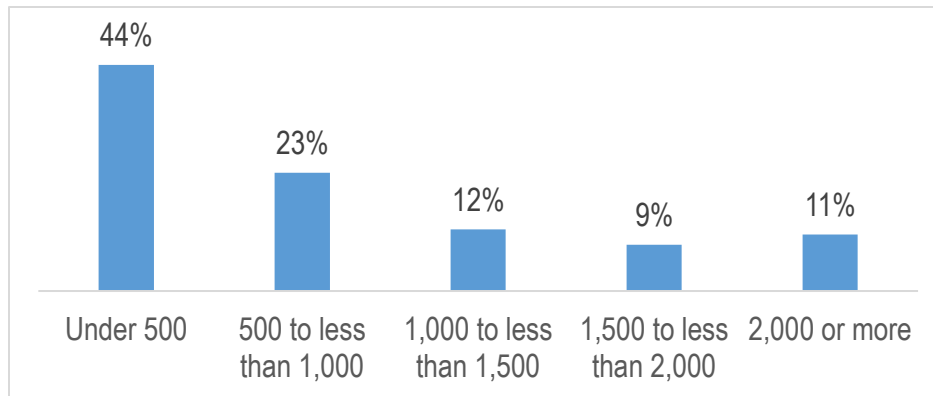


Figure 2 Number of full- and part-time students registered at institution (n=99)



³ Nineteen respondents indicated their office is not the sole provider of services and supports to students with disabilities, with most identifying one (n=7) or two (n=4) other offices providing services either on the same or other campuses. Seven respondents indicated there were four or more (up to 12) other offices providing services, while a very small number indicated they do not have a specific office for students with disabilities. One respondent did not know whether his/her office was the sole provider.

Figure 3 Number of students with disabilities registered at institution (n=99)



Provincial and territorial representatives

The survey of provincial and territorial representatives targeted those engaged in directing supports to post-secondary students with disabilities. SRDC sent email invitations to a total of 31 individuals for whom contact information was provided by BC's Ministry of Advanced Education.

Survey questions focused on: provincial and territorial level policies and guidelines for AT use at post-secondary institutions; professional development opportunities available to post-secondary staff; instructions and guidelines for AT use; related data collection and monitoring.

Fifteen individuals responded for a response rate of 48 per cent. Respondents represented eight provinces and two territories (with one to three respondents each). Just under half of respondents (n=7) reported that their province or territory had a department or division responsible for AT in general. Note that due to the low number of respondents, results from the survey are presented in this report as frequency counts (n) rather than percentages.

2.6 Key informant interviews

Between December 2016 and February 2017, SRDC researchers and Neil Squire Society staff conducted interviews with two groups of key informants: (a) post-secondary support staff, and (b) post-secondary students who use AT.

Post-secondary disability support staff

Interviews were conducted with 22 post-secondary disability support staff (21 by telephone and 1 by email), selected from among respondents to the prior survey of this stakeholder group described above. Recruitment efforts targeted a range of interviewees representing different types of post-secondary institutions across the country. A priority was placed on including those whose survey responses indicated their institution had implemented UDL principles. All provinces and one territory were represented in the final sample (from one to three interviews per province/territory) as well as a mix of colleges/CEGEP (n=9) and universities (n=13).

Interviewees' roles included assistive technologists, AT or learning specialists, support workers, facilitators, coordinators, advisors, counsellors, managers, and directors in the area of AT specifically or broader disability/accessibility policy as well as adapted, or learner services.⁴ The services they provided ranged from one-on-one support through consultation and support for students (e.g., to assess and select suitable AT) to overall management or oversight of services within the department or centre.

The interview protocol focused on: available AT services; processes to identify suitable AT for students and assess its effectiveness; assessment of new and emerging AT; UDL implementation, and recommendations for improvement. Each interview lasted approximately 20 to 40 minutes in length. All interviews were audio recorded and subsequently summarized and analyzed thematically at the aggregate level.

Post-secondary students

Interviews were conducted (19 by telephone and 2 by email) with 21 post-secondary students who identified themselves as users of AT. Interviewees were recruited through an online posting distributed by NEADS and the Neil Squire Society, inviting students with disabilities to sign up online for an interview. The final sample of students⁵ represented 15 post-secondary institutions across six provinces (from two to seven interviews per province). Their schools included a mixture of universities (n=14), colleges/CEGEP (n=6), and one technical institute. Respondents were studying in a range of different programs (including graduate programs) and at different stages of their studies (from the first to last year). They also identified a variety of disabilities – physical, sensory, communication, and cognitive.

The interview protocols focused on: the accessibility of courses and materials; processes to identify suitable AT; the types of AT they used and related training; important feature of AT; and recommendations for improvement. Interviews were approximately 30 minutes in length. Like the post-secondary staff interviews, the student interviews were audio recorded, summarized, and analyzed by theme in aggregate.

2.7 Ethical considerations

SRDC's planned survey and interview procedures, as well as the instruments themselves and consent forms were submitted for a privacy impact assessment by the Ministry of Advanced Education. The assessment documents were prepared in May and June 2016 and the review began in July. Approval for the study to proceed was granted at the end of September 2016. SRDC adhered to the recommended approach in the subsequent months of fieldwork.

⁴ One interviewee worked in information technology (IT) support but conducted his work jointly with student services.

⁵ One interviewee was in a post-doctorate role at the time of the interview but had been a student in the previous year. Another was taking continuing education courses at a university.

The study implemented a formal informed consent process. Survey respondents and interviewees were provided with background information on the study, including the purpose of the survey/interview and identification of SRDC as the research organization and the BC Ministry of Advanced Education as the funder (acting on behalf of the Canada Students Loans Program's multi-jurisdictional Permanent Disability Working Group). Details on the protection of privacy were also provided along with a formal Collection Notice. Survey respondents were required to confirm their understanding of the survey purpose and agree to the handling of their responses as described in order to access the survey questions. All interviewees provided informed written or recorded verbal consent prior to commencement of their interviews.

3. Results

3.1 Overview of Assistive Technology

AT definitions and classifications in the context of education

There are numerous and often inconsistent definitions of AT across the literature. **Assistive technology** is most often defined as “any item, piece of equipment, software, or system that is used to increase, maintain or improve the functional capabilities of a student with a disability in the context of addressing barriers to education” (Individuals with Disabilities Education Improvement Act [IDEIA], 2004). AT products are currently categorized in numerous ways, for example, classified by disability naming conventions, functional need, activity related needs, or vendors, and there are inconsistencies in AT classifications across legislation, benefits, and industry (Bauer, Elsaesser, & Arthanat, 2011).

In the context of education, AT is often incorporated into the term **accommodations** defined as, “any service, adaptation or support mechanism that enables students with disabilities to participate fully in academic, campus and community life” (National Educational Association of Disabled Students [NEADS], 2012). The term “access tools” has also been used to refer to a wide range of technology tools available to all students (Christensen & Rogers, 2013).

Some authors point out that under most circumstances, AT is necessary because the mainstream curriculum is inflexible and inaccessible to a student with disabilities without it. In contrast to UDL where the curriculum is designed with accessibility in mind (see section 3.3 on Application of Assistive Technology as part of the Universal Design for Learning in post-secondary education curriculum delivery), in the assistive technology model, the curriculum itself does not change, but the student uses a tool to help them access the curriculum (Simoncelli & Hinson, 2010).

Given differences in the potential role AT might play under these different definitions, the survey of post-secondary disability support staff included questions to gauge the approach to AT being applied in practice at Canadian institutions.

Overall approach to AT: post-secondary disability support staff surveyed

The survey of post-secondary disability support staff asked respondents to indicate their level of agreement with a series of statements that, together, helps to build a profile of responding institutions’ overall approach to AT. The results show that most considered AT needs for all their students with a disability, regardless of type or severity, and that a range of options would be considered for each student. In addition, while most respondents reported basing their recommendations for suitable AT on data gathered about individual students, their environments and tasks, many fewer collected data to determine the effectiveness of AT. Table 2 summarizes responses to questions about approach to AT. In addition, we return to many of the topics covered in this table in discussions later in this report.

Table 2 How well do the following statements describe your institution's approach to AT?

Area of inquiry	n	Somewhat / completely true	Neither true nor false	Somewhat / completely false
At my school, AT devices and services are considered for all students with disabilities regardless of type or severity of disability	99	79%	9%	12%
When AT is needed, my team explores a range of AT devices, services, and other supports that address identified needs	99	90%	6%	4%
The AT consideration process and results are well-documented at my school, and include a rationale for the decision and supporting evidence	99	68%	24%	8%
At my school, procedures for all aspects of AT assessment are clearly defined and consistently applied	99	48%	34%	17%
Recommendations from AT assessments at my school are based on data about the student, environment, and tasks	99	87%	11%	2%
AT needs are reassessed any time changes in student, environments, and/or tasks result in students' needs not being met with current devices and/or services	99	84%	11%	5%
At my school, AT is integrated into the curriculum and daily activities of the student across environments	99	38%	33%	28%
My team conducts evaluation of AT effectiveness that includes the quantitative and qualitative measurement of changes in the student's performance and achievement	97	28%	35%	37%
At my school, data are collected to provide disability support teams with a means for analyzing student achievement, identifying supports and barriers that influence AT use, and determining what changes are needed	96	17%	30%	53%
My institution has written procedural guidelines that ensure equitable access to AT devices and services for students with disabilities	97	29%	26%	45%
Faculty and staff at my school have the competencies needed to support quality AT services within their primary areas of responsibility at all levels throughout institution	98	22%	29%	49%
My institution provides access to ongoing learning opportunities about AT for staff and students	98	40%	23%	37%
My institution provides comprehensive AT professional development and training that address all aspects of selection, acquisition, and use of AT	97	26%	27%	47%

Current use of AT in Canadian post-secondary institutions

Empirical research on AT use by post-secondary students with different disabilities in Canada is limited (Fichten, Asuncion, & Scapin, 2014; Holmes & Silvestri, 2012). Available data from studies conducted in 1999 and 2000 showed that virtually all students with disabilities in Canadian colleges and universities used some form of technology to facilitate their learning. In this research, AT was categorized into three main classes: general use information and communication technologies (ICTs) (e.g., word processing), assistive computer technologies (e.g., Braille printer), and those that are “adaptable” (e.g., dictation and screen reading software).

A more recent survey of Canadian post-secondary students with disabilities conducted in 2010 found the most popular type of software was software that improves writing quality (e.g., spelling and grammar checkers, word prediction and mind mapping software).⁶ Other popular forms of technology included text-to-speech software, large screen monitors, alternative mice, and adapted keyboards.⁷ ICTs as well as dictation software, scanning and optical character recognition were substantially more likely to be used by students from English language schools compared to their French speaking counterparts (Fichten et al., 2010).

The specific AT most frequently used in Canada for reading was text-to-speech/optical character recognition/speech synthesis (e.g., Kurzweil 3000™ and Text Help software™), while for writing it was speech/voice recognition (e.g., Dragon Naturally Speaking™) and word prediction (e.g., Text Help™; Outlining/Mind Mapping Software) (Holmes & Silvestri, 2012). Based on available data, these trends in AT use appear similar to those on US campuses. In both Canada and the US, AT designed to support reading and writing is the most commonly used, with the exception of brainstorming/mind mapping software (to assist with writing), which is more frequently used in Canada (Holmes & Silvestri, 2012).

Both the survey of post-secondary disability support staff and interviews with students has provided SRDC with up-to-date information on the types of AT currently used at Canadian post-secondary institutions by students with disabilities, as well as the types of eLearning equipment available to post-secondary students with disabilities. This information is summarized below.

Perspectives of post-secondary disability support staff

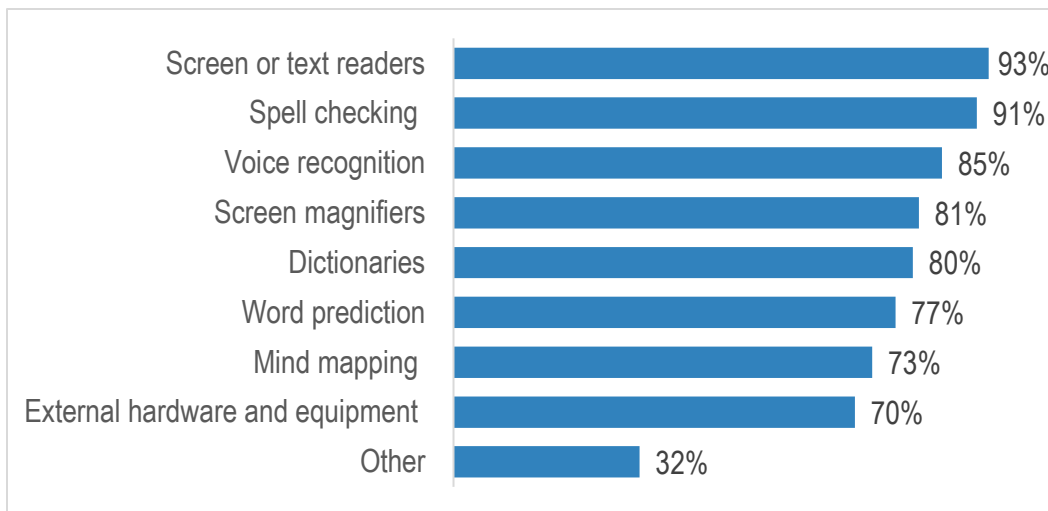
Respondents to the survey of post-secondary disability support staff confirmed uptake of a broad range of AT across their institutions. Screen or text readers were the most commonly reported form

⁶ Mind mapping software is designed to help visual thinkers, those with dyslexia, dyspraxia or other learning differences to organize their thoughts in diagrammatic form and transform the result readily to more standard written documents.

⁷ The term ‘alternative mice’ covers a range of devices (trackballs, joysticks, track pads, switches etc.), which replace mice in computing activities.

of AT, reported by 93 per cent of respondents, followed closely by spell checking AT (91 per cent). Figure 4 indicates the most prevalent types of AT.⁸

Figure 4 What AT devices are available at your institution to assist students with disabilities? (n=99)



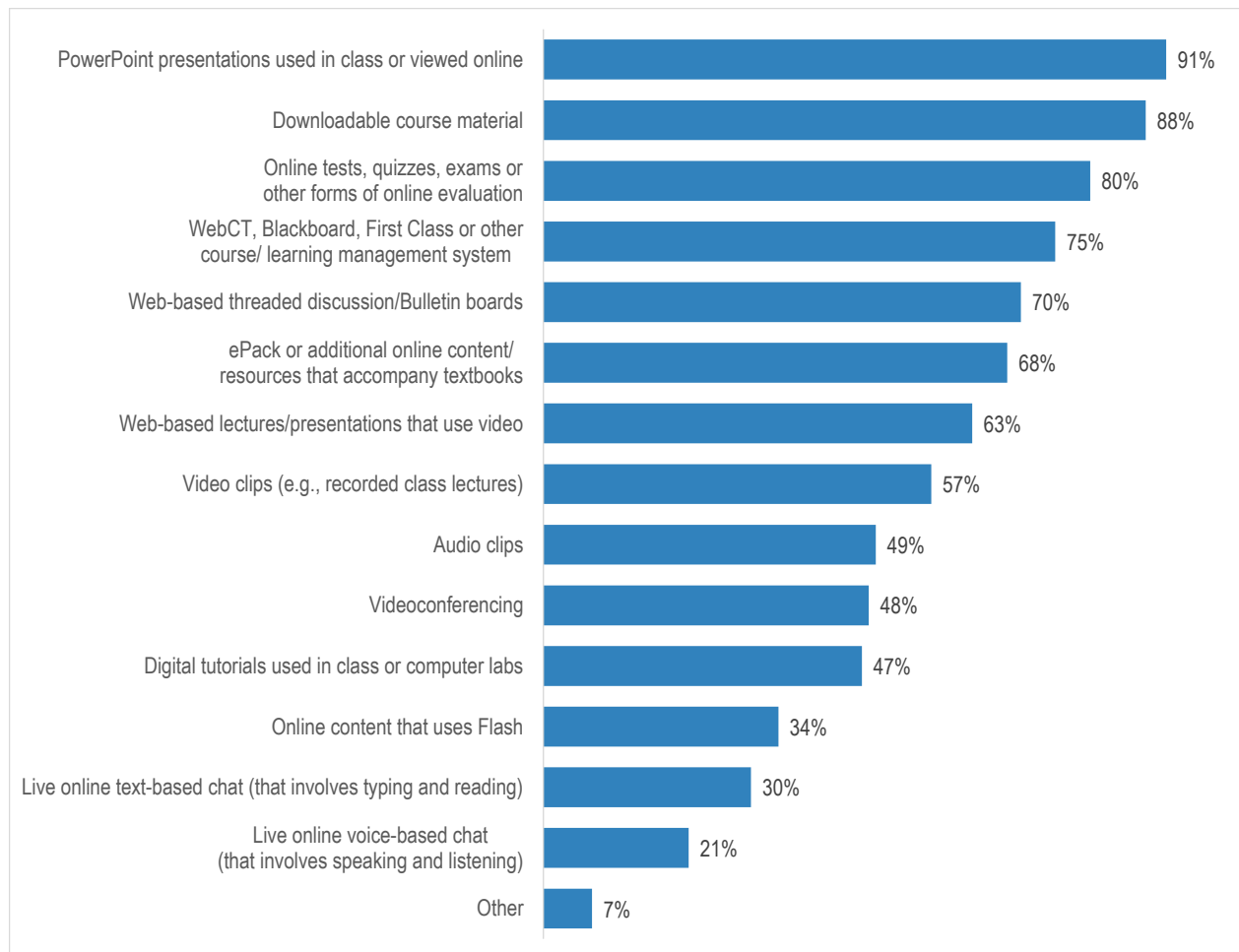
The 32 per cent of respondents who indicated their institutions used “other” types of AT devices identified equipment such as: audio recorders, smart pens, Braille equipment, CCTV, FM system, noise-cancelling headphones, and tablets and related applications. Other AT equipment included talking calculators, relaxation music, planning software, spectral filters, captioning tools, and MP3 players.

Survey respondents also identified the availability and accessibility of a broad range of eLearning equipment to students with disabilities at their institutions. Online or classroom PowerPoint presentations were the most commonly identified (by 91 per cent of respondents), followed by downloadable course materials (by 88 per cent of respondents). Figure 5 provides additional information.⁹

⁸ See the section on *Effectiveness of AT in removing barriers to post-secondary education*, beginning on page 47, for survey respondents’ perspectives on the effectiveness of AT devices in removing barriers to post-secondary education for students with disabilities.

⁹ See the section on *Effectiveness of AT in removing barriers to post-secondary education*, beginning on page 47, for survey respondents’ perspectives on the effectiveness of eLearning environments and equipment in removing barriers to post-secondary education for students with disabilities.

Figure 5 Types of eLearning environment and equipment available and accessible to students with disabilities at your institution (n=99)



The seven per cent of respondents who indicated “other” types of eLearning equipment are available and accessible to students at their institutions identified items such as: a video collaboration platform, remote desktop tools, and online plagiarism checker submissions.

Post-secondary support staff interviewees also mentioned a number of other services provided that complemented AT use, such as: the production of alternate format materials; loans of mainstream technology (e.g., laptops and tablets); making arrangements for other accommodations or human supports (e.g., note-takers, scribes, sign language interpreters); operating exam centres, AT laboratories and lending libraries; acting as a bridge to instructors; mentoring; tutoring; and providing socio-emotional support, academic and career advice, and assistance with study skills and general organization, among others. One interviewee had also partnered with non-profits on annual AT fairs.

Perspectives of post-secondary students

Students interviewed most commonly indicated they used a range of AT for reading, writing, listening, and note-taking activities, in particular:

- Reading – text reader/e-reader, text-to-voice software, optical character recognition, closed captioning, screen magnifier, alternate format materials;
- Writing – adapted keyboard, screen or hand-held magnifier, voice-to-text software, mind-mapping and outlining software, content generation tool, software to check written work;
- Listening – hearing aid, recorder/recording applications (“apps”) to play back later;
- Note-taking – recorder/recording apps, audio note-taker, note-taking app, smart markers/pens (as well as AT to assist with the listening and writing aspect of note-taking).

Students less commonly reported using AT for things like planning, organizing, memorizing, and focusing. When they did use AT for these tasks, they typically identified software or apps (e.g., for mind mapping). Some students indicated an interest in AT for these activities but said they were not aware of AT that would help them. Only one student interviewee noted use of technology for speaking (a Bluetooth keyboard paired with an iPhone to help others understand him), while none identified any technology for math, other than standard calculators.

Although typically satisfied with their AT, students also offered a number of suggestions to help improve their access to, and use of, AT including the following:¹⁰

- Access to a wider range of AT as well as access to AT they considered more responsive across a wider variety of user needs;
- Better or more user-friendly programs and devices (specific suggestions varied from student to student, according to their disabilities and needs, but included items such as reading, writing, and math programs and web browser navigation tools);
- Better ability to access AT software on smart phones;
- Centralized access to AT advice and support.

In addition to their AT, student interviewees noted frequent use of many other types of technology they did not consider to be AT, typically laptops, tablets, and smart phones with accessibility features and apps, as well as electronic calendars. Depending on the nature of their disabilities and program of study, they also used devices like large monitors, lighted bookstands, closed-circuit television and magnifying lamps (to monitor lab research), and miscellaneous software and apps

¹⁰ In addition to these student suggestions, post-secondary disability support staff interviewees identified student needs for the following: access to a wider range of AT in general; availability of more AT for on-campus use (e.g., a standard roster of select AT on all campuses or a minimum number of study rooms, depending on the size of the student population, outfitted with AT); more perpetual licenses for school wide access to software on both staff and students' personal devices; and better access to AT supports in rural areas.

(e.g., file sharing/editing documents for group work, Microsoft PowerPoint). Some also relied on human assistants, either in addition to or instead of AT, such as in-person note-takers, transcribers, and sign language interpreters; the latter could also help speak on the student's behalf.

Over half of students interviewed indicated that they had received **training from their post-secondary institution on how to use their AT**, either at their current school or at a previous one. The training was generally provided in a single one-one-one session approximately 30 to 60 minutes in length. In rare cases more extensive training was offered by the institution (e.g., weekly sessions for approximately two months, access to 24 hours of support per semester). Although the specific details varied depending on the AT, trainers generally showed students how to set up and use the AT and reviewed different features or functions. Students were generally satisfied with the training and felt it had prepared them to use their AT. As well, most reported they could contact staff again if they had any problems.

However, at least a couple of students were dissatisfied with the training. One indicated that the trainer was new to the role and unfamiliar with the technology. As well, the student had not received her own AT at the time of the training, so she had no opportunity to practice at home. Another would have liked more training time and, more importantly, the opportunity for the trainer to accompany her to her first classes to help her reach a level of comfort using the AT in a classroom setting. She reported that ultimately she did not feel prepared to use the AT in class and ended up abandoning it. Suggestions for improvement from students included: providing training modules online so students could learn at their own pace while referring back to the materials as needed; and providing the training prior to the beginning of the term. Students felt that once classes started, it was very difficult for them to try to learn about their new AT at the same time as staying on top of their courses).¹¹

Among the remaining students, three received training elsewhere (from the Neil Squire Society and an audiologist) and were satisfied with the training. The others had no training. Either they already knew how to use the AT from years of prior experience or they figured out how to use the AT on their own (e.g., by reading the help menu, watching videos, using online searches, and contacting the manufacturer). For some, this approach was sufficient. For others, the lack of training proved very challenging representing a pitfall to in their postsecondary experience.

“Even now think I could be using my assistive tech more efficiently or...maximize use of it, but I just don't really have time to figure it out or to learn the keyboard commands and that kind of thing.” (Post-secondary student interviewee)

¹¹ Post-secondary disability support staff interviewees also identified a need for ongoing or refresher training and alternative options for training (such as online, summer “technology camps”) and a need to improve training in rural areas.

Provincial/territorial monitoring and tracking of AT use at post-secondary institutions

Among the fifteen respondents to the survey of provincial/territorial representatives, fewer than half (n=6) indicated they knew their province or territory had **collected province/territory-wide data** to monitor the use of AT devices at post-secondary institutions. Another four did not know whether this had happened.

Where data had been collected, the frequency of collection ranged from less than yearly to monthly. There was variability in the types of data collected, including: number of students served, student usage, tracking of equipment processed through the department, money awarded for equipment and services, and technical and training support provided. One respondent noted that the data collected were not comprehensive while another added that the province was currently working with post-secondary institutions to identify and collect information.

Among the five respondents who indicated their province/territory had not collected data to monitor the use of AT at post-secondary institutions, four indicated it was not very likely that such information would be collected in the future and the remaining respondent said it was not at all likely.

Provincial and territorial survey respondents were also asked whether their province/territory had developed an **inventory** to track commonly-used AT devices at post-secondary institutions in their province or territory. Four of the fifteen said yes, while five did not know.

Where inventories did exist, the frequency of updating ranged from monthly to each semester/term or yearly. Two respondents indicated the information was only available upon request or not readily accessible while one indicated it was not publicly available; the remaining respondent did not comment on the accessibility of the inventory.

Among the six respondents who indicated their province/territory had not developed an inventory, four indicated it was not very likely that such an inventory would be developed in the future. The remaining two respondents said it would be very or somewhat likely.

3.2 Assessment processes and practices used by practitioners and organizations for identifying suitable AT to meet students' needs

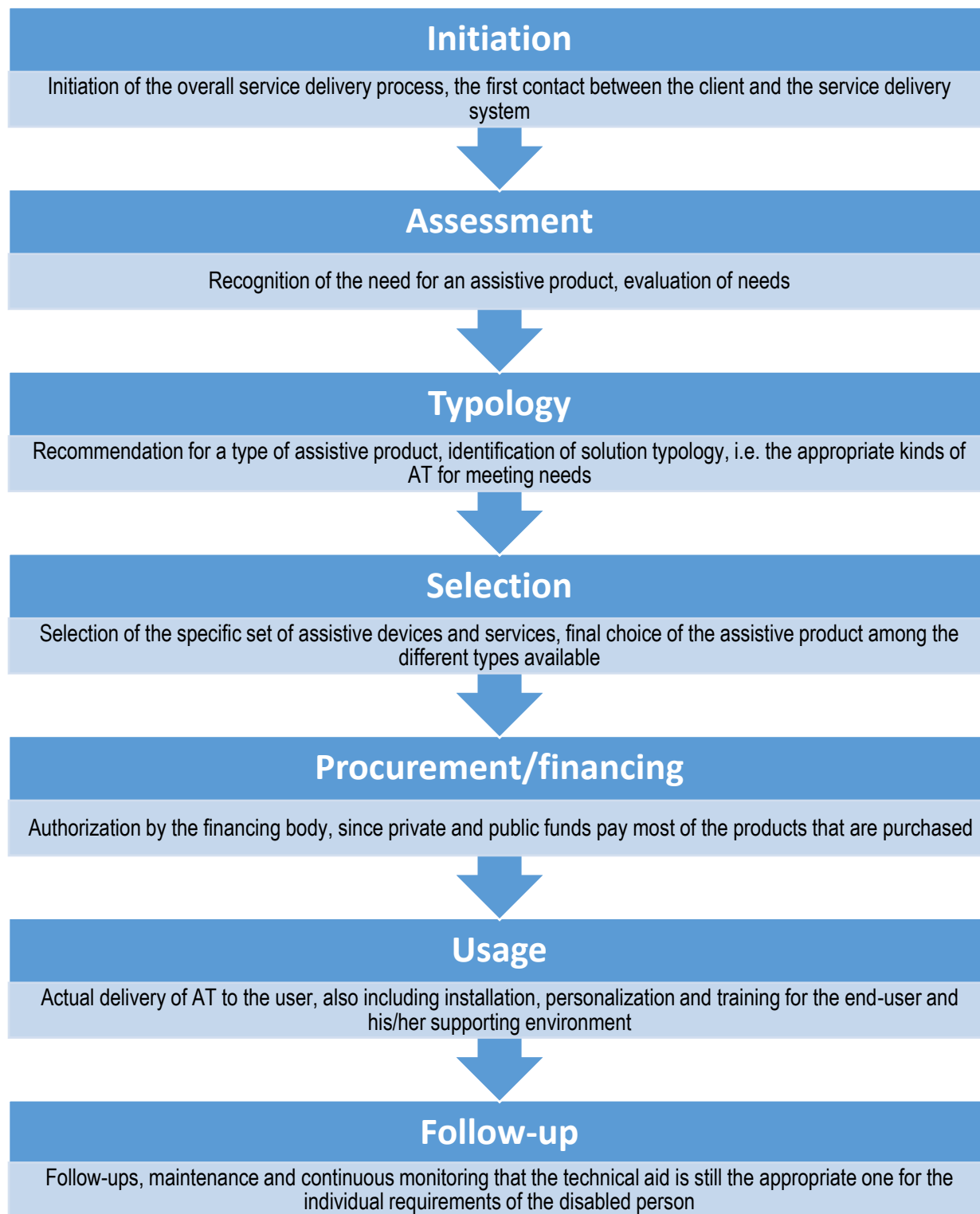
Overview of key terms

AT service delivery model can be defined as “the set of facilities, procedures and processes that act as intermediaries between the AT product manufacturers and AT end-users” (Federici et al., 2014). There are multiple examples of service delivery models (e.g. universal design). There are some common procedural steps regardless of the model. Figure 6 below presents the common procedural steps found in a review of AT service delivery models in 21 European countries (Stack et al., 2009; Federici et al., 2014).

AT service refers to “any service that directly assists a student with a disability in the selection, acquisition, and use of an assistive technology device” (IDEIA, 2004). Assistive technology services include but are not limited to evaluation, device acquisition, device maintenance and repair, training for the student, his family, and educators as needed, and technical assistance.

AT evaluation and **assessment** are often used interchangeably, however, these terms can be distinguished. An evaluation can be thought of as a composite picture of the technology system. Assessment, on the other hand, can be defined as the process of collecting data for the purpose of making decisions (Lahm & Mendoca, 2008). In this report, the term AT assessment is used.

Figure 6 Common steps in a AT service delivery model



Our interviews with post-secondary service providers indicated that the service delivery model followed with students was highly individualized across and within institutions – by necessity, given the wide range of students and disabilities they see. As well, the type and extent of AT services provided varied across institutions (some provided start-to-finish assistance while others provided services in specific areas only, such as funding applications). That said, the service delivery models typically aligned with the steps outlined in Figure 6 above.¹² Generally the student would initiate contact with the institution’s Disability/Accessibility Services Centre or similar agency and complete any required paperwork. The student would then meet one-on-one with a staff member to discuss his or her diagnosis (if any), his or her needs in light of the current program of study, and then eligibility for funding or other assistance.

Students for whom AT was deemed beneficial would then move onto the assessment phase. While some schools relied on prior or external assessments, others offered on-site assessments of AT needs (see the section on *Current processes and practices for identifying suitable AT applications in Canada* below for further details), followed by the identification of suitable AT to address those needs. (Note that, as shown in Figure 7, 98 per cent of respondents to the post-secondary support staff survey indicated that they recommended AT accommodations to students in the context of their specific academic goals.)

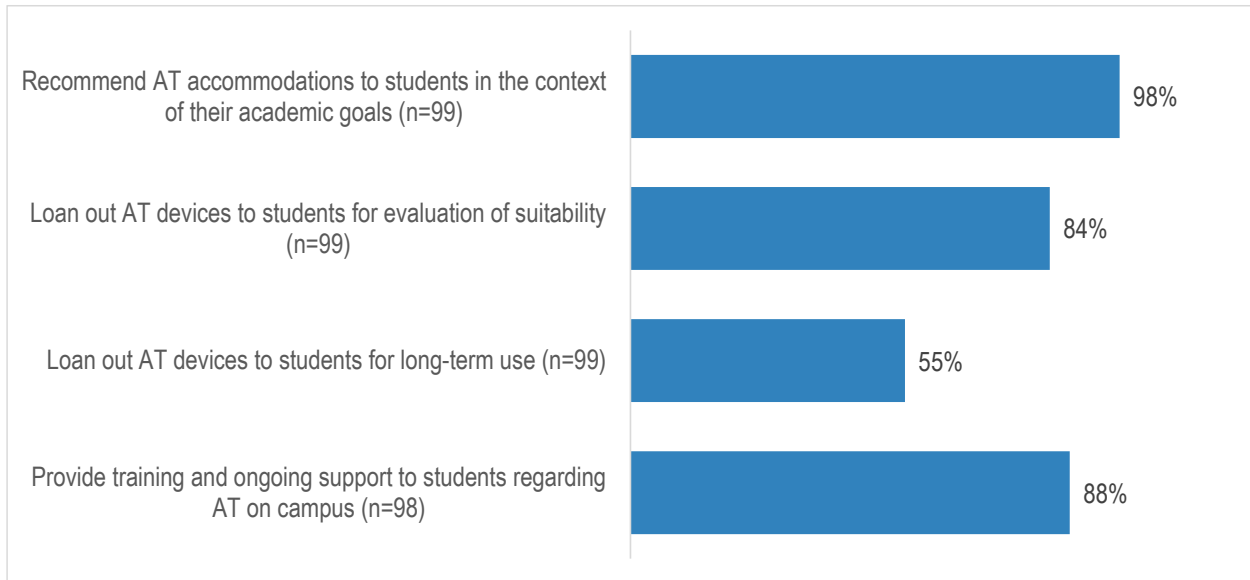
At this point, students at some schools would receive a demonstration of the AT or have a chance to trial or borrow it for a short amount of time prior to purchase (e.g., from a campus lending library or through an arrangement with the vendor). (In sum, 84 per cent of respondents to the post-secondary support staff survey indicated that they loan out AT devices to students for evaluation of AT suitability; 55 per cent also loan AT to students for long-term use. See Figure 7.)

In most cases, post-secondary support staff also helped students with the procurement and financing of AT, for example: by sourcing equipment; arranging for loaners or rentals; gathering price quotes; helping with funding applications (through the Canada Student Loans Program for eligible students or other grants/bursaries) or recommending private funding options; and placing AT orders with vendors. In some cases, staff also helped with set-up and installation of devices and software.

Most schools also provided training on the specific AT selected, usually about one to two hours of one-on-one training (small group training or workshops could also be scheduled where multiple students would be using the same technology). (In sum, 88 per cent of respondents to the survey of post-secondary support staff indicated that they or other disability support staff at their institutions provided training and ongoing support to students regarding AT on campus. See Figure 7.) One interviewee added that training was also available for family members and educators. Less frequently, staff arranged for training through outside vendors or organizations.

¹² One interview located in a remote community indicated the institution does not offer any AT services to students.

Figure 7 Do you or other disability support staff at your institution...?



Follow-up efforts were largely informal and limited by staff time and resources (see the *Assessing effectiveness of AT* section for further details). Furthermore, the onus was typically on students to contact staff when there was a problem. However, approximately three quarters of staff interviewed indicated they try to provide ongoing technical assistance and trouble-shooting support as needed, including providing additional training and finding alternative options when the selected AT was not working out. Some also provided assistance with maintenance and repair.

Importantly, fieldwork confirmed the process in BC differed from the above account for other jurisdictions, in that students applied through a single agency – Assistive Technology BC (ATBC) – for AT. ATBC offers individualized and centralized AT services, including assessments, access to technology, training, and follow-up for individuals in the province, including post-secondary students.¹³ Those aware of ATBC’s role (including interviewees from other provinces) generally appreciated the benefits of centralized services, reporting them to be efficient and effective.

Current processes and practices for identifying suitable AT applications in Canada

The peer reviewed research in this area is limited. In the Canadian context, a 2012 study provided an overview of existing processes and practices at post-secondary institutions with respect to AT for students with learning disabilities (Holmes & Silvestri, 2012). It described that the primary point of contact for those students is typically the disability services office. The number of staff in these offices and their skill varies from campus to campus, likely a partial result of differences in enrolment numbers and funding. Staff members are almost exclusively responsible for delivering AT services and products to students. However, AT evaluations appear to be conducted primarily

¹³ See also ATBC’s website: <http://www.at-bc.ca/>.

on an ad hoc basis (e.g., trial and error, intuition) and are dependent on the experience and training held by the evaluators, which varies considerably by province and territory. According to this study, specialized evaluations of AT match to students is currently an unregulated and unstandardized practice in Canada (Holmes & Silvestri, 2012).

These findings are consistent with a 2015 review of a large online AT Community of Practice (CoP) from the US, which found that research in effective AT service delivery practices is limited and that the field is struggling to define and understand the components of AT service delivery, and what makes it effective (Wojcik, 2015).

Instructions, guidelines, and checklists for assessment

The 15 provincial and territorial respondents were asked whether their province/territory had developed any instructions, guidelines, or checklists to help disability support staff at post-secondary institutions assess individual students’ or campus-wide AT needs or to assess the suitability of AT with respect to individual or campus-wide needs. No more than one third had developed any one type of material while equal or greater numbers indicated their province/territory had not, or they were unsure (see Table 3). Note that respondents indicating their province/territory had, in fact, developed such materials were also asked how educators and the public could access them. These responses are also provided in Table 3.

Table 3 Has your province or territory developed any instructions, guidelines, or checklists to help disability support staff at post-secondary institutions assess...? (n=15)

Developed materials to assess...	Yes	Access (asked to “yes” respondents)				No	Unsure
		Online	Printed publication (e.g., brochure, manual)	Other	Available upon request / not readily accessible		
Individual students’ needs for AT	5	--	1	1 ^a	2	5	5
Campus-wide needs for AT	2	--	--	--	1	8	5
Suitability of AT with respect to individual students’ needs	3	--	--	1 ^a	1	7	5
Suitability of AT with respect to campus-wide needs	2	--	--	--	1	8	5

^a Identified as emails, meetings, and teleconference calls.

Respondents who indicated their province or territory had not developed any instructions, guidelines, or checklists for assessment were subsequently asked how likely it was that guidelines would be developed in the future. The majority of respondents said not very or not at all likely (see Table 4).

Table 4 How likely is it that the following instructions, guidelines, or checklists will be developed in the future in your province/territory?

Future likelihood that province/territory will develop guidelines to assess...	Very likely	Somewhat likely	Not very likely	Not likely at all	Don't know
Individual students' needs for AT (n=5)	--	2	1	1	1
Campus-wide needs for AT (n=8)	--	1	3	3	1
Suitability of AT with respect to individual students' needs (n=7)	--	2	2	2	1
Suitability of AT with respect to campus-wide needs (n=8)	--	1	3	3	1

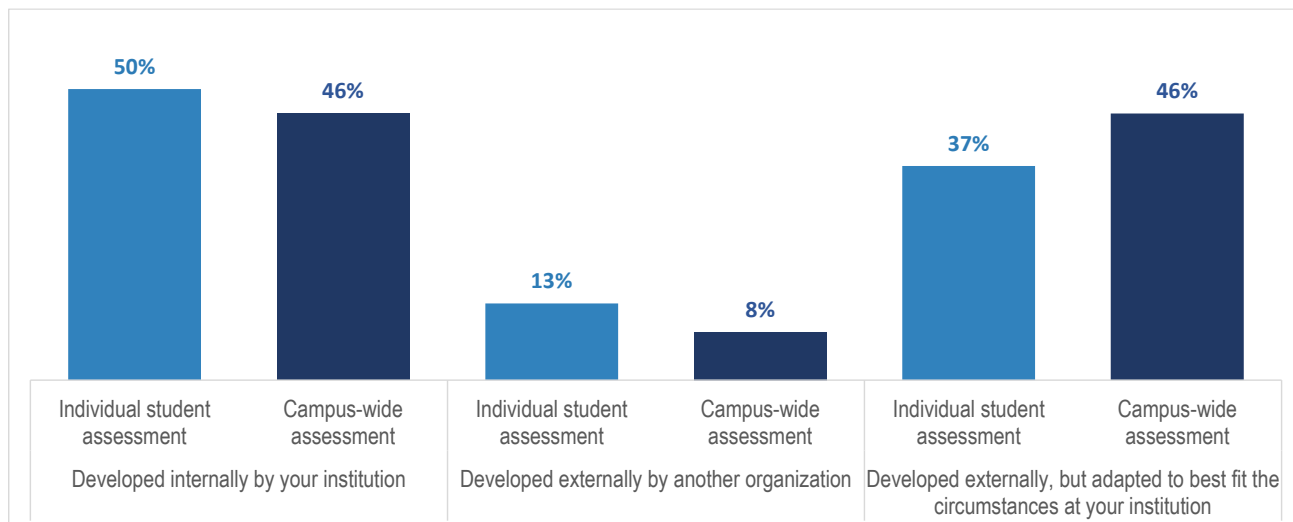
Post-secondary support staff surveyed were asked whether they followed guidelines to assess the suitability of AT devices. As shown in Table 5, most indicated they did assess suitability for students (78 per cent). However, only 24 per cent reported following assessment guidelines pertaining to the entire campus and another 25 per cent were unsure either way.

Table 5 Do you follow guidelines to assess the suitability of AT devices for...? (n=99)

Do you follow guidelines to assess the suitability of AT devices for...?	Yes	No	Not sure
Individual students	78%	13%	9%
The entire campus	24%	51%	25%

Among respondents who indicated they followed assessment guidelines for individual students (n=77) or the entire campus (n=24), in the majority of cases they added that the guidelines had been developed internally by their institutions (50 per cent and 46 per cent, respectively) or that guidelines developed externally had been adapted to best fit the circumstances at the institution (37 per cent and 46 per cent, respectively). Figure 8 provides additional details.

Figure 8 For assessments, do you use guidelines...?



In cases where guidelines had been developed externally, survey respondents identified the organizations as the *Association québécoise interuniversitaire des conseillers aux étudiants en situation de handicap* (AQICESH); ATBC; Canadian Occupational Performance Measures (available for [purchase](#)); Centre for Accessible Post-secondary Education Resources (CAPER-BC); Post-secondary Communication Access Services (PCAS); New Brunswick Department of Post-Secondary Education, Training, and Labour; Northern Ontario Assessment and Resource Centre (NOARC); and Post-secondary Disability Services, Nova Scotia Department of Labour and Advanced Education. AQICESH and NOARC place considerable resources online (<http://aqicesh.ca/association-aqicesh/presentation-101> [some material for members only]; <http://www.noarc-ferno.ca/English/InfoSheets.html>) while NOARC was the only organization to be identified as a source of guidelines for campus-wide assessment.

Assessment processes

As noted above, in many cases, post-secondary institutions required students to undergo assessments to match them to appropriate AT externally, and some students already held completed assessments from high school. Post-secondary disability support staff shed more light on the on-the-ground processes for assessments at their institutions, in interviews.

SRDC/NSS heard that staff sometimes use a series of guidelines, forms, or questionnaires to help with the selection of AT. These resources were not provided to SRDC/NSS. Students were also generally required to provide formal documentation¹⁴ of their disability (e.g., a medical diagnosis or psychoeducational assessment), which is taken into account alongside other materials such as self-

¹⁴ One staff interviewee suggested there should be more standardization across post-secondary institutions in terms of the documentation required.

assessments and reports from specialists. (Note that funding for AT requires proof of disability, although staff may still be able to recommend AT or provide some kinds of assistance without documentation.)

However, recognizing that even the same types of AT work differently for different people – even those with the same type of disability – many interviewees added that the process was very individualized. They considered students’ needs, preferences, and past experiences with technology on a case-by-case basis so as to understand the student’s “whole story.” They also tended to rely a great deal on their own knowledge and experiences with AT.

One staff interviewee added that the AT selection process also varies according to the student’s funding. In his specific situation, if the student is looking to apply for bursary funding the process is extremely rigid and only AT that matches the documented medical or disability-related need is allowed. In contrast, where there are no funding restrictions, staff can develop a plan to address the student’s needs more broadly (e.g., around more general challenges, such as note-taking).

Student interviewees indicated that various means had been used to assess and link them to their AT technology at their post-secondary institution, in the K-12 system, or through external organizations such as the CNIB or Neil Squire Society. Sometimes they had experienced a combination of approaches over the course of their lives. For the most part, they described an assessment process that sounded fairly similar to the ones staff described in their interviews (i.e., a meeting with staff to review documentation and identify needs, identification of possible AT solutions, followed by steps to obtain the technology). Some students also had a chance to try out the technology in advance. One student noted that because she was not receiving any AT funding, she was assessing her own needs and researching solutions.

The level of satisfaction among the students interviewed has been mixed. A slight majority were satisfied with the process overall, noting, for example, that it had been straightforward yet thorough, their needs had been heard and addressed, and that they were pleased with the AT recommended. Some also had a chance to try out the AT prior to purchase. However, others were either less satisfied or reported dissatisfaction. Reasons included: lengthy wait times to get an appointment or to obtain the technology and, more importantly, the selected AT did not meet their needs or was not a good fit for them. For example, one student interviewee mentioned that, when selecting a new system, staff had not paid proper attention to his years of experience with AT and computer systems background. They failed to provide him with the specifications he asked for so he could check, prior to purchase, that the system would work for him. In the end, the system was not a good fit, and he was – at the time of interview – in the process of trying to replace it.

Suggestions for improvement, offered by both those satisfied and dissatisfied, included the following:

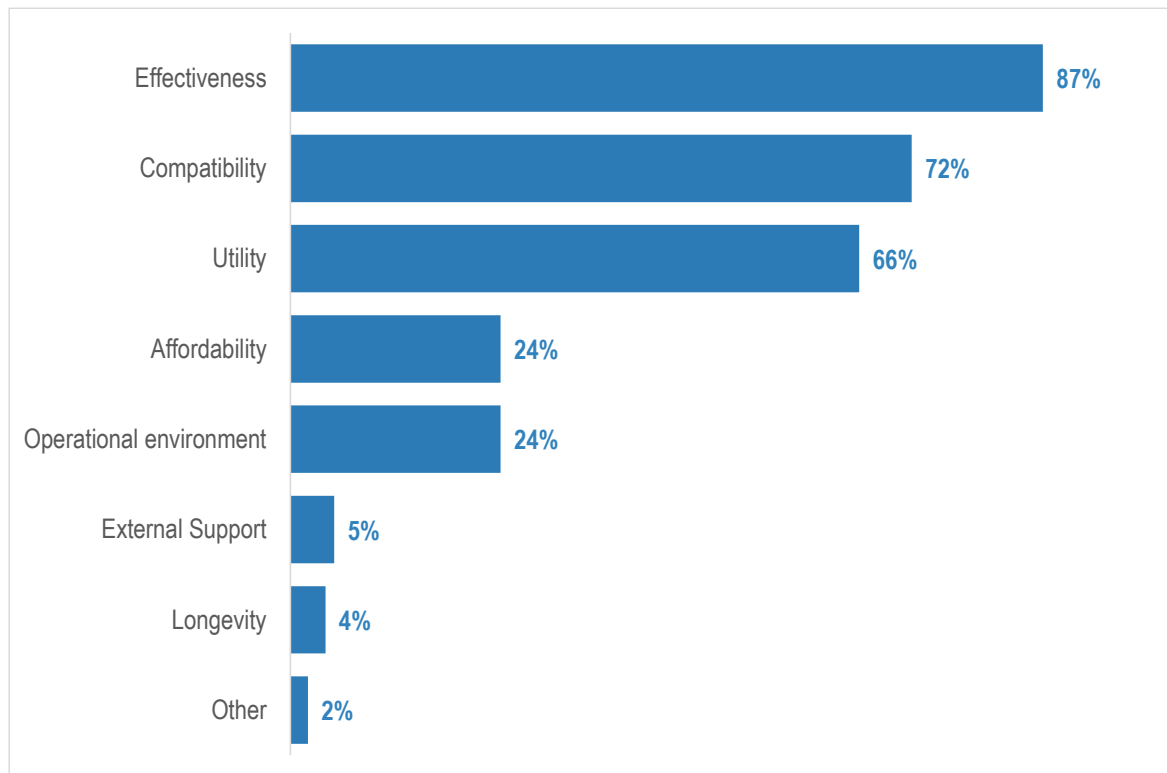
- Faster access to appointments – SRDC/NSS heard that having more staff would help decrease wait times;
- Proper diagnosis of new students and assessment of AT needs to ensure they do not “fall through the cracks”;

- Reduced red tape to allow for more “real-time” access to AT (e.g., relaxing rules for doctor’s confirmation of disability every year);
- Possible introduction of a federal student identification number attached to all of a student’s educational records to make them easily accessible for assessments;
- Better, more transparent communication during the assessment process to ensure selected AT is suitable;
- Creativity in recommending AT;
- Clearer mandate for post-secondary staff to provide recommendations themselves rather than relying on external recommendations or students’ own research;
- An opportunity to try out devices prior to order or purchase – e.g., a centralized place on campus to try out software and equipment, a demonstration night early in the semester with on-site vendors, or opportunities for loaner equipment and extended trials;
- An opportunity to talk to other AT users (e.g., a peer network) or AT professionals;
- Faster access to technology – ideally prior to the start of classes.

Important criteria when choosing an AT device

Respondents to the survey of post-secondary disability support staff were asked to rank the three most important criteria that influenced their AT assessment and recommendation decisions from among a list of eight items. The effectiveness of a given piece of AT (i.e., ability to accomplish the required tasks) was most consistently identified in the top three, followed by compatibility (the degree to which the device fitted with the student’s capability and personal preferences). Further details are provided in Figure 9.

Figure 9 Top three most important criteria that influence staff AT assessments and recommendations (n=99)



Post-secondary staff respondents identified “other” important criteria as: the student's willingness to use the product and the product’s ability to provide a better quality experience for the user.

Similarly, student interviewees were also asked how important various features of AT were to them when choosing an AT device. Like the post-secondary staff surveyed, effectiveness and compatibility were very high on their lists with nearly all students identifying these areas as very important. Some added that effectiveness was “the most important.” They also identified the importance they placed on the following features:

- The **operational environment**, or the extent to which conditions were already in place for successful implementation of the device – very important for just over half of interviewees (e.g., one said “Very important because if you can’t use it because of the environment, then you know it’s kind of not helpful”); most others indicated operational environment was important or somewhat important.
- **Affordability**. Most saw affordability as a very important issue, but because many received funding and did not have to pay for their AT out of pocket, the issues was less important to them personally.

- **How much users relied on others for setup, upkeep, maintenance, and proper functioning of the device.** Responses ranged widely from not very to very important; some students found it difficult to speak to the importance of this issue but mentioned that they would prefer to handle this area on their own. However, one student would prefer someone else to take care of maintenance. In the words of one interviewee, “The functionality and longevity is more important than the upkeep.”
- The device’s **longevity** or how long it could be used effectively. This was very important for most interviewees, but less important for others; a few also recognized that because technology changed so quickly, they inevitably needed to upgrade their AT at some point during their studies anyway.

AT service delivery models in Canada

A 2015 review of AT programs in Canada revealed significant disparities in provision of, and access to, AT programs and services. Currently, there are no organizations operating within the Government of Canada responsible for assistive devices. Instead, the Government refers the public to resources such as the Canadian Assistive Devices Association (Penton, 2015).

A study of community and post-secondary settings in Newfoundland and Labrador found that a single-entry point system presents a viable option to provide appropriate and timely equipment and services for persons with disabilities, educational or otherwise (Penton, 2015). It suggested that a single-entry point can be an efficient, effective, and user-friendly system to facilitate peoples’ ability to learn about eligibility for services, receive assistance with access, and coordinate service delivery. Such a site, staffed by knowledgeable service providers, could provide consultation, individualized assessment and appropriate training on the use of a device or technology as well as repair and troubleshooting services (Penton, 2015). Currently programs that rest on the single-entry model are available in the province of Ontario (Ontario’s Assistive Devices Program) and in British Columbia (Assistive Technology British Columbia [ATBC]). ATBC provides AT and related support services to adult residents of British Columbia who have permanent disabilities, including those pursuing post-secondary education.

Previously, the Equipment and Assistive Technology Initiative (EATI), an employment-focused program in British Columbia for provision of AT was grounded in the Participation Model. Its person-centred approach to the assessment, selection and attainment of AT formed the foundation of the program’s decision-making. While the Participation Model represents a significant shift from traditional AT programs, an evaluation of EATI showed support for this model (Jongbloed & Stainton, 2013). This finding is consistent with studies from outside of Canada that suggested a client-focused social and participatory service delivery model in AT has the potential to achieve the positive results for people with disabilities (Craddock & McCormack, 2002). Therefore, there is potential for this model to be utilized in the context of post-secondary education.

The Technology@Work program is just entering its third year of service delivery in British Columbia, and is an evolution of the EATI program. Technology@Work, delivered throughout the province by the Neil Squire Society, supports people who have a work-related barrier due to a disability or a functional limitation and who require Assistive Technology for employment or

volunteer activities in British Columbia. Technology@Work uses a person-centred approach for the assessment, selection and provision of AT, and can include training and support. While there has been no formal third-party study into the efficiency of this program, it has had positive outcomes and results, consistent with other client-focused models. Given the general scarcity of available evidence in this area, an overview of the AT service delivery process by the Neil Squire Society is included in Appendix B.

SRDC/NSS interviews with post-secondary service providers indicated that, for the most part, institutions were following Steps 1 to 5 in Figure 6 (Initiate Contact; Review Context, Eligibility and Resources; Evaluate the Student; Create AT Plan and Recommendations; Implement AT Plan), although typically much less formally. In fact, the process followed was fairly similar to the one outlined in Appendix B (Figure 28). However, while some institutions had established procedures for following up with students, in many cases additional follow-up and monitoring (Step 6), was limited by staff time and resources. SRDC/NSS found virtually none of the reported processes as implemented involved formal evaluations or exit processes (Steps 7 and 8). With respect to funding models, interviews didn't explicitly explore provincial variations in approach but different interviewees spoke favourably of the ATBC model mentioned above and of the Nova Scotia government funding for a position to help students complete the grant applications.

AT assessments

There are various types of AT assessments, sometimes called tools or models in the literature, and categorized in different ways. Some of their common purposes include: **screening** (provide a look at an individual for areas that may be addressed with AT), **implementation** (provide suggestions for implementing AT and measurements to demonstrate progress toward goals), **follow-up** (plan for periodic check-ups), and **impact** (document changes in performance and the system that contribute to performance). Figure 10 below outlines different frameworks guiding AT assessments while Figure 11 shows various AT assessment categories (Edyburn, 2001; Lahm & Mendoca, 2008). More information on the processes referenced for AT assessment (SETT, HAAT, QIAT, ASNAT, FEAT, MPT, QUEST, PIADS) are included in the glossary.

Figure 10 Frameworks guiding AT assessment

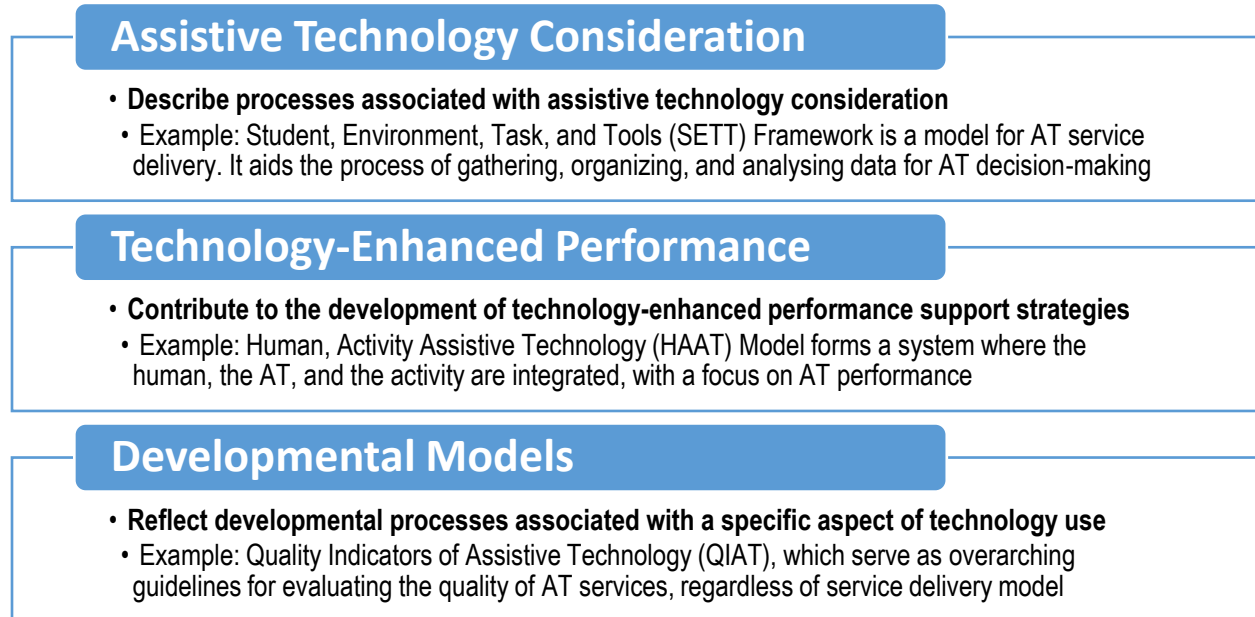
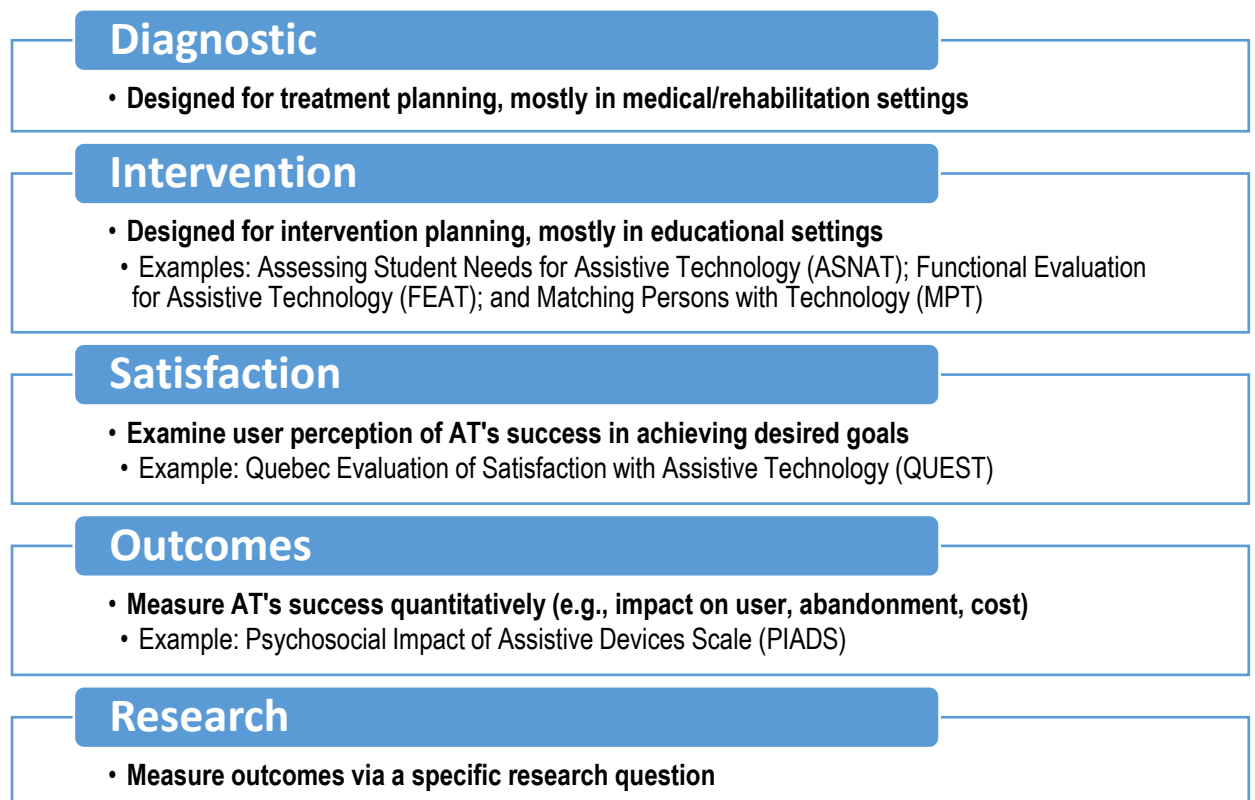


Figure 11 Categories of AT assessments



It was an intention in this research to identify best management practices for the application of assistive technology to address disability-related barriers in education. However, the research literature supporting the efficacy of various assessments is limited. For example, our review did not locate any studies regarding the application of these assessments, and their effectiveness, in the context of Canadian post-secondary institutions. Furthermore, many existing assessments are not specific to education. They are also often designed for individuals with a full range of disabilities and their comparative utility for particular disability types has not been established (Holmes & Silvestri, 2012). Only one review was found specific to mild disabilities in the K-12 setting, which concluded that FEAT, MPT, and SETT held promise (Wissick & Gardner, 2008). However, research is required to compare and evaluate various assessments models when used with students with various needs in post-secondary settings (Holmes & Silvestri, 2012).

Taking into account the limited evidence in this area, our information source review did point to two assessment frameworks designed specifically for educational contexts as promising practices: the SETT framework and the QIAT consortium. The SETT was designed to aid the process of gathering, organizing, and analyzing data to inform collaborative problem-solving and decision-making regarding assistive technology and appropriate educational programming for students with disabilities. The QIAT includes a set of descriptors that can serve as overarching guidelines for evaluating the quality of assistive technology services, regardless of service delivery model. In addition, a set of self-assessment matrices have been developed, designed to allow individual service providers and school districts to assess their current practices and plan for improvement.

Only one interviewee (a post-secondary disability support staff member) mentioned the use of frameworks. He noted that he kept SETT, QIAT, and the Matching Person and Technology (MPT) assessment process, for example, in the “back of his mind” when conducting assessments but did not necessarily follow them closely.

Other guidelines and principles

In addition to guidelines contained in these assessments, the literature provides additional guidelines and principles for practitioners working with students with disabilities in the area of AT. These are briefly summarized below (Alnahdi, 2014; Alquraini & Gut, 2012; D’Andrea & Siu, 2015; Holmes & Silvestri, 2012; Wissick & Gardner, 2008):

- Determine the appropriate AT device based on the individual student’s needs, prior skills, and the demands of the post-secondary environment;
- Make AT decisions based on the student and the educational task, but not based on the technology alone;
- Identify the necessary device early, so this device can be located, and the student can have time to be trained to use it;
- Identify low tech tools as the first option;
- Search among the available tools and devices first before looking for tools that were specially made for educational purposes;

- Determine if adjustments can be made to existing technologies;
- Rely on research-based information. However, the user of the AT may still fair differently. Document and report this to the field if this occurs;
- Given the lack of research comparing the efficiency of different brands, recommend a class of technology rather than a particular brand name (e.g., “text-to-speech” vs. “Kurzweil™”).

3.3 Application of Assistive Technology as part of the Universal Design for Learning in post-secondary education curriculum delivery

Universal Design for Learning

The term “universal design” (UD) refers to the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design (Burgstahler, 2011). The concept of UD as applied to AT refers to designing and delivering products and services that are usable by people with the widest possible range of functional capabilities, including those directly accessible (i.e., without requiring AT devices) and those that are interoperable with AT devices (Bauer et al., 2011).

Center for Applied Special Technology (CAST) educators expanded the concept of UD into the sphere of education and coined the term universal design for learning (UDL). UDL is defined as an educational framework that guides the development of flexible learning environments that can accommodate individual learning differences (Rose & Meyer, 2002). UDL principles call for creating curriculum from the outset in a way that provides:

- **Multiple means of representation** to give learners various ways of acquiring information and knowledge;
- **Multiple means of expression** to provide learners alternatives for demonstrating what they know; and
- **Multiple means of engagement** to tap into learners' interests, challenge them appropriately, and motivate them to learn.

Based on this framework, curriculum development includes creating instructional goals, methods, materials, and assessments that aim to provide equal opportunities for learning for all individuals regardless of their needs and abilities. Originally implemented in middle-schools, UDL has been expanding to higher education (Black, Weinberg, & Brodwin, 2015).

It is worth briefly elaborating on the difference between accommodation and UDL. Accommodation is grounded in the medical model of disability, in which a professional identifies an individual’s functional “deficits” and prescribes adjustments that allow an individual to participate to some degree in the “normal” environment (e.g., AT, extra time on tests). To receive accommodations students typically disclose disabilities to a specified individual or office at the institution, provide documentation, and request accommodations that may or may not be approved. An institutional representative shares approved accommodations with faculty members, who are required to

comply. Whereas accommodation is a *reactive* approach to provide access to an individual, UDL is a *proactive* approach focused on ensuring access to participants with a broad range of characteristics. UDL is consistent with an understanding of disability as a social construct. While it reduces, it does not eliminate, the need for accommodations for students with disabilities (Burgstahler, 2011).

Evidence on UDL

The Centre for Applied Special Technology (CAST) compiled the UDL framework using a large collection of published research studies that supported specific UD instructional practices. In the first stage, a general UDL framework was constructed using research in neuroscience, cognitive neuroscience, and neuropsychology. Distilled from that review were three basic learning networks in students and three corresponding UDL principles for educators (i.e., multiple means of representation, action and expression, and engagement). In the second stage, through a meta-analysis of educational research, practices that had been found to be effective in reducing barriers to instruction were identified, and organized around the three principles. In the third stage, secondary searches of the literature were conducted using keywords and concepts suggested by the meta-analysis. Nearly 1,000 articles were eventually selected as an evidence base for nine UDL guidelines, with 32 checkpoints developed as examples of implementation strategies for the nine guidelines (Burgstahler, 2011).

To-date, most of the available literature evaluating applications of UDL principles is in the form of grey literature. Numerous research gaps exist, including on applications of UDL to address the needs of students with hidden disabilities (Couzens et al., 2015). The literature also consistently identifies the need for faculty training to meet the needs of students with disability through UDL (Black et al., 2015; Burgstahler, 2011; Foley & Ferri, 2012). However, some peer reviewed research is beginning to emerge on the potential of UDL to have a positive impact on students (Black et al., 2015; Burgstahler, 2011; Foley & Ferri, 2012).

Universal Design for Learning and Assistive Technology

The goal of creating a UDL learning environment, whether face-to-face or via distance learning, is to consider the characteristics and needs of all potential learners, including but not limited to those with disabilities, from the design phase right to the delivery phase. In principle, UDL should allow those requiring accommodations and/or AT seamless access to their learning environment and its content because the multiple means of representation, expression and engagement are already embedded in the learning environment.

Advances in technology have increasingly allowed for individualization of the curricula to be possible and made it easier for those who require AT to integrate it into their learning environment through the use of built-in accessibility features and supports that help learners understand, navigate, and engage with the curriculum content.

Our review identified few studies that explicitly discussed the application of AT in UDL. Research on blending UDL with e-learning tools is also limited (Thomson, 2015). Because accessibility standards are often outpaced by the rapid changes in technology, accessibility through technology tends to follow a reactive model (i.e., disability-specific solutions). Consequently, the literature suggests that

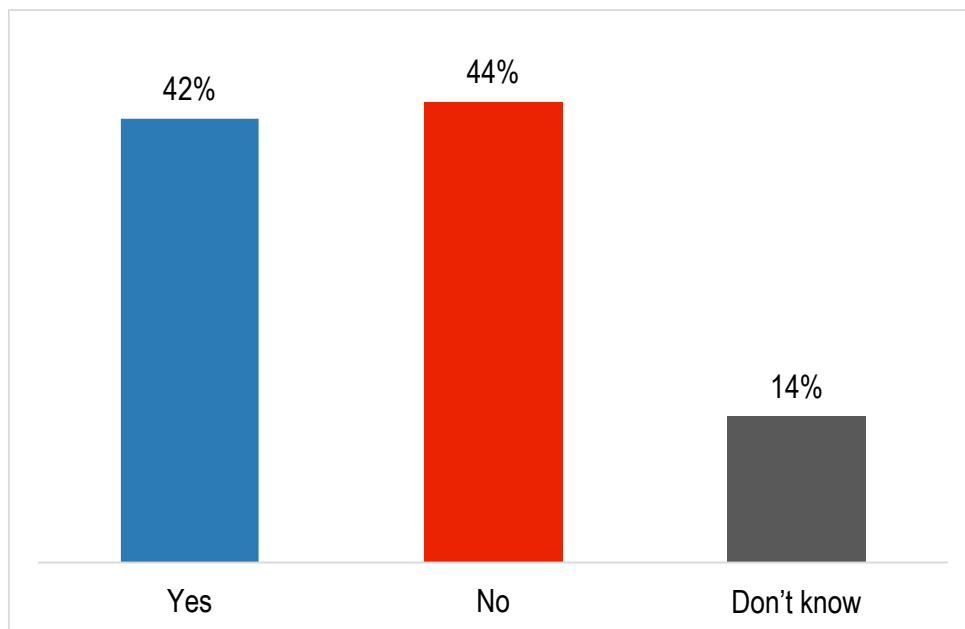
AT is best incorporated within the context of a supportive framework such as UDL (Alnahdi, 2014), which assists in addressing accessibility through AT from the outset of curriculum development (Foley & Ferri, 2012). To this end, the literature recommends developing policies and guidelines that provide “roadmaps” for faculty and staff on how to ensure access to electronic and information technologies for students with disabilities (Black et al., 2015).

In short, the relationship between AT and UDL is perhaps best viewed as one where UDL facilitates the integration of AT to address disability-related barriers. It should be noted that some students will continue to need AT even in learning environments that are well equipped with UDL materials and methods. UDL however, should help facilitate the use of AT that responds to individual needs. As illustrated in the text box (right), post-secondary support staff interviewees did not indicate specific AT was better suited to UDL, but they mentioned that some technology was potentially beneficial to all students. Text-to-voice is the most commonly-cited example, allowing all students to listen to their textbooks and notes, etc.

All respondents to the survey of post-secondary support staff viewed UDL as very (88 per cent) or somewhat important (12 per cent) for removing barriers to education for students with disabilities at their institutions. When asked whether the principles of UDL had been implemented at their school, responses were fairly evenly split between yes (42 per cent) and no (43 per cent) with the remaining 14 per cent unsure. However, most respondents from schools that had not yet adopted UDL said it was very (5 per cent) or somewhat (60 per cent) likely to be implemented in the future; 30 per cent said it was not very likely, while the remaining 5 per cent did not know (see Figure 12).

“Making technology accessible for everybody is the key I think because what it does is: it introduces people without disabilities, or even people with disabilities, to this stuff on a very even level, right. Here it is. Here is how it works for everybody, but especially to work well for people with disabilities. It will work well for everybody. It’s that old saying that I’ve heard before about ‘What’s essential for one is good for all,’ and that’s exactly how I think about assistive technology. All of this is essential for students with disabilities, but all of this is helpful for everybody. All of this.” (Post-secondary staff interviewee)

Figure 12 Are the principles of UDL implemented in your institution? (n=99)



Post-secondary disability support staff interviewees were similar to the survey respondents, when asked if their institutions had implemented universal design. Their responses were fairly evenly split with approximately half saying no and the other half saying yes, *to some degree*.¹⁵

Among the latter, one interviewee indicated that the university had an official mandate to understand UDL principles – it had developed a UDL primer, delivered a three-day UDL institute to faculty, addressed UDL during new faculty orientation, and provided tips and information on how UDL could look in the classroom. However, most interviewees tended to note that implementation was happening sporadically or in pockets (e.g., among certain faculty) or that only “weak” attempts had been made. That said, most staff interviewees felt at least some progress had been made in the past five years, such as:

- Better awareness, understanding, and appreciation of UDL;
- Recruitment of campus UDL champions and specialists;
- Faculty training on UDL principles;
- Adoption of UDL principles for updates to existing courses and development of new ones;
- Broader availability of so-called AT for the entire student body (e.g., text-to-speech and speech-to-text software);

¹⁵ Note, however, that where possible SRDC/NSS had sought staff interviewees who indicated in their survey responses that their post-secondary institution had adopted UDL principles, in the hope of getting best practice examples.

- Better accessibility of course materials (e.g., alternate formats, online platforms, digital materials);
- More course delivery options (e.g., online);
- Some change in practice (e.g., recognition of different learning styles and different means of assessment for each).

While in some cases faculty were seen as supporters of UDL, a few interviewees identified faculty, particularly older individuals, as a source of barriers, adding that many instructors were not interested in changing their courses to adopt UDL principles or were unsure how to go about it. In general, a lack of time, manpower, and understanding of how to implement universal design were also noted to be challenges.

“There’s almost no one who’s not interested in doing it. They just don’t have the time, and they don’t know from an operational standpoint what it means.” (Post-secondary staff interviewee)

When asked about their expectations for AT and UDL in the next five years, responses were mixed. Some interviewees felt the status quo would be maintained for some time to come or, at best, change will happen slowly. Others hope for or envision more advances, for example:

- More awareness of, commitment to, and investment in UDL principles in post-secondary education;
- Embedding AT in university systems for the benefit of all students (e.g., voice-to-text and text-to-voice software, access to recorded lectures);
- More centralized access to AT (e.g., so students with disabilities do not have to rely on specialized equipment or use separate laboratories);
- Expansion of alternate delivery methods (e.g., online courses, virtual classroom accessible by videoconference) or more opportunity for students to learn at their own pace;
- More access to technology on students’ own devices, where a number of accessibility features are now standard (e.g., magnifiers, screen readers, text-to-speech software);
- Better recognition of different learning styles and means to evaluate skills and competencies in the classroom.

“Institutions have to look at the big picture...Whatever is going to be good for students with disabilities is actually going to be very good for the whole school population, but you need to put this investment of money and time to prepare...your resource base to meet these challenges.” (Post-secondary staff interviewee)

One interviewee noted a particular interest in how advances in virtual reality technology will affect technology in the coming years, adding that virtual reality was already making its way into the classroom and that students with disabilities would need to be equal participants in its use.

However, a small number of interviewees felt that UDL would take much longer to be implemented (e.g., 10 to 15 years) or never be fully implemented at all, due in large part to faculty resistance.

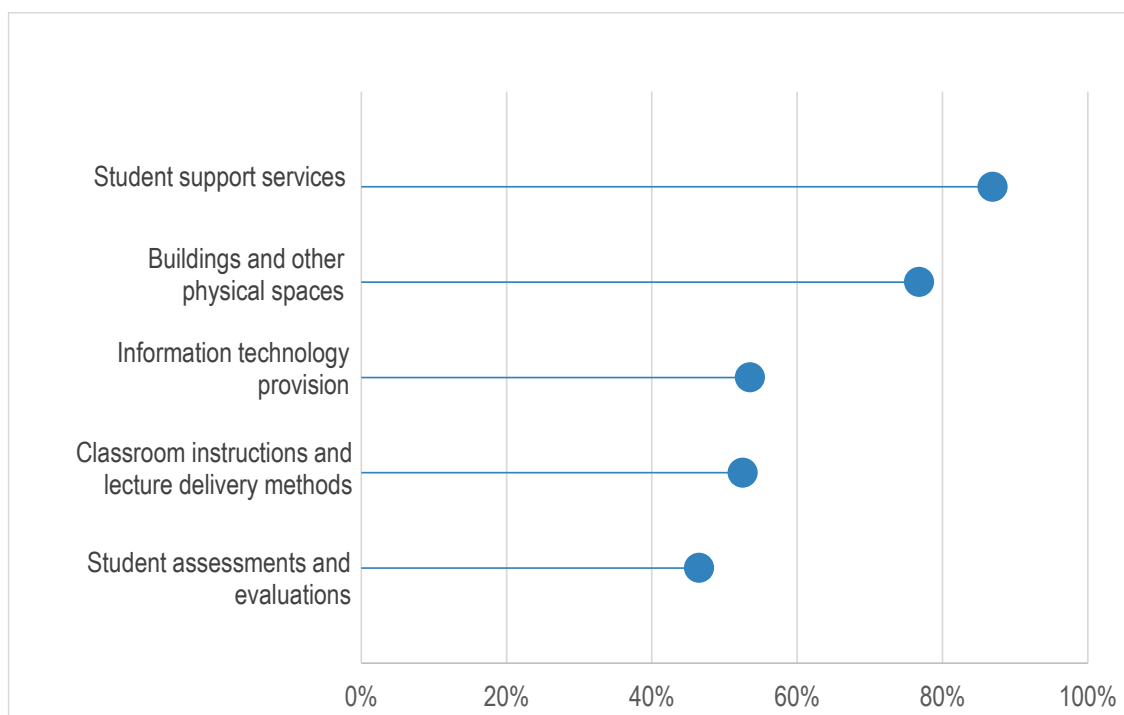
Note that student interviewees were not directly asked about UDL. However, a small number independently raised the concept of UDL or aspects of it, in interviews. They mentioned the need to

recognize the benefits of AT for all students, not just those with disabilities and recommended mainstream adoption of AT simply as “technology,” not a distinct category of technology only for persons with disabilities. Reported benefits of wider use included reducing stigma for students with disabilities (as they would not be singled out as a distinct group), better connections between disabled students and their non-disabled peers, and better accessibility to AT on campus. One interviewee also identified a need for a better understanding of AT among faculty, which should also be conveyed to Education students to carry with them to their later teaching in the K-12 system.

Incorporation of accessibility into post-secondary design

The survey questions on incorporating accessibility into institutional design immediately followed questions on UDL and so were likely interpreted in this context. When asked to identify whether accessibility had been incorporated into various elements of design at their schools, the post-secondary disability support staff surveyed most commonly indicated student support services (87 per cent), followed by buildings and other physical spaces (77 per cent). Somewhat smaller proportions indicated accessibility had been incorporated into their information technology provision (54 per cent), classroom instructions and lecture delivery methods (53 per cent), or student assessment and evaluations (47 per cent) (see Figure 13).

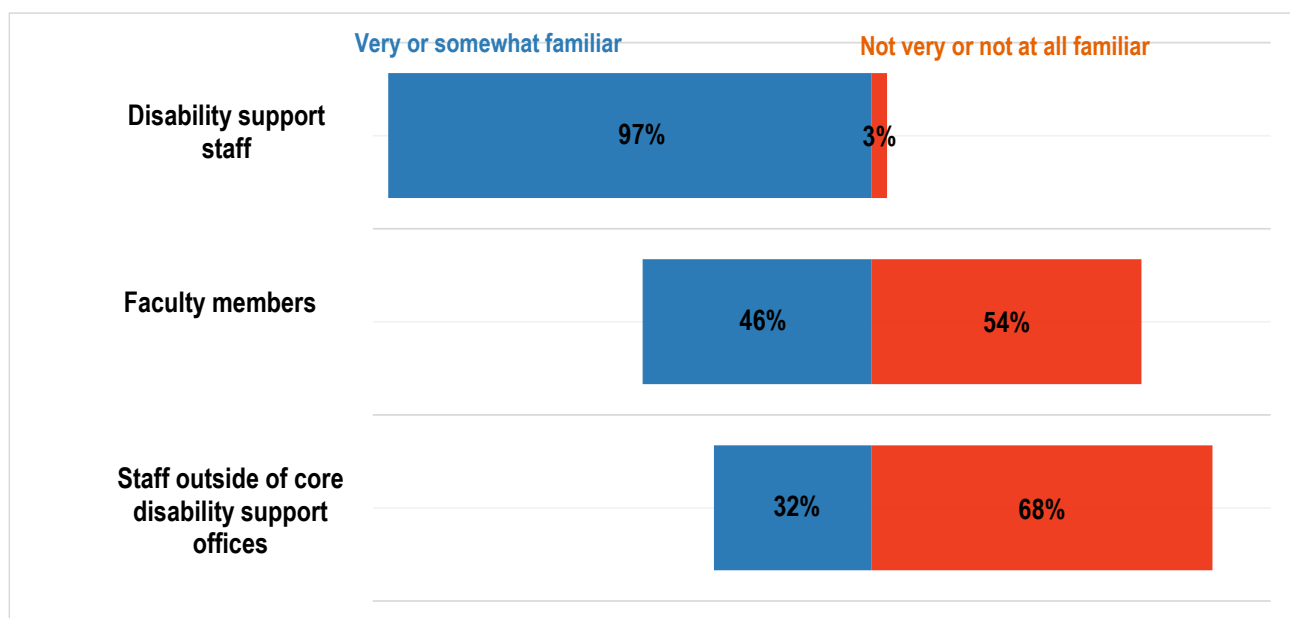
Figure 13 Please indicate if accessibility is incorporated in the design of the following at your institution (n=99)



Familiarity of campus groups with AT

As shown in Figure 14, when asked how familiar various groups on campus were with the availability and use of AT at their institutions, the vast majority of support staff identified disability support staff as very or somewhat familiar (97 per cent). However, they felt over half of faculty (54 per cent) and two thirds of staff outside core disability support offices (68 per cent) were not very or not at all familiar.

Figure 14 How familiar are the following groups with the availability and use of AT at your institution? (n=98)



3.4 Effectiveness of Assistive Technologies for addressing disability-related barriers to post-secondary education

Overview of peer reviewed studies

Our search of the peer reviewed literature showed that the evidence in the area of effectiveness is scarce. Based on substantive factors (e.g., post-secondary context, research questions) and methodological ones (e.g., sample sizes, research design, type of measures), we rated 38 articles as having low, 14 as medium, and 13 as having high relevance to our research questions.

In terms of designs, 17 studies were reviews of the literature; however, only 4 employed some form of systematic methods. Fifteen studies conducted analyses of quantitative data (most frequently, surveys), 9 were experimental, and the remaining ones were qualitative investigations, commentaries and case studies. Only a handful of studies had an explicit definition of effectiveness

of AT. While the studies covered a variety of AT types and educational tasks, a significant number tested the application of a particular piece of technology (e.g., adapted mouse) within a small sample of subjects. In terms of disability types, the majority involved seeing, hearing and learning disabilities, and none focused on mental health specific concerns. Forty six studies were conducted in the US, 7 in Canada, and the remaining ones in Australia, Taiwan, UK, among others.

Information from the grey literature is used to supplement the available peer reviewed evidence in sections below. Data collected in phase 2 has further informed and contextualized these findings.

Effectiveness of AT and evidence-based practice

Our search of the peer reviewed literature showed that the existing evidence supporting the effectiveness of AT is scarce. Similar results were obtained in other studies that assessed the body of evidence on effectiveness or efficacy of AT in various contexts. Below we highlight the results from three major studies in this area with respect to evidence-based practice.

First, Peterson-Karlan conducted a descriptive analysis of 249 studies covering 25 years of research on the effectiveness of technology to support the compositional writing of students with learning and academic disabilities (note: this review was not specific to post-secondary education). The study found that despite the growth of technology, little new research has appeared in the last decade. When assessing the existing evidence across the total corpus of applied research studies, the authors found that basic evidence-based criteria were not met (Peterson-Karlan, 2011).

Second, Kelly and Smith conducted a synthesis of the research literature from 1965 to 2009 on the assistive technology that is used by individuals with visual impairments (aged 3 to 21 in preschool through 12th-grade educational programs). The authors reviewed 256 articles for evidence-based research on assistive technology that had a positive impact on educational performance. Of the 256 studies, only 2 provided promising evidence-based practices (Kelly & Smith, 2011).

Third, in an article describing AT trends and delivery of AT services specific to post-secondary institutions in Canada, Holmes & Silvestri reviewed the evidence on the efficacy of AT for learning disabilities in post-secondary settings. The authors concluded that the use of AT by post-secondary education students with learning disabilities appears to have moved ahead of research (Holmes & Silvestri, 2012), and that the current evidence is insufficient to support evidence-based practice.

Many of the existing studies – both in our review as well as those assessed above – did not apply rigorous standards of scientific-based research required to establish evidence-based practice. Some common limitations included: discussion of beliefs or theories without a research design or method, evaluation of products without a research design or method, single subject design, no intervention group or an inappropriate comparison group, no reporting of effect sizes, insufficient data to determine effectiveness of intervention, and validity concerns (D’Andrea & Siu, 2015; Kelly & Smith, 2011). Finally, because of technological advancements, most information written about technology tends to be dated the moment it is published (Ayres, Mechling, & Sansosti, 2013), which further limits the ability to establish evidence-based practice based on the available published literature.

However, the current body of literature – exemplified in the results from the three synthesis studies of AT effectiveness and evidence-based practice reviewed above – is still informative. It provides substantive evidence in select areas of AT (e.g., writing supports for students with learning disabilities), which is to say other areas of AT may well be effective, but lack rigorous evidence. Some have argued that the existing literature albeit limited can help inform effective use of AT (Kelly & Smith, 2011). Since the literature on evidence-based practices will likely always lag behind the newest innovation, it has been suggested that these new innovations become reasonable tools when they are based on other evidence-based practices, techniques and procedures (Ayres et al., 2013).

Assessing effectiveness of AT

While the importance of measuring outcomes to assess effectiveness has been well documented, limited empirical work has been completed to-date and few measurement instruments are available (Edyburn, 2015; Lenker & Paquet, 2003, 2004). This lack of evidence is likely due to (a) the field of AT being a relatively new and rapidly evolving field, so that the evidence base is often inadequate for answering critical questions about AT's effectiveness and (b) the standard of proof evolving to increasingly require formal assessments of evidence (Edyburn, 2015).

Some authors have pointed out that AT is often deemed effective (defined as “the degree to which AT has a positive impact on educational performance”) by virtue of simply having a practical application. Indeed, one review found that a large percentage of studies used anecdotal evidence (e.g., with the use of AT an individual was able to perform a task they were not able to before) without evaluating effectiveness, such as comparing two assistive devices (Edyburn, 2015; Kelly & Smith, 2011). This type of evidence is not sufficient for all types of AT nor when selecting from a suite of available devices (e.g., two screen-reading software applications compared with each other or two electronic notetaking devices compared with each other) (Kelly & Smith, 2011).

In order to improve the quality of research on effectiveness, some authors have suggested using various frameworks to evaluate AT effectiveness (Lewis, Cooper, Seelman, Cooper, & Schein, 2012), accounting for disability service provider differences in training and their availability for support (Holmes & Silvestri, 2012), and generating research that provides a direct comparison of high and low tech applications (e.g., through within-subject alternating-treatment designs) (Reichle, 2011).¹⁶ These have not been evaluated for application to post-secondary education.

In general, many research gaps remain to determine how to quantify benefits of AT to address the needs of different students, for the purpose of specific educational tasks, and in different settings. In

¹⁶ The Lewis et al. (2012) study was geared towards the use of AT in rehabilitation. The frameworks it looked at included CER (comparative effectiveness research) and RE-AIM (Research, Efficacy, Adoption, Implementation, and Maintenance) – both used in the context of health. The two AT frameworks that have been extensively applied to post-secondary are SETT and QIAT – both of which are described in our report.

this context, it therefore important to assess the extent to which any measures employed in the literature, objective or otherwise, are employed by practitioners in the field.

Post-secondary disability support staff interviewees¹⁷ indicated that in general they used informal means to assess the effectiveness of AT in removing barriers to post-secondary education, usually relying on anecdotal feedback from students. In some cases staff checked in with students via telephone or email after one to two weeks of AT use to see how the technology was working for them. A few interviewees mentioned more regular monitoring, for example, through meetings, student surveys, or periodic checks of students' grades each semester or school year. One interviewee noted a more rigorous process, consisting of monthly monitoring and reporting of services for accountability and success measures, monitoring grades and learning outcomes, student self-reports, and instructor feedback. However, the onus was generally on students to contact staff if there was a problem. As well, students were not always interested or available for follow-up assessments.

In many cases staff interviewees indicated that they would have preferred a more systematic or formal means for assessment but were restricted by a lack of time and resources. Yet most were fairly satisfied overall with the process – they felt that staff members did a good job of assessment and that the AT provided was generally helpful in removing barriers to post-secondary education. However, some expressed concern that they had no hard information on the effectiveness of the AT and that less vocal students could be missed. Suggestions to make the assessment process more robust included the following:

- More institutional buy-in regarding the importance of assessment (e.g., creation of an AT laboratory to conduct more rigorous assessments);
- More staff time and resources for follow-up assessment;
- The use of formal tools (e.g., rubrics, questionnaires) and training service providers to use them;
- Pre-post assessment of grades, specific areas such as reading comprehension (depending on the student's disability), or overall post-secondary experience (both quantitative and qualitative information);
- More staff to follow-up with students and education of staff on assessment processes;
- More frequent follow-up with students (e.g., scheduled check-ins or surveys each semester);
- Feedback from instructors, tutors, or other departments.

When staff were asked if there was a need to standardize the assessment process on a provincial or national level, comments were mixed. Some interviewees were against the idea of standardization or felt it would be difficult because of the variation in students' disabilities and needs. They also felt it might limit students' access to technology or would create situations of trying to fit the student to the technology rather than the technology to the student. Among those in favour of some degree of

¹⁷ Only one interviewee indicated that the institution does not assess AT effectiveness at all.

standardization – or who could see some benefit to such an approach – most highlighted the need for flexibility and would prefer guidelines to fixed rules.

Similar to staff interviewees, where students described any sort of follow-up or monitoring from their post-secondary institution, the process described was informal. For example, a follow-up email, telephone call, optional survey, or in-person meeting, with a frequency as needed or each semester/year. For some, such a level of follow-up would be sufficient, because they knew “the door was always open” if they had any problems with their AT.

However, at least one student expressed frustration that staff were not able to help resolve the problems she was having with her AT. Staff had provided her with a statement of the cost of AT services she had received. While her funding had covered those costs in her first year of study, the statement deterred her from seeking assistance in her second year when she was no longer receiving funding. Some students would prefer more follow-up, for example, to find out whether students were successfully using the technology or to identify any commonalities in struggles they faced. However, one cautioned that students’ participation in follow-up should be optional, due to their limited time.

“There’s a lot of expectations placed on disabled students to have to do all of these things outside of attending their classes, that non-disabled students are not expected to do, and I would really be hesitant before I said universally there ought to be a follow-up because then we’re putting more burden on disabled students that non-disabled students don’t face.”
(Student interviewee)

Effectiveness of AT and eLearning in removing barriers to post-secondary education

The fieldwork gathered the perspectives of both post-secondary disability support staff and students on the effectiveness of AT and eLearning in removing barriers to post-secondary education. The results are summarized below.

Perspectives of post-secondary disability support staff

Respondents to the post-secondary support staff survey were asked to provide their opinions on the effectiveness of various AT devices and eLearning environments and equipment (only those they had previously indicated were available at their institution) in removing barriers to post-secondary education for students with physical, sensory, communication, and cognitive disabilities.¹⁸

¹⁸ These terms were defined in the survey as follows:

- Physical disability – a condition that limits one or more basic physical activity.
- Sensory disability – a condition affecting one of the five senses, typically vision, hearing, or touch.
- Communication disability – an impairment to the capacity to use expressive and/or receptive language in one or more of the following areas: speech, conveying information, and understanding information.
- Cognitive disability – an impairment that affects an individual’s ability to access, process, or remember information.

Effectiveness of AT devices

The majority of respondents indicated the various types of AT available were effective in removing barriers for students with a **physical disability**. In particular, external hardware/equipment and voice recognition devices were identified as very or somewhat effective by over 90 per cent of respondents. Further details are provided in Figure 15.¹⁹

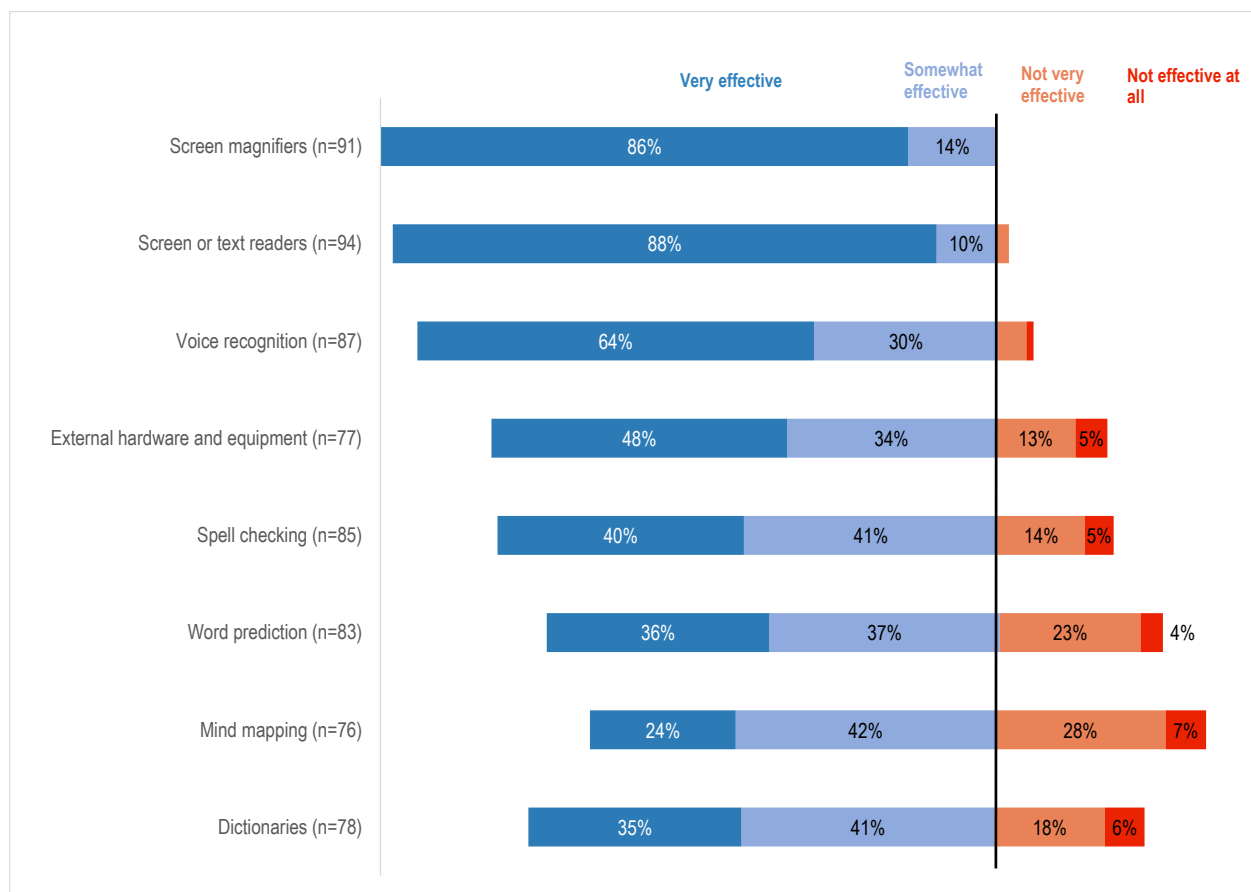
Figure 15 How effective are these AT devices, when they are available, in removing barriers to post-secondary education for students with physical disability?



¹⁹ Across the types of AT listed, between 4 and 16 respondents were unsure how effective the given device was in removing barriers to post-secondary education for students with physical disability. Responses of “not sure” have not been included in the calculation of figures in the table.

The majority of respondents also indicated that the same devices were effective in removing barriers for students with **sensory disabilities**. The top rated items were screen magnifiers, screen/text readers, and voice recognition AT, identified as very or somewhat effective by over 90 per cent of respondents (see Figure 16).²⁰

Figure 16 How effective are these AT devices, when they are available, in removing barriers to post-secondary education for students with sensory disability?

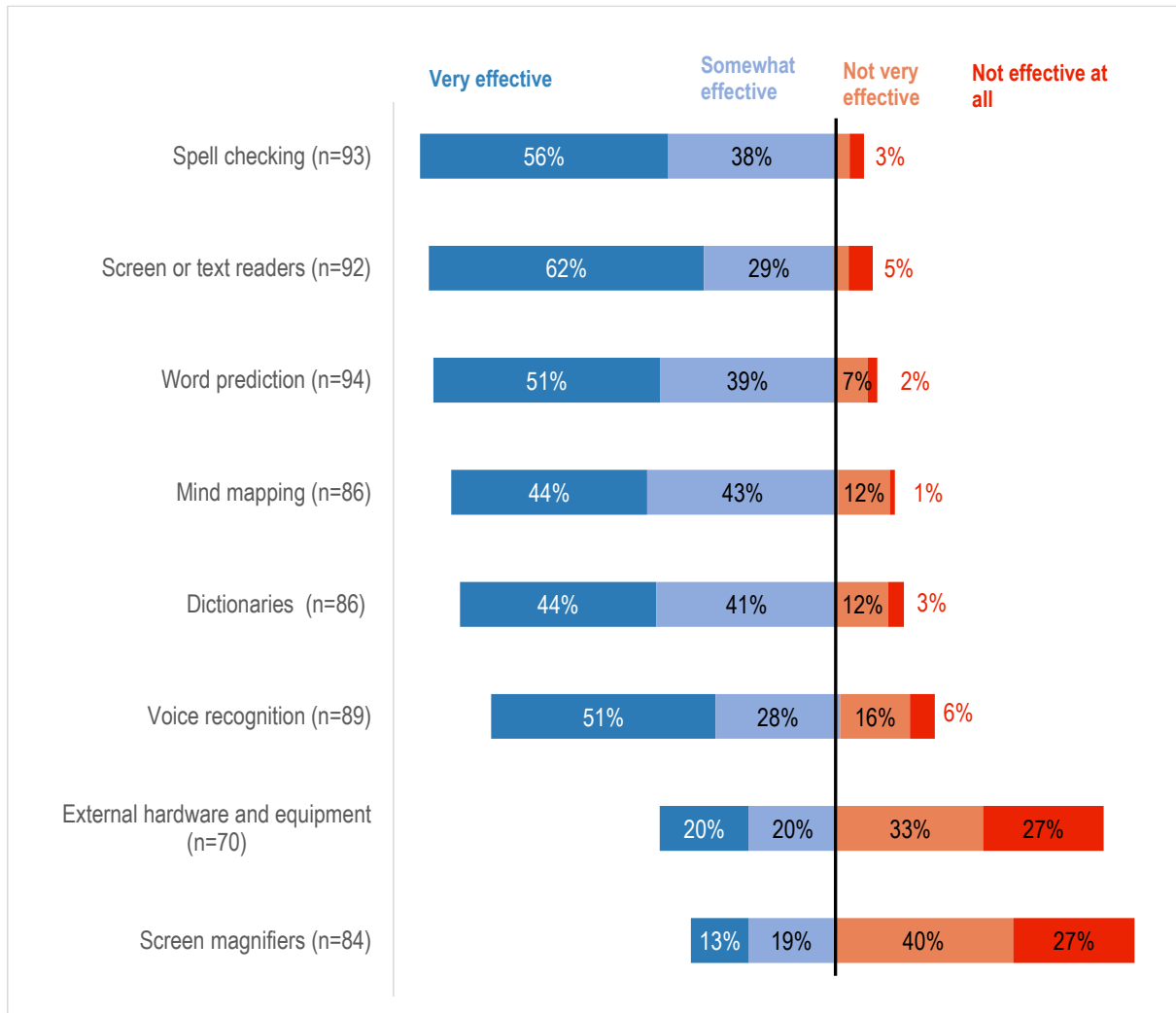


Most survey respondents deemed the majority of the AT available to be effective in removing barriers for students with a **communication disability**, particularly spell checking devices, screen or text readers, and word prediction AT, which were each seen as very or somewhat effective by at least 90 per cent of respondents. However, most respondents saw external hardware/equipment

²⁰ Across the types of AT listed, between 2 and 18 respondents were unsure how effective the given device is in removing barriers to post-secondary education for students with sensory disability. Responses of “not sure” have not been included in the calculation of figures in the table.

and screen magnifiers as not very or not at all effective for communication disabilities (see Figure 17).²¹

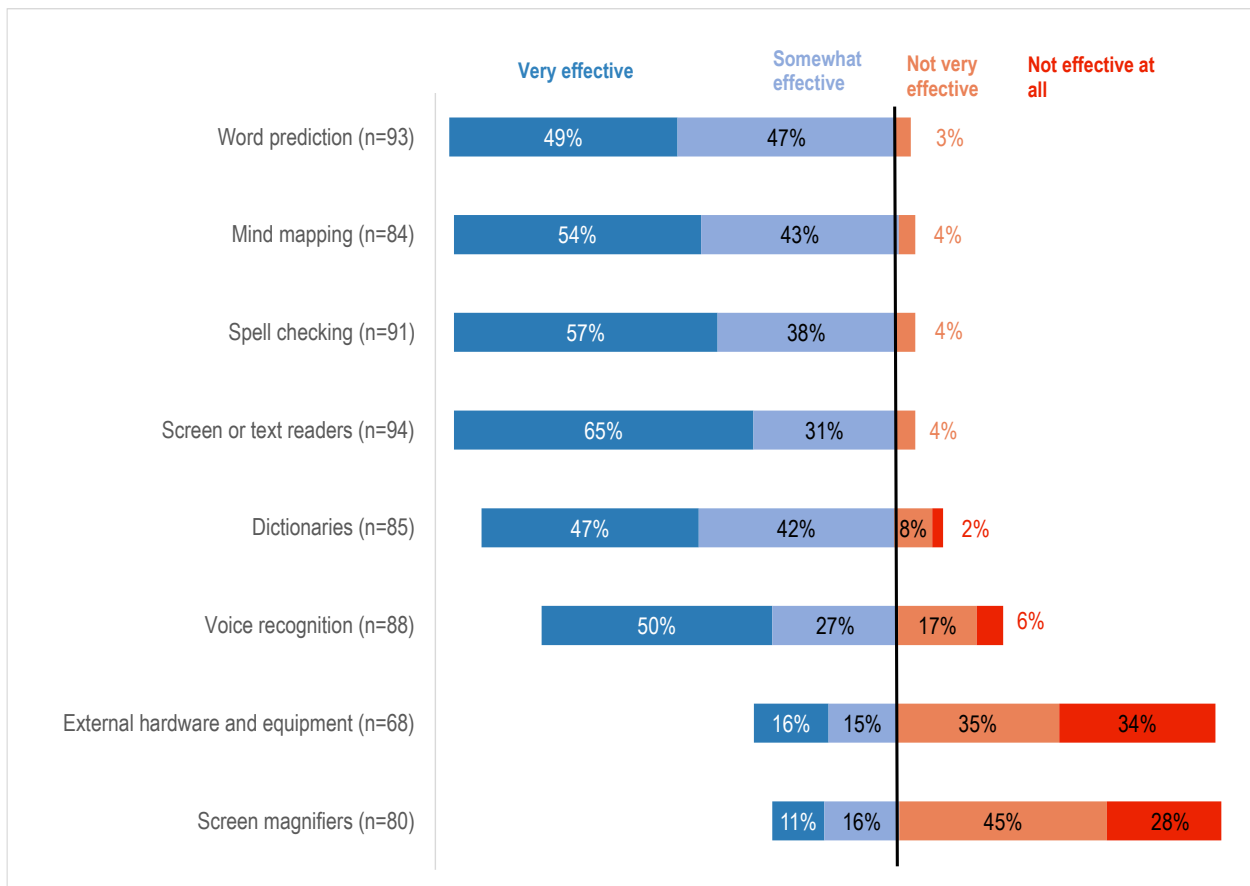
Figure 17 How effective are these AT devices, when they are available, in removing barriers to post-secondary education for students with communication disability?



²¹ Across the types of AT listed, between 3 and 19 respondents were unsure how effective the given device is in removing barriers to post-secondary education for students with communication disability. Responses of “not sure” have not been included in the calculation of figures in the table.

As shown in Figure 18, the majority of survey respondents also saw most of the AT available as effective in removing barriers for students with a **cognitive disabilities**, particularly word prediction, mind mapping, or spell checking AT, along with screen or text readers, which were deemed very or somewhat effective by at least 95 per cent of respondents. As with communication disabilities, however, most respondents found two types of AT – external hardware/equipment and screen magnifiers – to be not very or not at all effective for cognitive disability.²²

Figure 18 How effective are these AT devices, when they are available, in removing barriers to post-secondary education for students with cognitive disability?

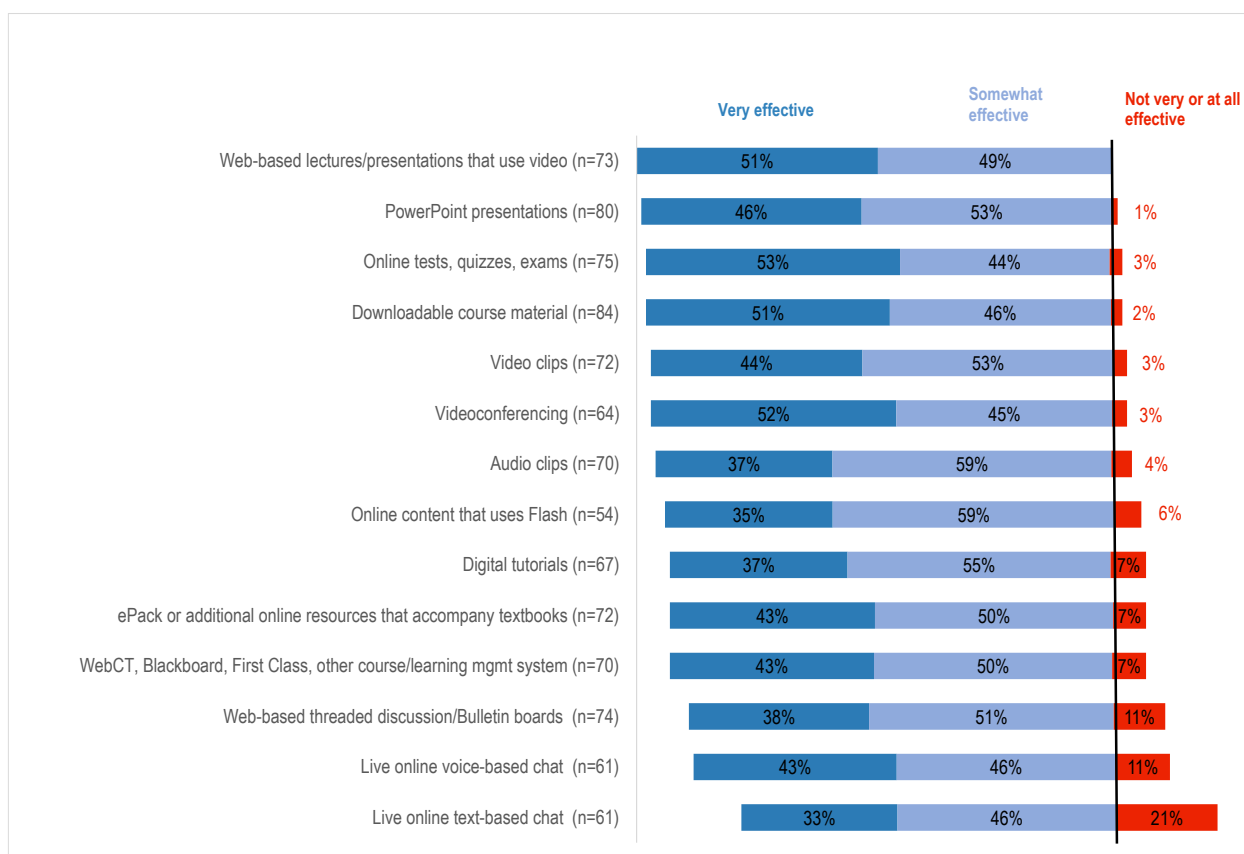


²² Across the types of AT listed, between 2 and 21 respondents were unsure how effective the given device is in removing barriers to post-secondary education for students with cognitive disability. Responses of “not sure” have not been included in the calculation of figures in the table.

Effectiveness of eLearning environments and equipment

The majority of survey respondents deemed the various forms of eLearning available as effective in removing barriers for students with **physical disabilities**. In fact, all but three items were deemed very or somewhat effective by over 90 per cent of respondents. Further details are presented in Figure 19.²³

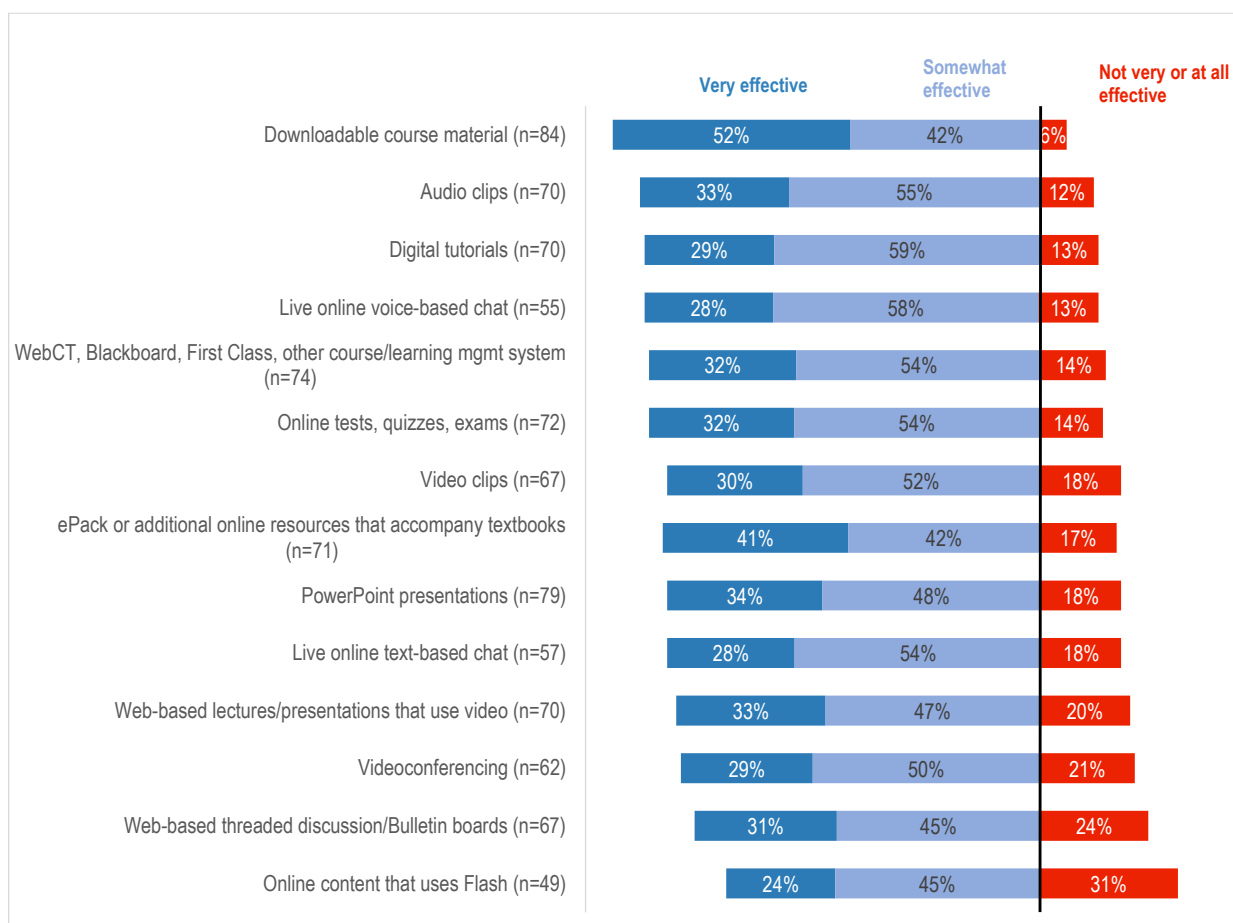
Figure 19 How effective are these eLearning environments and equipment, when they are available, in removing barriers to post-secondary education for students with physical disability?



²³ Across the types of eLearning listed, between 11 and 37 respondents were unsure how effective the given device is in removing barriers to post-secondary education for students with physical disability. Responses of “not sure” have not been included in the calculation of figures in the table.

Most survey respondents also deemed the eLearning items available to be effective in terms of removing barriers for students with a **sensory disability**, particularly downloadable course material, identified as very or somewhat effective by 94 per cent of respondents. However, nearly one third (31 per cent) found online content that uses Flash to be not very or not at all effective (see Figure 20).²⁴ As this was a close-ended question, no elaboration on why they felt this way was obtained.

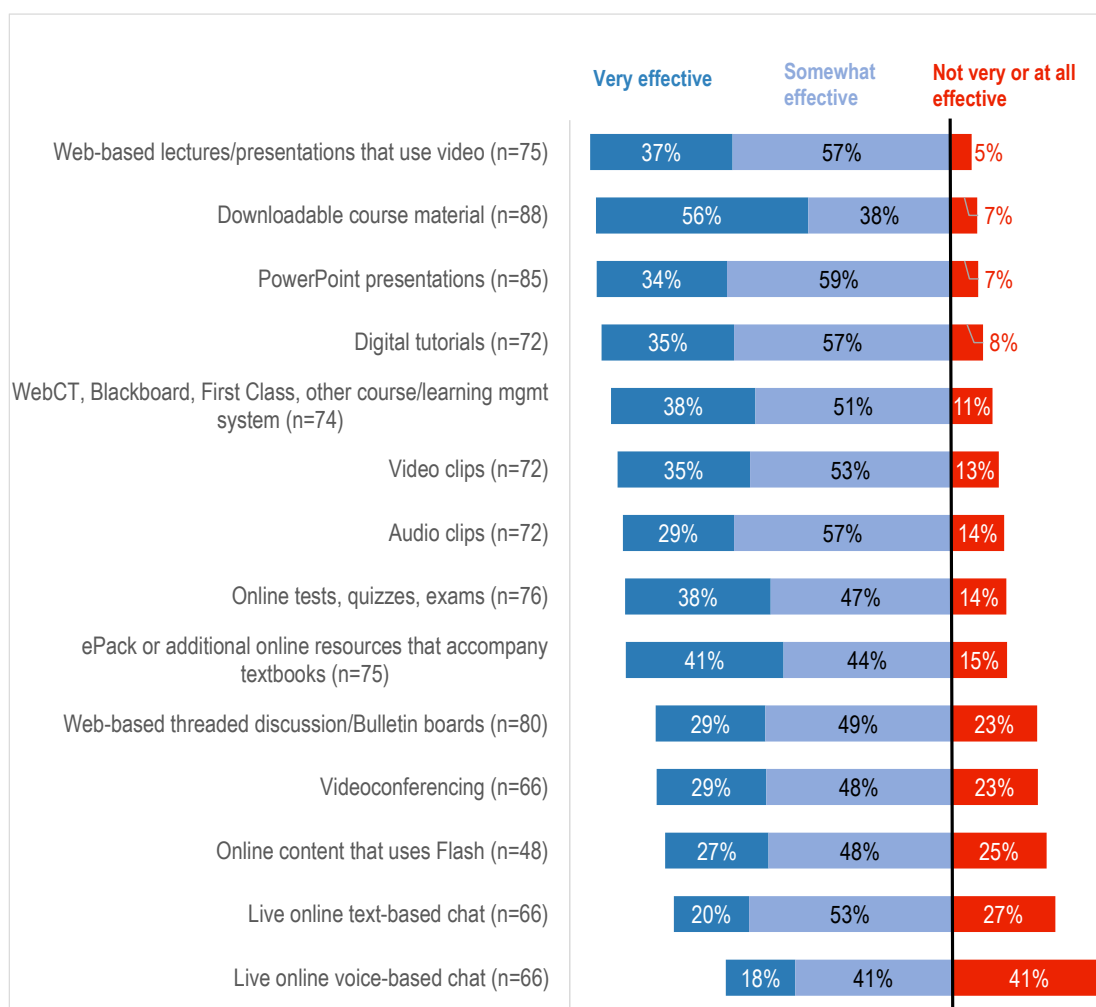
Figure 20 How effective are these eLearning environments and equipment, when they are available, in removing barriers to post-secondary education for students with sensory disability?



²⁴ Across the types of eLearning listed, between 10 and 38 respondents were unsure how effective the given device is in removing barriers to post-secondary education for students with sensory disability. Responses of “not sure” have not been included in the calculation of figures in the table.

As presented in Figure 21, most post-secondary disability support staff surveyed also found the eLearning items available to be effective in removing barriers to post-secondary education for students with a **communication disability**. In particular, web-based lectures/presentations that use video, downloadable course material, PowerPoint presentation, and digital tutorials were rated as very or somewhat effective by over 90 per cent of respondents. Live online voice-based chat was the item most frequently identified as not very or not all effective (by 41 per cent of respondents).²⁵

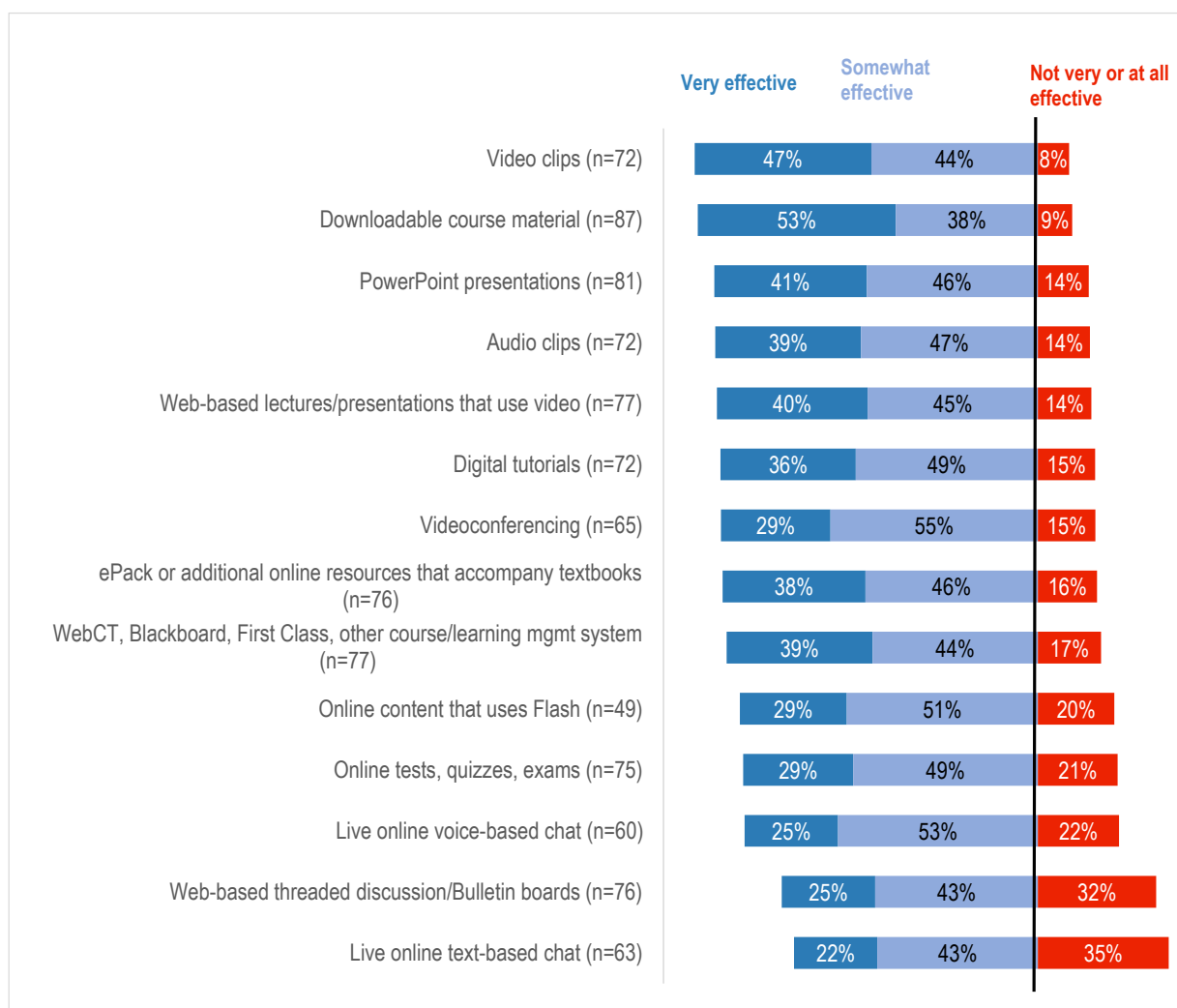
Figure 21 How effective are these eLearning environments and equipment, when they are available, in removing barriers to post-secondary education for students with communication disability?



²⁵ Across the types of eLearning listed, between 8 and 42 respondents were unsure how effective the given device is in removing barriers to post-secondary education for students with communication disability. Responses of “not sure” have not been included in the calculation of figures in the table.

Most post-secondary disability support staff surveyed also found most of the eLearning items available to be effective in removing barriers to post-secondary education for students with a **cognitive disability**, particularly video clips and downloadable course material, seen as very or somewhat effective by over 90 per cent of respondents. Web-based threaded discussions/bulletin boards and live online text-based chat were the lowest ranked items, each deemed not very or not at all effective by approximately one third of respondents (See Figure 22).²⁶

Figure 22 How effective are these eLearning environments and equipment, when they are available, in removing barriers to post-secondary education for students with cognitive disability?



²⁶ Across the types of eLearning listed, between 9 and 42 respondents were unsure how effective the given device is in removing barriers to post-secondary education for students with cognitive disability. Responses of “not sure” have not been included in the calculation of figures in the table.

AT within the larger system of accommodations

Post-secondary support staff interviewees were also asked about how AT fitted within the larger system of accommodations for students with disabilities. Responses ranged from viewing AT as a valuable supplement (one of many) to the larger system of accommodations to a “critical and very essential part” of the system. AT was also described as a “door-opener” or an “equalizer,” at least to some degree, in its ability to help students with a range of disabilities in areas such as note-taking, assignments, and exams. Some also saw AT as key to boosting students’ independence by, for example, reducing their reliance on human supports, such as scribes and interpreters. AT could also be especially important during exams when students are forbidden from using their own devices.

Perspectives of post-secondary students

Among the students interviewed, there was consensus that their AT had had a positive impact on their post-secondary experience. Depending on the nature of their disabilities and the type of AT they used, they felt they had generally seen improvements in tasks such as their reading, writing, listening, and/or note-taking abilities along with memorization, focusing, planning and organizing – allowing them to work more efficiently and resulting in better quality assignments and better grades. Some had found more independence (e.g., by no longer relying on human supports like interpreters). Even a student who had abandoned her AT felt that knowing it was there had increased her confidence. For some, post-secondary education would not have been possible without AT.

“Without access to assistive technology, I either wouldn’t be participating, or I’d be struggling a lot more. I would say it facilitates it, and it’s an essential part of my participation for sure.”

“If I didn’t have it, I would probably be a B student rather than an A student.”

“It changed everything. You know, I almost quit my PhD several times when I was in the process of trying to sort it out...it is so much difficult effort to do this work without assistive technology.”

“The success of my academic career is dependent upon assistive technology.”

“Not having access to disability technology can literally prevent someone from achieving any type of goal or dream in their life.”

“To get an education and be competitive in this world, we need to have the technology available to us to do that.”

(Student interviewees)

Barriers and facilitators to AT applications

While the evidence in the area of best and most promising practices is scarce, the literature does identify a number of factors, which have the potential to impede or facilitate successful applications of AT. Here we outline some common themes identified in the literature with respect to barriers and facilitators, supplemented with information gathered from the online surveys and key informant interviews undertaken in phase 2.

Training and professional development

The need for AT training and professional development was a key theme in the literature. Research suggests that few educators and professionals are adequately prepared to use technology themselves, or to teach and help students in its use (Ayres et al., 2013; Crider, Johnston, Rutledge, Doolittle, & Beard, 2014). In Canada, the literature indicates a lack of knowledge on the part of AT users, and limited availability of resources and trained personnel (Penton, 2015).

Numerous studies reported inadequacies in AT training for teachers (Bargerhuff, Cowan, & Kirch, 2010; Bausch & Ault, 2012; D'Andrea & Siu, 2015) and other professionals (Barzegarian & Sax, 2011). It has been argued that all individuals involved in AT-related decision-making should have workable knowledge of AT (Crider et al., 2014), and that university programs develop AT courses, and embed AT competencies in their training curricula (Li et al., 2012). However, a recent study found many existing AT competencies, at least in the US, are based on poor evidence (Dalton, 2015).

In addition to AT, some authors have identified educators' poor knowledge about accommodations and disabilities as a barrier (Christensen & Rogers, 2013). Specific to e-learning in Canada, in an online survey of post-secondary institutions only half of the study participants indicated professors are taught about e-learning accessibility, and that professors and e-learning professionals had relatively low awareness of the needs of students with disabilities and how to make e-learning accessible to them (Asuncion et al., 2010). There is no current data on what percentage of colleges and universities require accessibility training for faculty who teach online courses or for online course developers (Betts, Welsh et al., 2013), and more research is required.

To date (at least in the field of visual impairments) more research has been conducted about AT teacher preparation than on the actual outcomes of instruction when AT is used (D'Andrea & Siu, 2015). There has also been little research into what type of training in AT would be most valuable to practitioners in the field, or as to the intensity of in-service training. There are many vehicles to provide professional development, but no evidence to indicate which would be most useful or cost effective (D'Andrea & Siu, 2015).

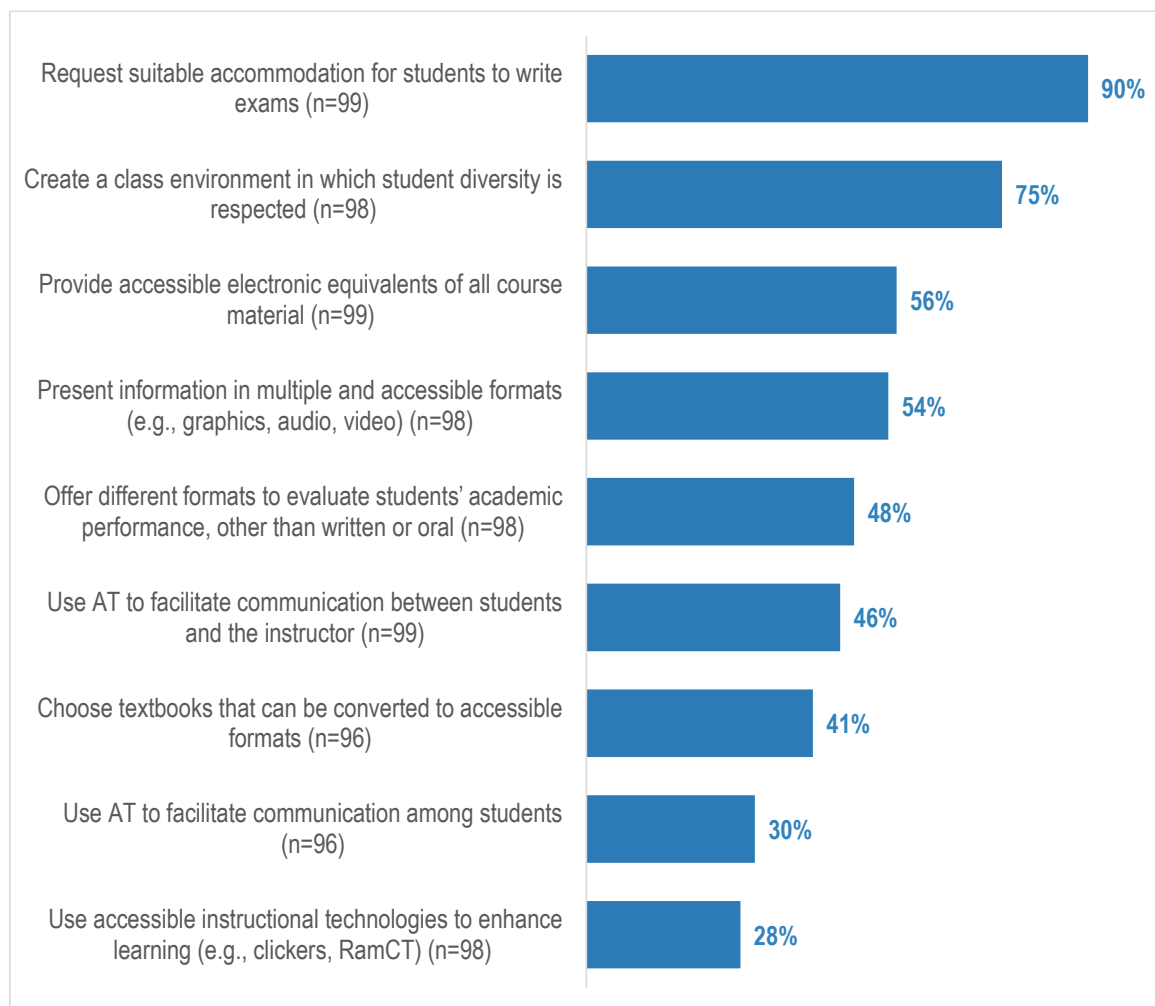
According to the results of SRDC's survey of provincial and territorial representatives, the majority of respondents' provinces/territories (n=8) did not provide AT-related professional development opportunities to staff at post-secondary institutions.

Among the four respondents who indicated that their province/territory did offer such professional development, all four indicated the province/territory provided *recommendations* for professional development in AT, and two indicated the jurisdiction provided *requirements* for professional development. One respondent indicated ongoing ad hoc (but non-certified) professional development was available upon request by institutional staff. None indicated their province/territory provided AT endorsement or certification.

Various post-secondary disability support staff identified a need for AT-related professional development on campus. Respondents to the survey of post-secondary support staff were asked to identify the training, instructions, or guidelines they provided to faculty members regarding the integration of AT in curriculum delivery. As shown in Figure 23, the most commonly identified area

of training, instruction, or guidelines was on how to request suitable accommodation for students to write exams (identified by 90 per cent of respondents). Training, instruction, and guidelines on the use of accessible instructional technologies to enhance learning was the least frequently identified response, at 28 per cent.

Figure 23 Do you or other disability support staff provide training, instruction or guidelines to faculty members on how to...?



Financial barriers

High cost was identified by students as a key obstacle to using technology in one Canada-wide study (Fichten et al., 2014). Similarly, in a study from Newfoundland and Labrador surveying consumers and service providers related to the provision of AT for people with disabilities, cost of AT and lack of funding subsidies represented significant barriers to AT access (Penton, 2015). Service providers

also identified lack of funding for AT assessments as a significant barrier to obtaining AT particularly for post-secondary students. They reported that provincial and federal funding for AT often required written documentation of a learning disability provided by a licensed professional who administered a psycho-educational assessment. Although the Canada Study Grant reimbursed 75 per cent of the cost of the assessment to a maximum of \$1,200 for each student, the up-front cost of completing this assessment (in addition to the cost of purchasing AT) was a financial barrier for many individuals in the province. Research from the US has also found costs of acquisition and maintenance to be barriers to AT for students (Ayres et al., 2013).

The results of SRDC/NSS interviews with post-secondary disability service providers and students also indicated significant financial barriers to accessing AT. Needless to say, paying for AT could be extremely challenging for students without access to funding through grants from the Canada Student Loans Program or other grants and bursaries. Although students deemed ineligible for funding were often presumed to be able to afford their own AT, SRDC/NSS heard that most would be hard-pressed to pay for more expensive items that were costed in the hundreds, if not thousands, of dollars.

Where funding was available, it was reported often to be making the difference: without it, many could “never” afford AT. However, funding often generated its own set of challenges for students and staff. Notably, funding could be restricted to specific types or pieces of AT and did not always cover the full cost of devices. For example, one service provider interviewed noted a case where a student’s specialized computer cost \$1,000 more than the funding cap; the difference had to be made up through private funding. Another added that the current cost of commonly used voice-to-text software exceeded the funding cap. As well, timeliness was an issue; in some cases funding did not arrive until weeks or even months after classes had begun, during which time many students had fallen behind. Some students could also be required to pay out-of-pocket initially and then face lengthy wait times for reimbursement, putting a large strain on their finances in the meantime. In addition, assisting students with funding applications could be time-consuming for staff.

Interviewees offered the following funding-related suggestions:

- Standardize the grant application process across provinces and territories, allowing for online applications;
- Consider establishing a government-funded position to assist students with funding applications, as in Nova Scotia;
- Establish a pool of funding to help students cover the initial out-of-pocket costs for AT – to be reimbursed once funding is received;
- Provide more flexible funding to help pay for a wider range of AT (not limited to specific types or pieces) and for other helpful technology not considered AT (e.g., smart phones) – i.e., fewer “strings attached”;
- Provide funding sooner (i.e., prior to the start of classes) and offer timely reimbursement of students’ up-front out-of-pocket AT expenses;
- Offer additional funding for students facing financial difficulties;

- Provide institutions with more (or more discretionary) funding for AT – e.g., to ensure all students have access to the AT they need more students (including those with and without documented needs), to purchase more on-site loaner equipment, to conduct assessments, etc.

In the post-secondary disability support staff survey nearly one half (43 per cent) of respondents indicated that AT was included in the technology planning and budgeting process at their institutions. Nearly equal proportions said AT was either not included in the process (30 per cent) or that they were unsure either way (28 per cent).

Wait times

Several interviewees – post-secondary institution disability support staff and students – identified wait times for AT appointments, for actual AT and for AT funding as significant challenges on post-secondary campuses. SRDC/NSS heard delays often resulted from understaffing at Disability/Accessibility Centres or lengthy procedures (i.e., for funding). Ultimately these delays mean that students go for longer period of time without the recommended AT and may fall behind in their studies as a result. Post-secondary students and staff suggested the need for the following:

- More staff at disability/accessibility centres or similar, ensuring they are knowledgeable about and can help students acquire the AT they need;
- A dedicated position for AT;
- A go-to person available for timely appointments or a support person to help students when their regular counselor/advisor is busy;
- Access to AT prior to the start of the semester (once classes start, it is extremely challenging for many students to find the time to become familiar with new AT);
- Faster and easier access to AT in general, including new and upgraded AT; one interviewee suggested this should also include everyday living devices like hearing aids, for free or at a significantly reduced cost (although not considered AT, they can be essential for education);
- Interim access to AT (e.g., through loaners or interim software licenses) while students are awaiting their recommended AT;
- Faster and easier access to alternate format textbooks (including a suggestion to allow students to contact publishers directly for alternate format materials).

AT abandonment and knowledge translation

Canadian literature suggests high levels of abandonment of AT (Penton, 2015), and there is some evidence on reasons for abandonment of AT among students. This literature provides further insight into barriers and facilitators to successful applications of AT.

A central theme on AT abandonment related to inadequate knowledge of AT. When individuals do not have sufficient knowledge of AT or different AT alternatives, they cannot select the most appropriate option, with AT abandonment rates as high as 30 per cent (Adya, Samant, Scherer, Killeen, & Morris, 2012). Studies have found that poor knowledge of available technologies (Reed &

Curtis, 2012), and lack of involvement in the pre-purchase decision-making process (Martin, Martin, Stumbo, & Morrill, 2011) were all related to AT abandonment.

Other reasons for AT abandonment (identified in Holmes & Silvestri, 2012) included that the AT:

- required significant time investment in training (Seale, 2013);
- did not improve academic functioning;
- was too difficult and expensive to repair;
- was too difficult to use or required too much assistance from another person;
- required a long or complicated series of commands, failed to function as intended;
- was not always reliable; and
- did not always address the curricular demands.

Finally, some abandoned AT because they felt it was “othering”: students reported feeling stigmatized by some AT, did not like being recommended AT based on their disability “label” (Foley & Ferri, 2012; Seale, 2013), and disliked it when the AT made them stand out in a group (Holmes & Silvestri, 2012).

Many of the reasons for abandoning AT listed by students can be linked to inadequate knowledge of AT, such as what the AT can and cannot do, what it looks like, and how much training it requires. This supports recommendations identified in the literature that to be effective and to ensure the best matches between AT and need, knowledge translation ought to be a central component of AT service delivery models (Adya et al., 2012).

A small minority of students interviewed indicated they had abandoned some or all of their AT, typically because they did not feel well-prepared to use the AT (e.g., due to a lack of training of time to explore full use of the technology) or found it to be ineffective or a poor fit for them. For one student, the main issue was the lack of training *in the classroom* specifically, leaving her frustrated on how to use the recommended AT.

“They are very good programs. They just don't work for *my* processing disabilities, if that makes sense. When I was shown the programs, I was like, ‘Wow. I wish I had these in school. These are amazing!’ And then when I actually used them in class, they caused me more grief and more stress, and I actually ended up dropping two classes because I had to learn how to use the two programs, how to log into [the university's platform], how to get into my classes, so I actually ended up wasting \$2000 on classes that I had to drop.” (Student interviewee)

Another student had abandoned the reading software he had received to help with his learning disability because he found it inefficient. He also mentioned that in some cases low-technology options – for him, placing a ruler below each line as he reads – can be very effective and minimize dependence on technology. Another student had abandoned use of a smart marker – a device to transfer the instructor's whiteboard notes to the student's computer – because so many instructors used PowerPoint presentations instead of white boards. He also added that inappropriate AT could

create an unnecessary dependency and, where possible, he would prefer to do things like note-taking himself as it helps him understand and remember the information better.

Interviewees suggested adequate AT training for students and more follow-up as means to reduce AT abandonment. Note, however, that at least one student interviewee was using AT that someone else had abandoned and then offered to her. In other words, not all abandoned AT will go to waste.²⁷

Institutional-level considerations

The importance of students' *experience* of accommodations (technological or otherwise), such as their quality and availability, has also been discussed (Cawthon, Leppo, Ge, & Bond, 2015). This research suggests that students experience a variety of difficulties including lack of specialised software, frustrations with the bureaucracy and speed of the funding and assessment procedures for obtaining AT, and lack of support or training to become fluent users of AT (Seale, 2013). Although students often express these concerns, they still indicate that AT is important to their success in the post-secondary education setting (Cawthon et al., 2015).

To this end, the literature identified a number of institutional-level factors needed to facilitate successful applications of AT, including:

- (1) collaboration across multidisciplinary teams (Ayres et al., 2013; Crider et al., 2014);
- (2) policies and procedures to ensure basic knowledge among stakeholders (i.e., teachers, service providers, administrators) about the needs of different learners, teaching techniques and curriculum strategies (Alquraini & Gut, 2012);
- (3) a shift whereby AT is not the sole responsibility of disability service offices, but is integrated into campus culture and business processes (Betts, Welsh et al., 2013); and
- (4) development of e-learning expertise on campus and adoption of E-Learning Accessibility Guidelines (Asuncion et al., 2010).

Data gathered in phase 2 and reviewed below provides an overview of existing policies, guidelines and procedures at Canadian post-secondary institutions, to inform this discussion of institutional-level considerations.

Government policy and guidelines

Among the 15 provincial/territorial staff members surveyed, only three indicated their province or territory had policies and guidelines regarding AT use, either for all levels of education (n=1) or specifically for post-secondary institutions (n=2). One of the three indicated the province/territory

²⁷ Of course, SRDC/NSS was talking to students who were nearly all currently enrolled in PSE. Abandonment may be more common among students who drop out of higher education because the AT didn't meet their needs.

had content standards and performance standards for students but no curriculum or delivery standards for instructors and administrators.

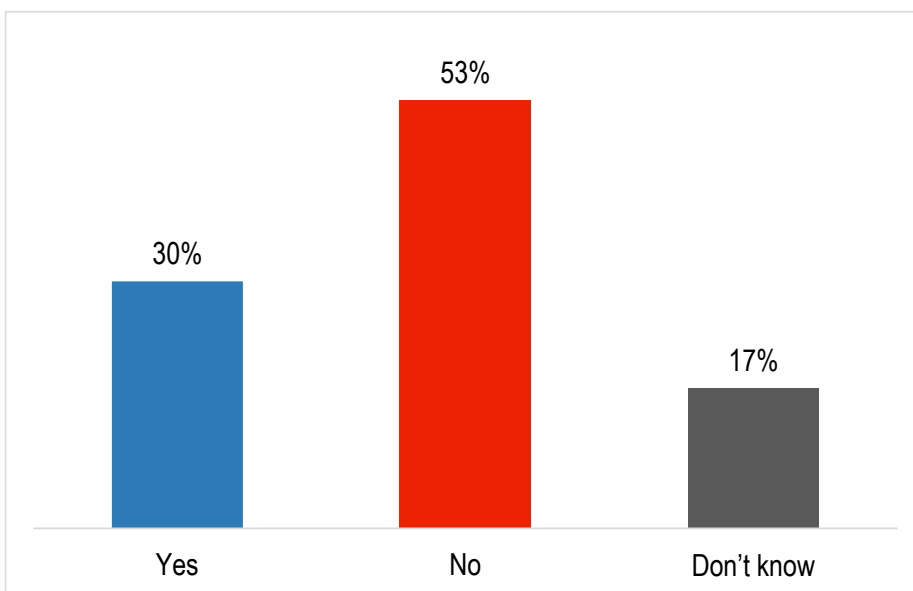
All three of these respondents indicated their policies and guidelines included: student rights and responsibilities with respect to AT provision at the post-secondary institution; confidentiality of students' AT request and usage; and procedures for determining and accessing reasonable AT accommodations. Two also said they included: institutional rights and responsibilities with respect to AT provision at the post-secondary institution.

Five respondents indicated that their province or territory did not have any policies or guidelines regarding AT use at post-secondary institutions (the other seven were unsure). Among the five who said no, three indicated it was not very likely or not likely at all that such policies and guidelines would be developed in the future. One said that policies and guidelines were somewhat likely to be developed while the remaining respondent did not know either way.

Institutional policy and guidelines

As shown in Figure 24, only three in ten (30 per cent) respondents to the post-secondary support staff survey indicated their institution had official policies and guidelines in place for faculty and staff on how to ensure access to electronic and information technologies for students with disabilities. Most indicated they did not have such policies or guidelines (53 per cent) or did not know either way (17 per cent).

Figure 24 Are there official policies and guidelines for faculty and staff on how to ensure access to electronic and information technologies for students with disabilities? (n=99)



Among the 30 per cent of respondents who did have policies and guidelines, most indicated the materials are updated only occasionally (e.g., every few years) (53 per cent of this group) or frequently (e.g., at least every year) (37 per cent). Three percent said they were not at all updated while seven per cent were unsure about the frequency of updates. When asked how the policies and guidelines were disseminated to staff, they most commonly indicated they were available as online resources to faculty and staff who were interested (43 per cent) or were sent to a subset of faculty and staff (23 per cent). Smaller proportions indicated they were sent to all faculty and staff (17 per cent) or made available upon request (7 per cent). The remaining 10 per cent of respondents with policies and guidelines in place were unsure about how they were disseminated.

Among the 52 per cent of respondents who indicated their schools did not have official policies and guidelines in place for ensuring students with disabilities had access to electronic and information technologies, most noted that such policies and guidelines were very (17 per cent) or somewhat (52 per cent) likely to be implemented in the future. Among the remaining respondents, 10 per cent said it was not at all or not very likely while 21 per cent did not know either way.

Additional barriers and facilitators

Interviewees were not restricted to the ranges of themes above when identifying barriers to use of AT and in making suggestions for improving how students with disabilities might access post-secondary education. SRDC/NSS heard numerous suggestions that one or more interviewees provided to improve access for students:

- Additional accommodation for AT users (e.g., extra time for exams);
- Access to video recordings of lectures;
- Alignment of AT to World Wide Web Consortium (W3C) standards;
- Provincial or national policy and legislation for persons with disabilities (e.g., akin to the *Americans with Disabilities Act*);
- Improvements to campus services and facilities – e.g., better/faster campus Wi-Fi; inclusive building design, such as stairwell markers for vision impaired individuals;
- Extra consideration AT needs beyond undergraduate students – e.g., graduate students, post-doctorates, sessional or contract instructors;
- Provincial/national policy to prevent discrimination against persons with disabilities;
- More bridging to the K-12 systems to help with the transition;
- More AT options for students with learning disabilities and mental health issues;
- More AT options for adults rather than children and youth;
- More interaction between ATBC and post-secondary institutions;
- More AT-specific training for disability staff;
- More acceptance of AT among instructors;
- Centralized access to AT advice and support.

3.5 Assessment of potential effectiveness of new and emerging technologies

Technological advancements are bringing new products and applications to the market on a continuous basis (Betts, Welsh et al., 2013). As the available evidence tends to lag behind the pace of innovation, as mentioned, some have argued that these new innovations become reasonable tools when they are based on other evidence-based practices, techniques and procedures (Ayres et al., 2013). In the absence of research, it has also been recommended that educational leaders seek out the informed judgment of experts and policy leaders in making decisions about these emerging technologies (Christensen & Rogers, 2013). Others have stressed the need to include the voice of students with disabilities and disability service providers regarding the adoption of new technologies on campus (Fichten et al., 2014). Finally, it is likely that low tech devices in particular will remain popular and useful, and various models will continue to be applied to seek person-technology matches that can be used as effective supports (Bryant, Bryant, Shih, & Seok, 2010).

Post-secondary support staff interviewees indicated that they commonly heard about and/or assessed new and emerging AT through three sources:

- (1) listservs, online information and webinars, and conferences, or
- (2) through communication with colleagues, peers, professional associations, private companies, or
- (3) organizations like the CNIB, ATBC, Neil Squire Society, and the High Tech Centre Unit in California.

They reported also using a variety of means to assess the effectiveness of new AT, including student feedback, their own tests and trials of devices (e.g., in their own AT labs or through loans from vendors), or “gut instinct” based on years of experience. One interviewee added that he also looked at online reviews and considered specific details about each given AT item (e.g., date of initial release and most recent update, number of versions released, cross-platform compatibility, etc.).

Several interviewees identified finding the time to stay abreast of ever-changing AT as a major challenge to their work, and in some cases they were not able to keep up. Individual interviewees also noted challenges in terms of finding information specific to (a) post-secondary education rather than the elementary school context and (b) Canada (much information is reportedly from the United States). Getting access to AT (e.g., through loans from vendors) in order to try out AT as part of the assessment process could also be difficult (SRDC/NSS was told short-term loans typically do not provide enough time for thorough testing). Nevertheless, most were relatively satisfied with their processes and felt there were able to stay reasonably up to date on new and emerging technology.

When asked if processes to assess the effectiveness of new and emerging technology should be standardized provincially or nationally, comments were mixed. Some were unsure how such a process could be standardized due to the wide range of technologies on the market. There would also be differing institutional contexts and variation in students’ needs to take into account. Others

were generally in favour of a more formal process but would typically prefer flexible guidelines to mandatory standards.

Other suggestions for improving processes to assess new and emerging AT included the following:

- Opportunity to communicate directly with AT developers (rather than only with company support lines) – e.g., focus groups/product testing or advice from developers on what one should consider when assessing the technology;
- A provincial – or ideally a national – research body to keep all post-secondary institutions up to date and make recommendations around new and emerging technology;
- Centralized website or community of practice accessible;
- Tools (e.g., a checklist) for evaluating new software or devices;
- Funding for professional development related to the identification and assessment of new and emerging technology and/or to hire additional staff to help keep up to date AT.

One interviewee added that the QIAT indicators may also be applicable to the assessment process.

It is also worth noting that there are existing online AT databases that allow students to search for and obtain information about established as well as new and emerging technologies. Information about these databases, along with a listing of other online resources, can be found in Appendix C: Additional resources.

3.6 Trends

In this final section we review trends. The peer-reviewed literature is necessarily backward-looking and so is not a source to identify new AT applications. Fieldwork did not identify any particular new/promising AT applications although respondents mentioned that new AT was coming out all the time, increasingly free or low-cost. For example, one support provider was enthusiastic about the role virtual reality technology could play in the future for students with disabilities. No specific new AT was identified to add to the project inventory.

Thus in this section we focus initially on three of the most documented areas of AT development. Existing evidence on AT trends as they relate to Canadian post-secondary institutions is currently limited. Therefore, we conclude with the perspectives of stakeholders on trends.

Digital materials

An important trend is with respect to the increased use of digital materials. With advances in technology, digital materials can now easily be made multi-modal and allow for the customization of the materials to meet individual needs. Digital information can be adapted using AT software and apps. It can be enlarged, moved, change colour or font, extra or distracting information can be removed, and links can be provided to additional supports, such as websites, videos, audio, pictures, graphs and tables. Video and audio materials can be captioned or transcripts provided to ensure they are multi-modal.

Reading supported by AT is a key educational task that has benefited from UDL. A digital format allows for text-to-speech conversion and the ability for the text to be read aloud. This can be useful to students with vision loss and learning disabilities, but also those who are auditory learners. In the past, printed text was transformed through scanning and an optical character recognition process to create digital text that could be read through text-to-speech. Now, text-to-speech is a feature of many AT apps and software, and is also an accessibility feature in most operating systems. Other AT can support learners through features, such as zoom, rulers, highlighters and the ability to annotate digital text with type or handwritten or audio notes, pictures and video.

Learning online

The rise of distance and blended learning has led to an increase in online learning environments. Face-to-face programs also increasingly post materials online, with online course sites for students to access notes and participate in discussions. Many institutions utilize a Learning Management System to deliver their courses, which often have a baseline of accessibility settings to ensure a usable environment for all students. Most have many accessibility features, and major operators have accessibility task forces to identify, test and address issues and solutions. Guidelines such as Web Content Accessibility Guidelines (WCAG) 2.0 for learning management systems and websites provide a way to ensure digital content can be accessed by AT such as screen readers, switches, keyboards or other input alternatives.

Less than one-fifth of students interviewed were currently taking online courses or had taken an online course very recently. Those who were included one student whose entire program was online and self-paced. All but one of these interviewees indicated the courses had good accessibility – they generally had no trouble accessing course materials or completing assignments, even though exams were usually taken at an exam centre. They also mentioned appreciation for features such as the ability to play back videos as many times as needed and ease of use of PDFs (which can be enlarged for those with vision disabilities) and screen magnifiers. That said, at least one of these students stated a clear preference for classroom courses with an in-person instructor.

One student interviewee appreciated the convenience of online courses (with no need to commute) but found that accessibility varied from instructor to instructor. In addition, the online platform was challenging, and not all materials were suitable for a wide range of disabilities (e.g., there could be no closed captioning on videos; time limits for some quizzes – although extensions were possible). In the end, this student did not feel she was able to engage as much as some others students and reported online education to be a “medium” quality experience overall.

However, nearly all students interviewed said that instructors in their class-based courses regularly used online or digital materials, mainly posting articles, class notes, assignments, and other materials (e.g., videos). Some courses also required students to submit assignments online and to participate in discussion forums. For the most part, students found the materials quick and easy to access. They also appreciated aspects such as cost saving due to reading materials online rather than printing them, convenience of accessing materials from their own electronic devices, ease of use of PDFs, and ability to access notes they had missed without having to ask someone else.

That said, some found use of an online platform – which varied by institution and course – to present an initial learning curve (becoming typically easier to use with practice) or reported similar challenges to those in the online-only courses (e.g., lack of closed captioning on videos). One student, who described himself as being not very computer literate, said that he usually needed someone to help him access the site. Another student noted the extra time it took to compose a well-articulated contribution to an online discussion as compared to speaking aloud in class. One interviewee had had a far more negative experience with online materials due to the need to log-in in three different places before accessing the materials and the fact that all of her different instructors used different platforms and system for online materials. Overall, she found her experience “excessively frustrating.”

Universal Design multimedia approach to assessment

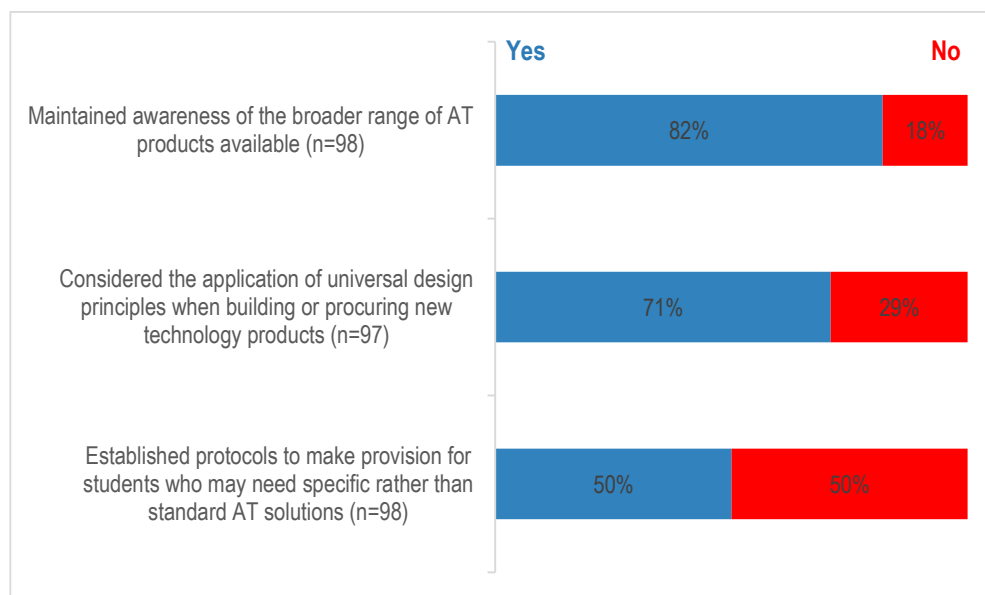
A wide-ranging theme relates to the increased use of universal design multimedia for assessing student performance. In order to provide equal opportunities for students to interact and navigate the material, UDL recommends that the instructor provides multiple means for students to control their learning environment, and many students may require the use of AT to effectively interact in that environment. For example, in order to demonstrate their knowledge, a student may provide a written page with the use of AT, which could be typed using an alternative input method such as an eye gaze system or by voice recognition. Alternatively, the student could demonstrate their knowledge using a video, a poster or an audio recording, with or without AT.

Overall trends

The survey of post-secondary service providers provided a glimpse into trends across respondents’ past and present approaches and activities in the area of AT as well as their future intentions.

As shown in Figure 25, the majority of respondents indicated that they or other disability support staff at their institution had: a) maintained awareness of the broader range of AT products available (82 per cent); b) considered the application of UDL principles when building or procuring new technology products (71 per cent); and c) established protocols to make provision for students who may need specific rather than standard AT solutions (50 per cent). Nearly all others indicated that they were not yet taking the above steps but would consider doing so in the future (17 per cent, 26 per cent, and 45 per cent, respectively). Only a small minority of respondents (1 per cent to 5 per cent) did not expect to consider it in the future.

Figure 25 Have you or other disability support staff at your institution...?²⁸



Post-secondary disability support staff were also asked to consider various aspects of their post-secondary context in comparison to five years ago. Results showed that the majority somewhat or strongly agreed that barriers to post-secondary education for students with disabilities had been more effectively addressed because of advancement in AT (84 per cent) and that educators were now more aware of post-secondary students’ needs for AT (81 per cent). Further details are provided in Figure 26.

Thinking about the next five years, most respondents agreed that more standardized practices related to AT provision at post-secondary institutions would be developed at a provincial/territorial level (75 per cent) or at the federal level (55 per cent). A smaller proportion (44 per cent) agreed that all Canadian post-secondary schools would adopt UDL principles (see Figure 27).

²⁸ Due to the small number of respondents who indicated “No, and do not expect to consider it in the future,” these responses have been combined with those of “No, but will consider it in the future” in the figure shown.

Figure 26 Compared to five years ago...

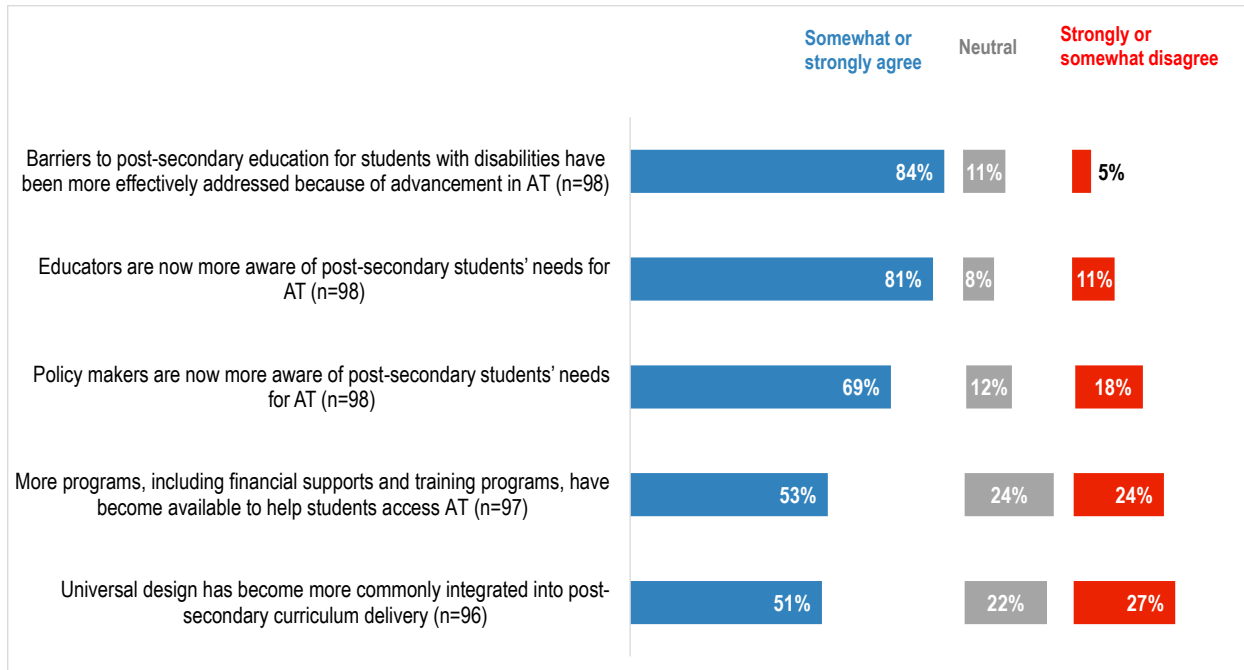
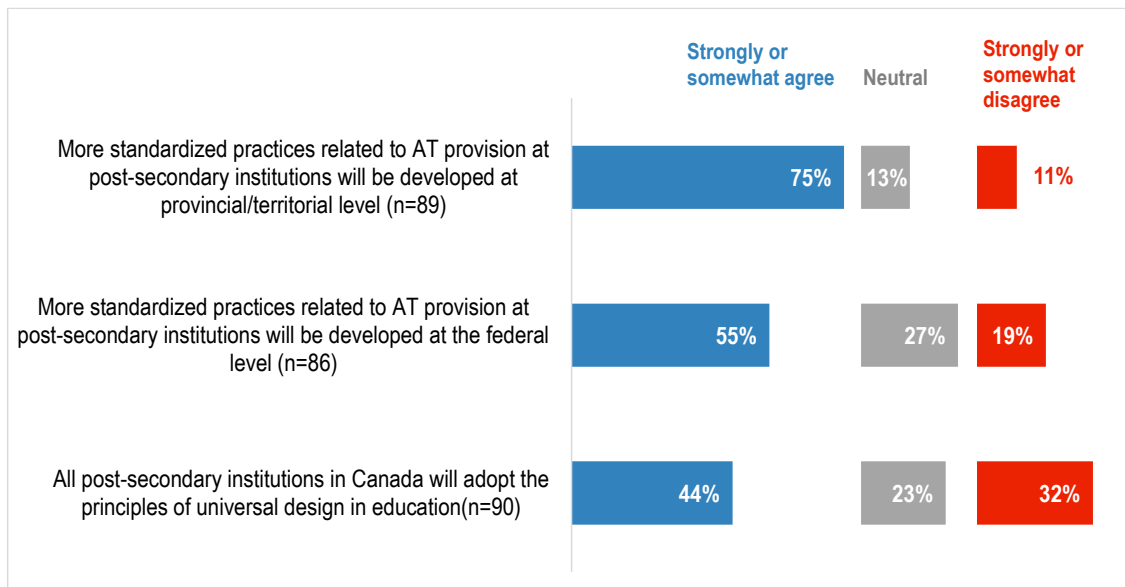


Figure 27 Thinking about the next five years, do you think...?²⁹



²⁹ Across the three areas of inquiry, between 8 and 12 respondents were unsure how much they agreed or disagreed with the statements listed. Responses of "not sure" have not been included in the calculation of figures in the table.

4. Overview and conclusions

This study has collected a great deal of information on AT practices and utility in the Canadian postsecondary context using a wide variety of data collection methods: from literature review, information and environmental scan through the development of an AT inventory and fielding of numerous surveys and interviews.

The triangulation of these different sources have proven sufficient to meet the requirements of the project: to inform AT-related decision making for Canadian post-secondary institutions and jurisdictions; to provide guidance and direction for individuals with disabilities, post-secondary staff, and policy makers around the selection of appropriate AT to address disability-related education barriers; and to assist Canadian jurisdictions in forming policy and practice for the delivery of funding, notably the Grant for Services and Equipment for Students with Permanent Disabilities.

Of course, as with any fieldwork conducted with a finite budget to assess diverse experiences across multiple jurisdictions and hundreds of institutions, there are some limitations. In particular, only a relatively small sample size be achieved within the available time and budget for incentives. The final samples are still national in scope and sufficient for drawing broad lessons about processes and procedures with respect to AT. They provide a rich, qualitative understanding of service providers' and students' experience of programming as implemented. Naturally, including a set of 20+ student interviews rather than a full-blown survey prevents accurate quantification of the scale student experiences. Students with disabilities who are not in education at all due to problems accessing AT were not included. Furthermore, it has not been possible to obtain respondents from all territories. But neither is strictly necessary for research to identify the most important areas for policy development.

There are two overarching themes related to findings. The first is that, overall, the existing system of provision of AT is making a big difference to the learning experience of students in Canada. Students said that, at a minimum, they would not be able to do as well in post-secondary education without AT. For some, post-secondary education would be impossible without the AT they could access.

The second, counterbalancing theme is that there are still challenges, including (especially) long wait times to get appointments with disability staff and to receive AT. Some students also struggle with paying initial up-front costs for their AT and their learning would be facilitated by faster access to the funding.

4.1 Findings

The study has identified a very wide range of AT and eLearning materials used (from Screen or text readers, voice recognition and mind mapping to PowerPoint, downloadable course materials and WebCT). Students were generally satisfied with the available AT and no large discrepancies emerged between post-secondary student and staff perspectives. However, there was a large

variation in the extent of monitoring/ tracking of AT use at the provincial, territorial and institutional level, with several jurisdictions unsure whether monitoring data were collected.

Assessment processes to identify suitable AT were often informal, and typically respondents described a process in keeping with those SRDC/NSS summarized earlier from the literature (as depicted in Figure 6). Most respondents were satisfied with the process and the recommended AT, although naturally some suggestions for improvement were forthcoming. In general, those involved in the process were not seeking a formal set of assessment standards rather more standardization in guidelines that would still be *flexible*. Both service providers and students felt more options to try out AT before ordering/buying would be useful.

Adoption of UDL at institutions was very mixed, ranging from happening *to some degree* or not at all; most service providers reported having seen progress in past five years and expected more progress in the next five.

AT was reported essential for removing disability-related barriers to post-secondary education for students with disabilities – student interviewees were very clear that it made huge difference for them. Staff also saw most AT and eLearning as effective in removing barriers. For the most part, however, there was very informal follow-up with student recipients of AT, and that which was done sought anecdotal evidence of success. The onus was on students to contact staff if they had problems. Funding and wait times were particular barriers/issues. Within our small sample, abandonment was not found a major issue but the literature recognizes abandonment as key concern overall.³⁰

Assessment of new and emerging AT was difficult. Staff reported keeping up with developing AT to be a major challenge. Again, assessments were performed in an ad hoc way. Staff tended to want a more systematic set of *flexible* guidelines and were not looking for rigid assessment standards.

Generally trends were thought to be moving in the right direction. More than 80 per cent both saw barriers for students being more effectively addressed than five years ago and felt educators' awareness of issues had increased. For the future, staff strongly tended towards seeing more standardization in practices related to AT at the institution (75 per cent) and federal (55 per cent) levels in the next five years, though fewer (44 per cent) were optimistic that UDL principles would be adopted at all institutions in the same time frame.

4.2 Remaining knowledge gaps

Gaps in knowledge on how to best utilize AT identified in the literature review are summarized below. Responses to SRDC/NSS surveys and interviews did not necessarily fill these gaps, but responses obtained during the fieldwork were able to shed more light in some areas of ongoing knowledge shortfalls.

³⁰ Of course, SRDC/NSS was talking to students who were nearly all currently enrolled in PSE. Abandonment may be more common among students who drop out of higher education because the AT didn't meet their needs.

- There is a persistent gap in knowledge on the **relative effectiveness of AT devices**, and a paucity of high quality research on the efficacy of specific AT. Our fieldwork found perceptions of effectiveness of AT in removing barriers to post-secondary education very high in general, but there is a difference in levels. Broadly defined types of AT were reported effective, rather than specific pieces of AT. The dearth of information on combinations of approaches remains. Fieldwork identified few examples where individual student needs were addressed by effective combinations of multiple types of AT or specific pairings of AT with learning strategies.
- More work is still needed to better understand **the factors influencing acceptance or abandonment of AT**. In-depth longitudinal research could explore the interaction between the characteristics of AT users and their academic task demands to pinpoint flaws in the process that lead to AT mismatch. SRDC/NSS obtained relatively little additional insight from its collection of point-in-time accounts from a handful of cases with abandonment.
- **Optimal training and professional development** – SRDC’s survey has identified the types of professional development currently provided and sought, as well as failings in existing training provision. For example, not many provinces coordinate training leading to ad hoc development of AT expertise. On campus provision of AT training to faculty to support exam-taking is almost universal, while training on use of accessible instructional technologies is much less widespread.
- While **understanding applications of AT within UDL** will always remain a moving target, the survey did provide some evidence of universal endorsement and even take up of UDL. All respondents to the survey of post-secondary support staff viewed UDL as very or somewhat important for removing barriers to education and 42 per cent felt the principles had been adopted at their institution. Interviewees provided many clear examples of progress towards UDI on their campuses, while recognizing most still had a long way to go.
- **Trends in AT applications** represent another moving target. The survey shed light on the most prevalent trends on Canadian campuses and included 44 per cent who were optimistic that the principles of UDL would be adopted across all institutions within five years.

4.3 Recommendations

Recommendations for increasing the accessibility of post-secondary education for students with disabilities through changes to AT are derived from the literature review (especially a recent study by Fichten et al. of Canadian AT and emerging trends) and from analysis of the fieldwork data by SRDC/NSS.

- Increase the use of universal design principles, in particular, to ensure the accessibility of digital technologies. Train faculty how to use technology in an accessible way in their teaching, educate on UD principles and provide ongoing support with adoption.
- Require vendors to demonstrate (“show me how”) that their products are accessible to users with disabilities. If the institution purchases an inaccessible product, it should require vendors to provide a timeframe for when an accessible version of a product will be available.

- Institutions should explicitly describe their commitment to digital inclusion in policies that govern the use of technology in teaching and learning.
- Deliver training on the use of frequently used AT to helpdesk and other IT staff who interact with the student body and provide them with awareness training on accessibility. By doing this, day-to-day technical trouble-shooting can shift from the access technologists and offices providing disability related services to the mainstream helpdesk.
- Minimizing wait times for appointments, funding, and actual AT. These delays can have a real impact on students (who fall behind while waiting for AT to arrive). Ideally systems should be structured to provide AT to students before their classes start.
- Addressing funding barriers. The Canada Study Grant for persons with permanent disabilities does not require pre-payment for AT. Nonetheless the scope of the project included all post-secondary students with a disability. Among those with other funding sources, cost recovery can be slow meaning many students have to pay money up front and wait for reimbursement – that some find very difficult to manage. There is a large challenge also for those students facing high AT costs who find they are ineligible for funding.
- Re-thinking Training. Most students in our sample were satisfied with their training, but not all. Some provided concrete suggestions, such as providing training prior to start of classes, making available options for online training. Inadequate training is cited as one of the prime reasons for abandonment.
- Need for more follow-up on AT utility with students. Although students and staff seem satisfied with the processes, in some cases staff are really unaware of whether students are using AT successfully. Again this can be related to abandonment.
- Many institutions have limited resources (time, money, staff) for AT. Resource allocations need to keep pace with demand and the costs of technology requirements.
- Assessment guidelines. Interviewees would prefer guidelines to absolute standards, thus a recommendation is to consider developing sets of guidelines. These could be specific for existing needs and more generic for new/emerging technology.
- New and emerging technology. This is a big challenge for many staff interviewed. There is scope for establishing a clearinghouse to compile and share information on available and optimal AT solutions in a timely manner. There is a lot of duplication currently as all institutions strive to varying degrees to stay up to date on their own.

Appendix A: AT inventory overview

Approximate Cost: refers to a general cost based on the Canadian suppliers pricing model

AT Option for Distance: When selecting AT, the focus should be on the educational task that needs to be completed and the disability related barrier. While this choice is informed by the environment, given the diversity and the differences in the integration of UDL and Accessibility Principles currently in both face to face and distance settings, it may be difficult to classify accurately if a particular AT works in either setting. It is important to note that the majority of AT could be used in either setting depending on the task and the specific environment

Category of Equipment: indicates what broad category the item falls under in four categories: (a) Computer Access Peripheral, (b) Software/Apps (e.g., settings within the operating system of a given device, or additional software that can be purchased such as desktop software or an app), and (c) Accessories/Other (e.g., writing aids, recorders)

Class: indicates what class the category fits into (e.g., vertical mice; split keyboard; speech recognition; magnification software; braille display)

Company Website: includes the direct link to the product page providing the details about the product in question

Description: includes a brief description of the device

Disability Barrier Addressed: indicates “Yes” or “No” to allow sorting of data in the following categories: Developmental, Hearing, Learning, Memory, Mobility, Pain, Seeing, Emotional/Psychological, Agility, Communication, Other

Educational Use Case: indicates when would this assistive technology be used in an educational setting, such as: Written expression, Writing mechanics, Reading comprehension, Reading decoding, Doing Math, Listening, Speaking, Taking notes, Organizing, Planning, Focusing, Remembering, Studying, Other

Name: includes brand and model (e.g., Kensington Trackball Expert Mouse)

OS Compatibility: indicates compatibility with the following categories: Windows, MacOS, Linux, iOS (iPads, iPhones), Android, and Google Chrome

Required Training: indicates which category a product fits into: (a) Minimal Training – can pick up and fully use very quickly, such as less than one hour (e.g., most mice); (b) Formal Orientation and setup – can take over an hour but less than five to setup and full user (e.g., a live scribe pen would fit into this category as there is the use with the software, connecting to computers, and using with compatible); and (c) Ongoing Training and Support – can be an effective but complicated solution to master (e.g., a screen reader and speech recognition programs may require significant training to effectively use in an educational setting).

Appendix B: AT service delivery process

Ideally, AT assessments should be based in a framework, such as the Student, Environments, Tasks, and Tools (SETT), or a similar framework, and be grounded within a larger AT service delivery model. The SETT framework specifically, involves evaluating the student, the environment, the task, as well as the AT, with the view to allow the student to perform a task that is difficult or impossible for them to do without the device. A service delivery model, such as the Participation Model, would utilize a person-centred approach to the assessment, selection and attainment of AT. It is recommended that disability support centers in post-secondary institutions use a client-centered, collaborative evaluation approach to identify and understand the student's disability related barriers and to determine their technology needs (performed in-person or by distance communication) based on their unique goals, and the desired outcomes.

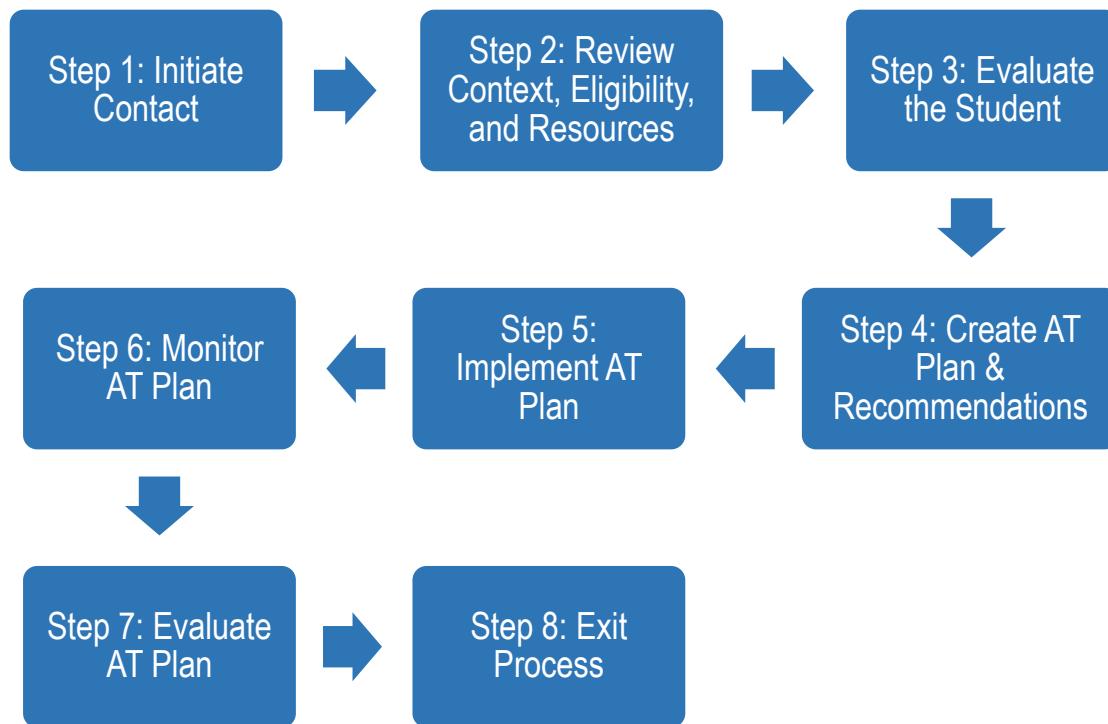
It should be noted that there are a variety of different types of situations that a students may require an AT assessment. These include but are not limited to:

- (a) Transition to post-secondary from the school system and are in possession of a transition plan, relevant assessments such as the Psycho-Educational Assessment, documented use of accommodations, strategies and Assistive Technology
- (b) Transition to post-secondary from the school system but were either never diagnosed with a disability, the disability is progressing, the change in educational environment has increased their needs or no formal supports were put in place
- (c) Transition to post-secondary after completing the GED but were never previously diagnosed with a disability, or no formal supports were put in place
- (d) Transition to post-secondary from the workforce needing to change career because of a progressive disability, illness or accident. Student may or may not have a history of AT use.

In some cases, the first point of contact may be the institution's Disability Support Services where the student may self-identify. Generally these students would be assessed by a Disability Support Counsellor and it would be determined if the institutions' regular set of accommodations would be sufficient to support the student (e.g., tutors/mentors, learning strategy support). If the student requires additional support beyond the available accommodations, the student could be directed to an AT Professional. A certified AT professional may be external to the Disability Support Services available at the institution. AT assessment referrals may also come from outside the institution, such as from an employment counsellor or a rehabilitation specialist working with the students.

It is recommended that the evaluation of a student's AT needs be conducted by a designated professional who has experience specifically in AT. This role requires a combined knowledge of disabilities, funding opportunities for AT, curriculum, current AT in an ever changing field as well as experience with IT and training skills. Certified AT professionals may have their own additional reporting, forms, and checklists. However, the document below provides a framework for conducting AT evaluations and is based on the stakeholders' experience of best and promising practices. The sequence of AT evaluations is summarized in Figure 28 below.

Figure 28 Assistive Technology evaluation process



Step 1: Initiate Contact

- a) The AT Specialist receives a referral from either the Disability Support Team at the Post-Secondary Institute, an Employment Counsellor, a Rehabilitation Specialist or the client may self-refer
- b) Connect with the student, in-person or via distance (telephone, online), to gain an initial overview about the student, their needs and current supports, as well as explain support services available to them

Step 2: Review Context, Eligibility and Resources

- a) Verify disability and functional limitations through the post-secondary institution's verification process
- b) Review relevant information related to the student's self-described disability and how it impacts the student's abilities in relation to their desired outcomes
- c) Identify past history of accommodations, modifications, AT and strategies
- d) Request supporting documentation, transition plans and reports
- e) Identify the service delivery approach and channels that will be most suitable for the student
- f) Ascertain the student's AT support network as well as their roles and responsibilities
- g) Outline possible funding sources for AT including but not limited to Canada Study Grant as well as the required funding criteria

Step 3: Evaluate the Student

- a) Determine the nature of the disability related barrier (i.e., is it due to a change in condition, a change in job task or role, or it is due to out-dated or dysfunctional equipment)
- b) Understand the environment to determine the best product to meet their needs, and ensure the environment is compatible with the AT being recommended and supportive for the student's needs
- c) Identify and consult with the student's AT support network (if required to enhance or expedite the acquisition process). This can include but is not limited to the disability support staff at the post-secondary institution, tutors, learning strategies, faculty, employment counsellor, rehabilitation counsellor
- d) Identify the disability related barriers as they relate to educational tasks, paying attention to future job environment as this can impact the choice of AT. The aim is to choose AT that can support the student through post-secondary and allow them to make a smooth transition to the world of work. This is also key if the student's program involved a co-op or work placement. The environment should also be taken into account
- e) Create a short list of the AT types (i.e., text to speech, voice recognition, alternative input device) that potentially address the identified barrier to access the curriculum
- f) Trial the pre-selective AT types that may be available or acceptable in order to determine appropriateness
- g) Once AT type is selected, select the specific AT based on the SETT framework, considering student, environment task and available technology
- h) If student's needs are beyond the AT evaluation process, consult a professional for specialized assessment options (e.g., Occupational Therapist for pain or Mental Health practitioner for issues around mental health and substance use)

Step 4: Create AT Plan and Recommendations

- a) Document a formal AT Plan. It should include the following information:
 - Description of the student's disability related educational task barriers
 - List of accommodations, learning strategies and AT requirements previously used
 - Outline of the AT type short listed, trialed and the successful outcomes
 - Description of AT selected for recommendation with justification
 - An estimate of the costs of AT selected, including cost comparisons between vendors, and a list of vendors where the products can be purchased
 - The process for the student to obtain the recommended solutions

- The requirements for implementation of the AT setup and training, as well as the time frame, additional resources and the responsibilities of all parties involved, including the student and their AT support network
 - AT agreement outlining the ownership rights of the assistive technology solution
- b) Share the AT Plan with the AT support network previously identified

Step 5: Implement AT Plan

- a) Ensure that approval has been granted via the funder/referral source. If funding has been denied or is insufficient, explore other sources of funding if they exist
- b) Confirm recommendations with the student to ensure that they continue to be suitable for their needs and that there have been no changes to their needs before purchasing
- c) Order the equipment, making sure to remain within the approved budget. If additional funds are required, approval must be granted by the funding source before proceeding
- d) Ensure that the equipment and supports are located and set-up, as intended
- e) Provide any agreed upon support for AT setup and/or training as identified in the AT Plan
- f) Engage the student and their AT support network throughout this process, ensuring that they are aware of the progress of the implementation process

Step 6: Monitor AT Plan

- a) Conduct a follow-up evaluation as necessary
- b) Monitor the student's progress through ongoing evaluation and modify the recommendations and implementation plan as needed
- c) Ensure that the assistive technology is working as expected to support the student in achieving their desired outcome

Step 7: Evaluate AT Plan

- a) Evaluate the outcome of the AT Plan and implementation of the recommendations by reviewing the student's performance challenges as outlined in the initial AT Plan with their current functional abilities and subjective account of barriers
- b) Notify the referral source and create an additional action plan if barriers and performance issues continue to be identified

Step 8: Exit Process

- a) Communicate with the student regarding the achievement of the outlined goals and ensure that it is appropriate to conclude the service delivery relationship
- b) Document the conclusion and communicate with the student how to re-enter this process if required in the future

Note that the process outlined may change depending on a student's individual circumstances. For a student with more complex needs, certain steps may require additional time or resources.

Appendix C: Additional resources

We identified additional information in the course of this project that may provide more context for the reader and direct them to additional resources. We outline them briefly below.

AT assessment tools and processes

DO-IT Accommodations Model: <http://www.washington.edu/doi/accommodation-model>

QIAT Indicators: <http://www.qiat.org/>

The SETT Framework: <http://www.joyzabala.com/>

AT searchable databases

AbleData provides impartial, comprehensive information on products, solutions and resources for customers and their family members, vendors, distributors, organizations, professionals and caregivers in understanding AT options and programs available. It is funded by the National Institute on Disability, Independent Living, and Rehabilitation Research, part of the U.S. Department of Health and Human Services' Administration for Community Living. Available at <http://www.abledata.com/>

Assistivetech provides access to information on AT devices and services as well as other community resources for people with disabilities and the general public. The was created by Georgia Tech's Center for Assistive Technology and Environmental Access, with funding from the National Institute on Disability and Rehabilitation Research, and Rehabilitation Services Administration. Available at <http://assistivetech.net/>

TechMatrix a searchable database that provides information on resources for students with special needs. The site provides a complete product profile page, including information such as cost range, operating platform, and link to Learning Supports that apply to the product. There is also a product comparison feature. The site is funded by the U.S. Department of Education's Office of Special Education Programs and developed by the National Center for Technology Innovation and the Center for Implementing Technology in Education. Available at <http://www.techmatrix.org/>

Adaptech Research Network maintains a database of free or inexpensive hardware and software and applications for various platforms. The site includes a set of demonstration videos highlighting the capabilities of some of these tools. The Network, based at Dawson College in Montreal, consists of a team of academics, students and consumers. Available at <http://www.adaptech.org/en/downloads>

Canadian AT programs

Assistive Technology British Columbia: <http://www.at-bc.ca/programs/index.html>

Ontario's Assistive Devices Program: <http://www.health.gov.on.ca/en/public/programs/adp/>

E-learning and accessibility

Equal Access: Universal Design of Distance Learning Programs:

<http://www.washington.edu/doit/equal-access-universal-design-distance-learning-programs>

Province of Ontario: How to Make Websites Accessible: <https://www.ontario.ca/page/how-make-websites-accessible>

WebAIM PowerPoint Accessibility: <http://webaim.org/techniques/powerpoint/>

Web Content Accessibility Guidelines: <http://www.w3.org/WAI/intro/wcag>

Universal design for learning

The National Centre on Universal Design for Learning provides detailed information on UDL guidelines, including implementation and latest research. Available at

<http://www.udlcenter.org/aboutudl/udlguidelines>

Disabilities, Opportunities, Internetworking, and Technology (DO-IT) Centre at the University of Washington provides comprehensive information on UDL, accommodations by academic activity and disability, publications on AT, links to numerous CoPs, as well as guidelines, case studies and a listing of promising practices. Available at <http://www.washington.edu/doit/>

Examples of resources available via the DO-IT Centre include:

- Assistive Technology Used by DO-IT Scholars: <http://www.washington.edu/doit/assistive-technology-used-do-it-scholars>
- DO-IT Prof: A Promising Practice in Making Postsecondary Instruction Accessible to Students with Disabilities: <http://www.washington.edu/doit/do-it-prof-promising-practice-making-postsecondary-instruction-accessible-students-disabilities>
- The University of Washington: A Promising Practice in Making Distance Learning Courses Accessible to Students with Disabilities: <http://www.washington.edu/doit/university-washington-promising-practice-making-distance-learning-courses-accessible-students>
- The University of Washington IT Accessibility Guidelines and Checklist: <http://www.washington.edu/accessibility/>

References

- Adya, M. M., Samant, D., Scherer, M. J., Killeen, M., & Morris, M. W. (2012). Assistive/rehabilitation technology, disability, and service delivery models. *Cognitive processing, 13 Suppl 1(s1)*, 75-78.
- Alnahdi, G. (2014). Assistive Technology in Special Education and the Universal Design for Learning. *Turkish Online Journal of Educational Technology - TOJET, 13(2)*, 18-23.
- Alquraini, T., & Gut, D. (2012). Critical Components of Successful Inclusion of Students with Severe Disabilities: Literature Review. *International Journal of Special Education, 27(1)*, 42-59.
- Asuncion, J. V., Fichten, C. S., Ferraro, V., Chwojka, C., Barile, M., Nguyen, M. N., & Wolforth, J. (2010). Multiple Perspectives on the Accessibility of E-Learning in Canadian Colleges and Universities. *Assistive Technology, 22(4)*, 187-199.
- Ayres, K. M., Mechling, L., & Sansosti, F. J. (2013). The Use of Mobile Technologies to Assist with Life Skills/Independence of Students with Moderate/Severe Intellectual Disability and/or Autism Spectrum Disorders: Considerations for the Future of School Psychology. *Psychology in the Schools, 50(3)*, 259-271.
- Bargerhuff, M. E., Cowan, H., & Kirch, S. A. (2010). Working toward equitable opportunities for science students with disabilities: using professional development and technology. *Disability & Rehabilitation: Assistive Technology, 5(2)*, 125-135.
- Barzegarian, B., & Sax, C. L. (2011). Rehabilitation counsellors: incorporation of assistive technology device selection and referrals into professional practice. *Disability & Rehabilitation: Assistive Technology, 6(5)*, 378-385 378p.
- Bauer, S. M., Elsaesser, L. J., & Arthanat, S. (2011). Assistive technology device classification based upon the World Health Organization's, International Classification of Functioning, Disability and Health (ICF). *Disabil Rehabil Assist Technol, 6(3)*, 243-259.
- Bausch, M. E., & Ault, M. J. (2012). Status of Assistive Technology Instruction in University Personnel Preparation Programs. *Assistive Technology Outcomes and Benefits, 8(1)*, 1-14.
- Betts, K., Welsh, B., Pruitt, C., Hermann, K., Dietrich, G., Trevino, J. G., Watson, T., L., Brooks, M. L., Cohen, A., & Coombs, N. (2013). Understanding Disabilities & Online Student Success. *Journal of Asynchronous Learning Networks, 17(3)*, 15-48.
- Black, R. D., Weinberg, L. A., & Brodwin, M. G. (2015). Universal Design for Learning and Instruction: Perspectives of Students with Disabilities in Higher Education. *Exceptionality Education International, 25(2)*, 1-26.
- British Columbia Ministry of Advanced Education. (2015). *2015/16 – 2017/18 service plan*. Available at <http://www.bcbudget.gov.bc.ca/2015/sp/pdf/ministry/aved.pdf>
- Bryant, B. R., Bryant, D. P., Shih, M., & Seok, S. (2010). Assistive Technology and Supports Provision: A Selective Review of the Literature and Proposed Areas of Application. *Exceptionality, 18(4)*, 203-213.

- Burgstahler, S. (2003). The Role of Technology in Preparing Youth with Disabilities for Postsecondary Education and Employment. *Journal of Special Education Technology*, 18(4), 7-19.
- Burgstahler, S. (2011). Universal Design: Implications for Computing Education. *ACM Transactions on Computing Education*, 11(3).
- Cawthon, S. W., Leppo, R., Ge, J. J., & Bond, M. (2015). Accommodations Use Patterns in High School and Postsecondary Settings for Students Who Are D/Deaf or Hard of Hearing. *American Annals of the Deaf*, 160(1), 9-23.
- Christensen, L. L., & Rogers, C. M. (2013). Leadership for Access to Technology-Based Assessments. *Journal of Special Education Leadership*, 26(1), 16-24.
- Cook, A., and Polgar, J.M. (2007) *Cook and Hussey's Assistive Technologies: Principles and Practice* St. Louis, Missouri: Elsevier
- Couzens, D., Poed, S., Kataoka, M., Brandon, A., Hartley, J., & Keen, D. (2015). Support for Students with Hidden Disabilities in Universities: A Case Study. *International Journal of Disability, Development and Education*, 62(1), 24-41.
- Craddock, G., & McCormack, L. (2002). Delivering an AT service: a client-focused, social and participatory service delivery model in assistive technology in Ireland. *Disability and Rehabilitation*, 24(1-3), 160-170.
- Crider, T. K., Johnston, L., Rutledge, V., Doolittle, A. L., & Beard, L. (2014). Assistive Technology at the University of Tennessee-Chattanooga: Providing Pre-Service Educators with the Opportunity to Utilize Assistive Technology as an Instructional Strategy. *Universal Journal of Educational Research*, 2(4), 326-329.
- D'Andrea, F. M., & Siu, Y.-T. (2015). Students with Visual Impairments: Considerations and Effective Practices for Technology Use *Efficacy of Assistive Technology Interventions* (p. 111-138).
- Dalton, E. M. (2015). Assistive Technology Standards and Evidence-Based Practice: Early Practice and Current Needs *Efficacy of Assistive Technology Interventions* (p. 163-201).
- Demers L., Weiss-Lambrou R. and Ska B. (1996) Development of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) *Assistive Technology* 8(1): 3-13.
- Edyburn, D. L. (2001). Models, Theories, and Frameworks: Contributions to Understanding Special Education Technology. *Special Education Technology Practice*, 3(2), 16-24.
- Edyburn, D. L. (2015). Expanding the Use of Assistive Technology While Mindful of the Need to Understand *Efficacy of Assistive Technology Interventions* (p. 1-12).
- Employment and Social Development Canada. (2015). *Canadians in context – people with disabilities [website]*. Available at <http://well-being.esdc.gc.ca/misme-iowb/.3ndic.1t.4r@-eng.jsp?iid=40>

- Federici, S., Corradi, F., Meloni, F., Borsci, S., Mele, M.L., Dandini de Sylva, S., Scherer, M.J. (2014). A person-centered assistive technology service delivery model: a framework for device selection and assignment. *Life Span and Disability*, XVII, 2, 175-198.
- Fichten, C. S., Asuncion, J., & Scapin, R. (2014). Digital Technology, Learning, and Postsecondary Students with Disabilities: Where We've Been and Where We're Going. *Journal of Postsecondary Education and Disability*, 27(4), 369-379.
- Fichten, C. S., Nguyen, M. N., Asuncion, J. V., Barile, M., Budd, J., Amsel, R., & Libman, E. (2010). Information and Communication Technology for French and English Speaking Postsecondary Students with Disabilities: What Are Their Needs and How Well Are These Being Met? *Exceptionality Education International*, 20(1), 2-17.
- Foley, A., & Ferri, B. A. (2012). Technology for People, Not Disabilities: Ensuring Access and Inclusion. *Journal of Research in Special Educational Needs*, 12(4), 192-200.
- Gierach, J. (2009) *Assessing Students' Needs for Assistive Technology (ASNAT) A Resource Manual for School District Teams*, Milton WI: Wisconsin Assistive Technology Initiative.
- Holmes, A., & Silvestri, R. (2012). Assistive Technology Use by Students with LD in Postsecondary Education: A Case of Application before Investigation? *Canadian Journal of School Psychology*, 27(1), 81-97.
- Human Resources and Skills Development Canada. (2009). *2009 federal disability report: Advancing the inclusion of people with disabilities*. Available at http://www.esdc.gc.ca/eng/disability/arc/federal_report2009/fdr_2009.pdf
- Iezzoni, L. (2011). Eliminating health and health care disparities among the growing population of people with disabilities [Abstract]. *Health Aff (Millwood)*, 30(10), 1947-1954.
- Individuals with Disabilities Education Improvement Act of 2004, Pub. L. No. 108-446, 118 Stat. 2647 (2004).
- Jongbloed, L., & Stainton, T. (2013). *Equipment and Assistive Technology Initiative (EATI) Evaluation*. Vancouver, BC: Centre for Inclusion and Citizenship. Available at http://citizenship.sites.olt.ubc.ca/files/2014/07/CIC_2013_EATI_report_FINAL.pdf
- Jutai, J. and Day, H. (2002) Psychosocial Impact of Assistive Devices Scales (PIADS) *Technology and Disability* 14 107-111, IOS Press.
- Kelly, S. M., & Smith, D. W. (2011). The Impact of Assistive Technology on the Educational Performance of Students with Visual Impairments: A Synthesis of the Research. *Journal of Visual Impairment & Blindness*, 105(2), 73-83.
- Lahm, E., & Mendoca, R. (2008). Assistive Technology Assessment Tools. *Technology in Action*, 3(4).
- Lenker, J. A., & Paquet, V. L. (2003). A Review of Conceptual Models for Assistive Technology Outcomes Research and Practice. *Assistive Technology*, 15(1), 1-15.

- Lenker, J. A., & Paquet, V. L. (2004). A New Conceptual Model for Assistive Technology Outcomes Research and Practice. *Assistive Technology*, 16(1), 1-10.
- Lewis, A. N., Cooper, R. A., Seelman, K. D., Cooper, R., & Schein, R. M. (2012). Assistive Technology in Rehabilitation: Improving Impact through Policy. *Rehabilitation Research, Policy, and Education*, 26(1), 19-32.
- Li, Z., Ajuwon, P. M., Smith, D. W., Griffin-Shirley, N., Parker, A. T., & Okungu, P. (2012). Assistive Technology Competencies for Teachers of Students with Visual Impairments: A National Study. *Journal of Visual Impairment & Blindness*, 106(10), 656-665.
- Martin, J. K., Martin, L. G., Stumbo, N. J., & Morrill, J. H. (2011). The impact of consumer involvement on satisfaction with and use of assistive technology. *Disability & Rehabilitation: Assistive Technology*, 6(3), 225-242.
- National Educational Association of Disabled Students. (2012). *Enhancing accessibility in post-secondary education institutions: A guide for disability service providers*. Available at http://www.neads.ca/en/norc/eag/eag_en.pdf
- Penton, V. M. (2015). Assistive Technology Provision for People with Disabilities in Newfoundland and Labrador, Canada Efficacy of Assistive Technology Interventions (p. 139-162).
- Peterson-Karlan, G. R. (2011). Technology to Support Writing by Students with Learning and Academic Disabilities: Recent Research Trends and Findings. *Assistive Technology Outcomes and Benefits*, 7(1), 39-62.
- Raskind, M. H., & Bryant, B. R. (2002). *Functional evaluation for assistive technology: Examiners manual*. Austin, TX: Psycho-Educational Services.
- Reed, M., & Curtis, K. (2012). Experiences of Students with Visual Impairments in Canadian Higher Education. *Journal of Visual Impairment & Blindness*, 106(7), 414-425.
- Reichle, J. (2011). Evaluating Assistive Technology in the Education of Persons with Severe Disabilities. *Journal of Behavioral Education*, 20(1), 77-85.
- Rose, D., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Seale, J. (2013). When Digital Capital is Not Enough: Reconsidering the Digital Lives of Disabled University Students. *Learning, Media and Technology*, 38(3), 256-269.
- Scherer, M. J. (1986). *Values in the creation, prescription, and use of technological aids and assistive devices for people with physical disabilities*. Doctoral dissertation, University of Rochester, and final report to the National Science Foundation.
- Stack, J., Zarate, L., Pastor, C., Mathiassen, N. E., Barberà, R., Knops, H., & Kornsten, H. (2009). *Analysing and federating the European assistive technology ICT industry. Final Report*. Available at: <http://ec.europa.eu/einclusion>

- Thomson, R. F., C., Budd, J., Havel, A., & Asuncion, J. (2015). Blending universal design, e-learning, and information and communication technologies. In S. E. Burgstahler (Ed.), *Universal design in higher education: From principles to practice*. Boston: Harvard Education Press.
- Wissick, C. A., & Gardner, J. E. (2008). Conducting Assessments in Technology Needs: From Assessment to Implementation. *Assessment for Effective Intervention*, 33(2), 78-93.
- Wojcik, B. W. (2015). Learning from Experience: Understanding Assistive Technology Knowledge and Skills through an Online Community of Practice Efficacy of Assistive Technology Interventions (p. 203-227).
- Zabala J. (2005) Using the SETT Framework to Level the Learning Field for Students with Disabilities

Glossary

Accessibility: “ensuring an equivalent user experience for people with disabilities” (Betts et al., 2013).

Accommodations: “any service, adaptation or support mechanism that enables students with disabilities to participate fully in academic, campus and community life. In particular, academic accommodations provide students with disabilities an equal opportunity to master the essentials of a post-secondary education. Accommodations are intended to level the playing field so that students with disabilities have the chance to develop the same skills and abilities expected of all students” (NEADS, 2012).

Adaptive technology: “any object or system that is specifically designed for the purpose of increasing or maintaining the capabilities of people with disabilities.”

Assessing Students’ Needs for Assistive Technology (ASNAT) Process – a compendium of resources for assessing students’ AT needs in diverse settings, developed for Wisconsin Assistive Technology Initiative (Gierach, 2009).

Assistive technology: “any item, piece of equipment, software, or system that is used to increase, maintain or improve the functional capabilities of a student with a disability in the context of addressing barriers to education” (IDEIA, 2004).

Assistive technology assessment: “the process of collecting data for the purpose of making decisions” (Lahm & Mendoca, 2008).

Assistive technology service: “any service that directly assists a student with a disability in the selection, acquisition, and use of an assistive technology device” (IDEIA, 2004).

Assistive technology service delivery model: “the set of facilities, procedures and processes that act as intermediaries between the AT product manufacturers and AT end-users” (Federici et al., 2014).

Cognitive disability – an impairment that affects an individual’s ability to access, process, or remember information.

Communication disability – an impairment to the capacity to use expressive and/or receptive language in one or more of the following areas: speech, conveying information, and understanding information.

Effective: “having a positive impact on education” (Kelly & Smith, 2011).

Effectiveness: “the degree to which the assistive technology (the independent variable) has a positive impact on educational performance (the dependent variable)” (Kelly & Smith, 2011).

E-learning: “instruction that involves technology, online course delivery systems, digital communication, and educational paradigms used by higher education faculty” (Thomson, 2015).

Evidence-based research: “the use of scientific research to establish best practices determined by an evaluation of the research” (Kelly & Smith, 2011).

Functional Evaluation for Assistive Technology (FEAT): an assistive technology evaluation system designed for elementary aged students through postsecondary adults with cognitive or learning disabilities or brain injury. The scale can be used to determine the most appropriate and effective assistive technology devices to help individuals with learning disabilities compensate for difficulties and meet the demands of specific tasks and contexts. The assessment has five scales: the Contextual Matching Inventory (provides information about setting-specific demands), the Checklist of Strengths and Limitations (used to gather data regarding person-specific characteristics), the Checklist of Technology Experiences (offers information about the person's past/current use of technology), the Technology Characteristics Inventory (examines device-specific characteristics such as dependability, product support, etc.), and the Individual-Technology Evaluation Scale (used to determine whether the proposed assistive technology adaptation offers legitimate potential for compensatory effectiveness) (Raskind & Bryant, 2002).

Human Activity and Assistive Technology (HAAT) model is proposed as a framework for understanding the place of assistive technology in the lives of persons with disabilities, guiding both clinical applications and research investigations. The model has four components – the human, the activity, the assistive technology, and the context in which these three integrated factors exist. Activities are categorized within three basic performance areas: activities of daily living, work and productive activities, and play and leisure activities (Cook & Polgar, 2007).

Matching Person and Technology (MPT) model: an organizational framework to assess and recommend successful use of a variety of assistive technologies for people with disabilities: operationalized by a series of measures intended to provide a person-centred and individualized approach to matching individuals with the most appropriate technologies (Scherer, 1986).

Physical disability – a condition that limits one or more basic physical activity.

Psychosocial Impact of Assistive Devices Scales (PIADS): a 26-item, self-report questionnaire designed to assess the effects of an assistive device on functional independence, well-being, and quality of life. PIADS was developed to fill a need for a reliable, valid and economical measure generically applicable across all major categories of assistive technology. Preliminary investigations suggest PIADS has good validity for predicting device use and discontinuance, can be used reliably by caregivers to give proxy ratings of device impact (Jutai & Day, 2002).

Quality Indicators of Assistive Technology (QIAT) were developed by AT service providers concerned about the complexity of selecting, locating, and delivering AT and AT services in K-12 and postsecondary environments. The Centre for Applied Special Technology (CAST) developed professional guidelines to improve the quality and consistency of AT delivery. It gathered diverse input from students and families to school staff, policy makers and higher education faculty to produce self-evaluation matrices, suggested activities, checklists and other tools.

Quebec Evaluation of Satisfaction with Assistive Technology (QUEST): a clinical instrument designed to evaluate user satisfaction with assistive technology devices. It represents an interactive and user-directed approach to assess satisfaction with assistive technology based on the theoretical and practical foundations of assistive technology as well as on the concept of satisfaction (Demers, Weiss-Lambrou, & Ska, 1996).

Sensory disability – a condition affecting one of the five senses, typically vision, hearing, or touch.

SETT – an acronym for Student, Environments, Tasks and Tools. The SETT Framework is based on the premise that in order to develop an appropriate system of Tools (supports – devices, services, strategies, accommodations, modifications) teams must first develop a shared understanding of the student, the customary environments in which the student spends time, and the tasks that are required for the student to be able to do or learn to do to be an active participant in the teaching/learning processes that lead to educational success. When the needs, abilities, and interests of the Student, the details of the Environments, and the specific Tasks required of students in those environments are fully explored, teams are able to consider what needs to be included in a system of tools that is Student-centered, Environmentally useful, and Tasks focused (Zabala, 2005).

Scientifically based research: “a research design that determines with the highest degree of probability” (Kelly & Smith, 2011).

Universal design for learning: “an educational framework based on research in the learning sciences, including cognitive neuroscience, that guides the development of flexible learning environments that can accommodate individual learning differences” (Rose & Meyer, 2002).

Usability “designing products to be effective, efficient, and satisfying” (Betts et al., 2013).

Usable accessibility “combines usability and accessibility to develop positive user experiences for people with disabilities” (Betts et al., 2013).



Ottawa



Vancouver

Ottawa

55 Murray Street, Suite 400
Ottawa, Ontario
K1N 5M3

55, rue Murray, bureau 400
Ottawa (Ontario)
K1N 5M3

Vancouver

789 West Pender Street, Suite 440
Vancouver, British Columbia
V6C 1H2

789, rue Pender Ouest, bureau 440
Vancouver (Colombie-Britannique)
V6C 1H2

www.srdc.org

1 866 896 7732

info@srdc.org