Canadian Journal of Learning and Technology
La Revue Canadienne de l'Apprentissage et de la Technologie

Canadian Journal of Learning and Technology

Volume 29(2) Spring / printemps 2003

Citation: Fichten, C.S., Asuncion, J.V., Robillard, C., Fossey, M.E., & Barile, M. (2003). Accessible computer technologies for students with disabilities in Canadian higher education. Canadian Journal of Learning and Technology, 29(2), 5-34. Retrieved from http://cjlt.csj.ualberta.ca/index.php/cjlt/article/view/41/38

Accessible Computer Technologies for Students With Disabilities in Canadian Higher Education

Catherine S. Fichten

Jennison V. Asuncion

Chantal Robillard

Myrtis E. Fossey

Maria Barile

Authors Catherine Fichten, Ph.D. teaches psychology at Dawson College, where she also co-directs the Adaptech Research Network. She is also a clinical psychologist at the Jewish General Hospital in Montreal and is Associate Professor of Psychiatry at McGill University. Jennison Asuncion, M.A. is a Project Manager with BMO Financial Group Institute for Learning in Toronto. He co-directs the Adaptech Research Network at Dawson College in Montreal at a distance. Maria Barile, M.S.W. co-directs the Adaptech Research Network at Dawson College in Montreal. She is a social worker and an activist in the disability community. Myrtis E. Fossey, M.A. is a psychologist and long time researcher with the Adaptech Research Network. Chantal Robillard, M.A. is long time researcher with the Adaptech Research Network. She is also a Ph.D. student in Anthropology at Université de Montréal. All authors can be contacted as follows: Adaptech Research Network Dawson College 3040 Sherbrooke West Montreal, QC, H3Z1A4 Canada Tel.514.931.8731#1546 e-mail adaptech@dawsoncollege.qc.ca

Abstract

Two studies explored how well English and French speaking colleges and universities in Canada address availability and access to new computer and information technologies for individuals with disabilities. In Study 1, 156 professionals who provide disability-related supports on campus responded to structured interview questions. In Study 2, 40 professionals who work in Quebec's Francophone junior/community college system (CEGEP) participated. Results showed that most institutions had specialized adaptive computer equipment, though colleges were less likely than universities, and loan programs providing adaptive computer equipment were seen as very effective. Respondents believed they were not very knowledgeable about adaptive computer technologies and those from Francophone institutions scored lower than from Anglophone institutions. The needs of students were seen as moderately well met, with Francophone respondents more favorable than Anglophone. Respondents from Anglophone universities expressed different needs than those from Anglophone colleges or Francophone institutions. Disability service providers wished students were better equipped and prepared for the postsecondary experience, computer based teaching materials used by professors were more accessible, and more extensive support services for adaptive hardware and software available. We provide recommendations based on universal design principles that are targeted at those involved in technology integration in postsecondary education.

Résumé

Deux études ont été menées afin d'évaluer la façon dont les collèges et les universités du Canada, tant anglophones que francophones, gèrent la mise à disposition et l'accessibilité des ordinateurs et des nouvelles technologies de l'information aux personnes souffrant d'un handicap. Dans la première étude, 156 professionnels fournissant des ressources pour personnes handicapées aux campus ont répondu aux questions d'une entrevue structurée. La seconde étude a porté sur 40 professionnels qui travaillent au sein du système des collèges pré-universitaires/communautaires francophones du Québec (CEGEP). Les résultats ont démontré que la plupart des institutions possèdent des équipements informatiques spécialisés et adaptés, bien que cela puisse être moins vrai des collèges que des universités, et que les programmes de prêt pour l'acquisition d'équipements informatiques adaptés sont jugés très efficaces. Les personnes interrogées pensaient qu'elles ne connaissaient pas très bien les technologies informatiques adaptées et celles appartenant à des institutions francophones ont eu des résultats inférieurs à celles des institutions anglophones. Elles estiment que les besoins des étudiants sont raisonnablement satisfaits, bien que les francophones interrogés aient répondu plus favorablement que les anglophones. Les personnes interrogées dans les universités anglophones ont exprimé des besoins différents de ceux des collèges anglophones ou des institutions francophones. Les fournisseurs de services aux handicapés souhaitent que les étudiants soient mieux équipés et mieux préparés à l'expérience postsecondaire, que le matériel informatique d'enseignement utilisé par les professeurs soit plus accessible et également que les services de soutien pour le matériel et les logiciels informatiques adaptés disponibles soient étendus. Nous présentons des recommandations, fondées sur les principes de l'aménagement organisationnel, à l'intention des personnes responsables de l'intégration technologique dans le cadre de l'enseignement postsecondaire.

Introduction

Information and communication technologies (ICTs) are rapidly expanding in all fields and are becoming important tools in the new Canadian economy. Consequently, computer-related knowledge has become critical to secure employment. Consistent with this stance, the policy document, "Future directions" recently published by the Government of Canada (1999) highlights problems caused by systemic barriers and stresses the need for access to ICTs for people with disabilities in the new knowledge based economy.

The new knowledge based economy will provide citizens with disabilities an unprecedented opportunity to fully participate in the social and economic life of Canada. This will happen only if they have the same opportunities as other Canadians for acquiring postsecondary education and computer skills, the tools of the new economy (e.g., Government of Canada, 1999; Human Resources Development Canada, 2002; Pettigrew, 1998). Postsecondary education is supporting the need for computer literacy by providing students opportunities to learn and use new technologies in all aspects of their schooling, from online registration to virtual labs. The challenge is to ensure that these opportunities are both physically and technologically accessible to all learners, including those with various impairments. Unless this requirement is met, people with disabilities face a real danger of being rendered technologically illiterate and, thus, unattractive to the labor market of tomorrow. The goal of the research presented here is to examine how well English and French speaking colleges and universities in Canada are addressing the need to ensure that their new ICTs are available and accessible to students with disabilities.

Information and Communication Technologies (ICTs) in Postsecondary Education

Computer literacy and knowhow are part of most postsecondary students' formal education. One need only look at North American colleges and universities to see this trend in action. Campuses are becoming increasingly "wired" and the technology is appearing in all aspects of academic life (cf. Bernstein, Caplan, Glover, 2001; EDUCAUSE Online Guide to Evaluating Information Technology on Campus, 2002; Green, 2002). In parallel with this trend is evolution in the accessibility and affordability of both popularly used and adaptive computer technologies (cf. Adobe, 2003; Apple, 2003; Freedom Scientific, 2003; IBM, 2003; Microsoft Corporation, 2003). If these technologies are designed for compatibility then the two trends have the potential to level the playing field for learners with disabilities. This outcome is, of course, contingent on individuals with disabilities gaining timely access to the specialized technologies they need.

For example, if a department decides to teach the majority of its courses online, and these courses are developed using web sites and authoring tools that do not adopt accessible and inclusive design standards, what are the educational implications for the estimated 100,000 postsecondary students with disabilities (Fichten, et al., 2003) on Canadian campuses, many of whom need adaptations to use computers effectively (Fichten, Asuncion, Barile, Fossey, & Robillard, 2001a)? Adaptations include both software (e.g., software that reads what is on the screen) and hardware solutions (e.g., an adapted mouse) to enable students with various disabilities to access electronic materials. Solving the accessibility issue by replacing a technology rich computer based learning experience for students with disabilities by a learning experience that fails to use computer technologies defeats the purpose of the original learning goal.

How Students With Specific Disabilities Use Computers

In previous research we asked close to 800 postsecondary students with various disabilities and 36 campus based disability service providers about the type of computer adaptations the used (Fichten, et al., 2001a; Fichten, et al., 2001b). It is the campus-wide integration of computers with adaptive hardware and software, such as those noted in our previous studies and listed below, that the present research addresses.

Individuals who are blind typically reported using specialized software that reads to them what is on the screen. Some also use a special hardware/software combination that takes a line of text on the screen and converts it into a line of text on a Braille display. To turn a printed page into a format they can use (eText), these individuals often use specialized systems consisting of a scanner and optical character recognition (OCR) software.

People with some useable vision also indicated that they used a scanner, OCR, and software that reads what is on the screen. In addition, many also used magnification software and/or large screen monitors. Persons with low vision can also use a variety of specialized software as well as built-in features of popular commercially available software packages to change the contrast and enlarge and otherwise make text, cursors, and other visual elements more visible on the screen.

People with learning disabilities reported using many of the same technologies as students with visual impairments to help them better process printed materials and what is written on the screen. In addition, dictation software (speech-to-text), document managers, schedulers, concept mapping software, electronic dictionaries, grammar and spell checkers, and word prediction software were frequently used.

Students with hearing impairments reported using writing aids such as spelling and grammar checkers, e-mail and chat programs, accessibility features built into the operating system of conventional software (e.g., visual flash instead of sounds), captions and subtitles for video clips (when available), and the C-Note System (CNS, 2003), a set-up that involves two joined laptop computers).

Learners with speech/communication impairments also used e-mail and chat programs. They also used portable note taking devices to interact with others in face-to-face contexts and multimedia projectors for oral presentations.

Students with mobility and neuromuscular impairments reported using a variety of ergonomic adaptations, dictation programs and voice control software that allows hands free dictation and control of menus as well as software based keyboard adaptations, software or hardware that allows for one handed typing, along with a variety of alternative mice and input devices.

Campus Based Professionals Who Provide Services to Students With Disabilities

At most Canadian postsecondary institutions there is at least one designated professional whose responsibility it is to provide disability related services and accommodations to students as well as to liaise and advocate with the campus community. Ensuring that the computer technology needs of students with disabilities are met has often become part of the job description.

There are several American (Burgstahler, 1992, 1993; Burris, 1998; Coomber, 1996; Horn & Shell, 1990; Jackson, Morabito, Prezant, & Michaels, 2001; Michaels, Prezant, Morabito, & Jackson, 2001; Lance, 1996) as well as Canadian studies (Epp, 1996; Killean & Hubka, 1999) that deal, at least in part, with the views of postsecondary disability service providers about computer and adaptive computer technologies on campus. Nevertheless, these studies do not provide a comprehensive picture of current realities in Canada's colleges and universities for a variety of reasons. First, several of the studies are now more than 10 years old (Burgstahler, 1992, 1993; Horn & Shell, 1990). Some are based on very small samples (Coomber, 1996) and most are from American postsecondary institutions (Burris, 1998, Jackson et al., 2001;

Michaels, et al., 2001). Of course, both Canada's postsecondary system and the policies related to disability accommodations are considerably different from that of the United States, especially when it comes to the Americans with Disabilities Act (ADA, 1990) and to the private vs. public postsecondary institution distinction.

Of the two Canadian studies, Epp's (1996) investigation was targeted specifically to individuals who provide disability related services to students who use electronic text and Braille in the province of British Columbia. Although this is an important investigation, it clearly does not - nor was it intended to - evaluate views and concerns of campus-based individuals who provide disability related services to a wide range of students with disabilities in postsecondary institutions across Canada's 13 provinces and territories. The Killean and Hubka (1999) study was a wide-ranging Canadian investigation of 70 individuals (41% return rate) who provide disability related services to postsecondary students. This is an interesting and important investigation of a broad range of issues related to disability service provision at Canadian postsecondary campuses. Given the objectives of this study, however, new computer and information technology accessibility accommodations were not examined in a comprehensive manner.

New Computer Technologies and Language Issues

Of 34 countries surveyed by the Angus Reid Group (2000) in the fall of 1999, Canada tied for 2nd place in "home PC penetration" and ranked 2nd in Internet use, with 56% of the population after the US (at 59%). It is evident that English is the predominant language of both the computer industry, as France ranked 19th with 22%, while Belgium ranked 15th, with 28%. For example, Internet use in France was 10% in a study conducted by PricewaterhouseCoopers (2000).

Quebec has been at the forefront of computer and Internet use in the Francophone world, and it has followed the North American rather than the European trend. For example, Quebec offers eLearning based distance education in French both at the university as well as junior/community college (CEGEP) levels. Quebec's computer integration in the elementary and secondary schools has been similar to that of the rest of Canada (Statistics Canada, 1999), although home access to the Internet has been somewhat lower in Quebec (e.g., 29% compared to 48%: PricewaterhouseCoopers, 2000). Data concerning the use of computers and the internet in the CEGEPs suggest that by the late 1990s, almost half of CEGEP professors, regardless of age or years of experience, used some type of computer assisted learning in their courses (Jacques Joly Consultant Inc., 1999).

Francophone Students With Disabilities in Quebec and the Rest of Canada

The situation of Canada's Francophone and Anglophone students with disabilities is different in a variety of important ways. First, the language of instruction is different. Second, the conceptualization of disability is very different in Quebec, where the vast majority of Francophone postsecondary students study, from that of the rest of Canada (e.g., Fougeyrollas, Cloutier, Bergeron, Coté, & St. Michel, 1998; Lemieux-Brassard, 2000). Third, most adaptive computer technologies were designed and developed in the US. This means that they work only in English, and not in French. Fourth, although Quebec is the most highly computerized Francophone region in the world, nevertheless, computer and Internet use among Francophones lags somewhat behind Anglophones. Fifth, the proportion of students with disabilities in Francophone colleges and universities is substantially and significantly smaller that that in Anglophone institutions (Fichten, et al., 2003). Sixth, in Quebec, high schools end in Grade 11, and students who plan on pursuing a university education must complete a 2 year junior/community college (CEGEP) program of pre-university studies. This system is unique in Canada and Quebec's 48 tuition free public CEGEPs accounted for close to 150,000 postsecondary students in 2001 (Ministère de l'éducation, 2002a).

There are Francophone junior/community colleges and bilingual universities outside Quebec. The circumstances of the students with disabilities enrolled in these institutions are likely to be different from both their Anglophone and their Quebec based Francophone peers. Given the nature of the literature on the Canadian context, clearly, a more comprehensive look at the computer and adaptive computer technologies needs and concerns of individuals who provide services to postsecondary students with a variety of disabilities is needed.

Present Investigation

The goal of the two studies that comprise this investigation was to explore the use of computer and information technologies in Canada's Anglophone and Francophone colleges and universities. Study 1 focused on a cross-Canada comparison of Anglophone and Francophone universities and junior/community colleges. Study 2 focused exclusively on Quebec's Francophone junior/community colleges, the CEGEPs.

Method

Study 1

Participants were 156 Canadian postsecondary personnel responsible for providing services to students with disabilities (110 females and 46 males). They were participating in a larger investigation of the technology needs of students with disabilities (Fichten, et al., 2001c). Ninety-six worked in a junior/community college, 58 in a university, and 2 in a postsecondary distance education institution (1 junior/community college and 1 university). They represent 91 of the 115 community/junior colleges and 55 of the 68 universities that were listed on the web pages of the Association of Canadian Community Colleges (ACCC, 2003) or the Association of Universities and Colleges of Canada (AUCC, 2003) on April 22, 2000.

In cases where 2 or more individuals were responsible for different campuses or for students with different disabilities (e.g., a learning disabilities specialist vs. someone who provides services to students with physical disabilities), we attempted to interview all of them. Thus the 156 participants represent 146 independent institutional members of the ACCC or the AUCC. The overall institutional participation rate was 80%: 79% participation from junior/community colleges, 81% from universities, and 2 of the 3 postsecondary distance education institutions. One hundred and sixteen (74%) respondents represented Anglophone institutions, 39 (25%) represented Francophone institutions, and 1 (1%) represented a bilingual institution. 31 of the 39 respondents (80%) representing Francophone institutions were from Quebec. Participants had an average of 9.25 years of experience working with students with disabilities (median = 9.50, mode = 10).

Participants were faxed or emailed the questions and an informed consent form prior to the scheduled appointment for the interview during the spring 2000 semester. These consisted of 60 items, including demographic information (questions are available in Fichten, et al., 2001c). Most used a 6-point Likert scale (1=strongly disagree, 6=strongly agree) and took two forms: "actual situation" and "desired situation." "Actual situation" items were generally positively worded, described a set of conditions at the institution (e.g., computer equipment is up-to-date), and stated that the characteristic met the needs of students with disabilities (e.g., "At my institution, computer and/or adaptive computer technologies are sufficiently up-to-date to meet the needs of students with disabilities"). "Desired situation" items revolved around making the interviewee's job easier to perform if certain conditions were to be met (e.g., "It would make my job easier if students with disabilities were knowledgeable users of computer and/or adaptive computer technologies"). For 12 topics the two types of items, "actual " and "desired" situation, were paired (e.g., "The availability of adaptive computer technologies in specialized labs/centres for students with disabilities at my institution meets their needs" and "It would make my job easier if there were more adaptive computer technologies available in specialized labs/centres at my institution"). A key criterion item inquired about how well, overall, the computer and/or adaptive computer technology needs of students with disabilities are met at the respondent's institution.

Study 2

The same procedure was followed in Study 2, where 40 Quebec junior/community college (CEGEP) personnel responsible for providing services to students with disabilities (18 females and 22 males) at Francophone colleges took part. They, too, were participating in a larger investigation of the technology needs of students with disabilities (Fichten, et al., 2000). Of the 50 individuals who were asked to volunteer, 40 (80%) participated. They represent 34 of the 38 public Francophone CEGEPs, which enrolled students with disabilities, an overall institutional participation rate of 89%. Respondents had worked providing services to students with disabilities for an average of 8.49 years (SD = 5.5, range < 1 to 24). Additional details are available in Fichten et al., 2000.

It should be noted that there is substantial overlap between Studies 1 and 2: 18 of the 40 participants (45%) are also part of the Study 1 sample. Nevertheless, doubling the sample size of Francophone disability service providers allowed for a more focused analysis of the situation in Francophone colleges.

To allow for analyses which take into account the overall size of the institution as well as the total number and proportion of students with disabilities we obtained the following enrollment statistics about each CEGEP: (a) total enrollment for 1999 (from the web page of the Ministère de l'éducation, 2002b) and (b) the number of students with disabilities in each CEGEP who are receiving government subsidized disability related services (provided by the 3 designated "centres d'accueil" that are responsible for administrative aspects of services for students with disabilities for all CEGEPs).

Results: Study 1

Computer Related Expertise of Canadian Campus Based Disability Service Providers

Overall, participants indicated that they were not especially knowledgeable about adaptive computer technologies. The mean was 3.70 (SD = 1.52) on a 6-point scale, with higher scores indicating being more knowledgeable. Indeed, the scores of 12% of participants suggest that they were not at all knowledgeable, while only 9% of scores suggest that the respondent was an expert. A 3-way ANOVA (2 Sex (Female/Male) x 2 Institution (College/University) x 2 Language (Anglophone/Francophone) indicates that while there were no significant differences between males and females or between individuals from colleges and universities on how knowledgeable they felt they were, scores of Francophone respondents were lower (M = 2.97) than those of their Anglophone colleagues (M = 3.93), $F(1,143)=5.83$, $p<.05$.

Specialized and Adaptive Computer Technologies at Anglophone and Francophone Colleges and Universities

Twenty-three variables evaluated campus based disability service providers' perceptions of the adequacy of the institution's computer technologies in meeting students' needs. A key criterion was a 6-point Likert scale rating on the following item, *"Overall, the computer and/or adaptive computer technology needs of students with disabilities at my institution are adequately met."* It can be seen in Table 1 that the computer related needs of students were moderately well met at respondents' institutions (mean greater than 4 on a 6-point scale).

Test results for a series of 2-way multivariate and univariate analysis of variance comparisons (MANOVAs and ANOVAs) which compared linguistic and institutional factors (2 Institution (College/University) x 2 Language (Anglophone/Francophone) are presented in Table 2. None of the MANOVA interaction effects were significant. Means in Table 1 and the test results indicate that institution type was generally not related to perceptions of adequacy. Nevertheless, what differences do exist suggest that respondents from universities had higher scores than those from colleges. Language, however, was clearly an important variable (significant findings on 3 of the 5 MANOVAs and on the single ANOVA not included in any of the MANOVAs) and on almost half of the univariate comparisons.

Thus, the results show that ratings of campus based disability service providers at Francophone institutions are generally higher than those at Anglophone institutions. For example, the results show that disability service providers at Francophone institutions had significantly higher scores on the accessibility of the institution's library and the availability of adapted computers with Internet compatibility. A notable exception was that Anglophone institutions are significantly more likely feel that the presence of a specialist in adaptive computer technology on campus adequately meets students' needs.

As an alternate way of evaluating differences, we examined items that indicated that the aspect was adequate (i.e., scores above the scale's mean of 3.50) or inadequate in meeting the needs of students (i.e., below the mean). It can be seen in Table 1 that both Anglophone and Francophone institutions agreed that they provided adequate hours of access to computers; that their computer technologies were up-to-date; there were adequate adapted computers in specialized labs; that administration reacts positively concerning computer accessibility; and that outside agencies provide students with appropriate equipment. Table 1 also shows that the following were seen as adequate in Francophone but not in Anglophone institutions: funding for computer technologies; accessibility of the library's computers; availability of technical support; accessibility of computer based teaching materials used by professors; and appropriate training provided by rehabilitation agencies. Anglophone institutions did not have adequate ratings on any items where Francophone institutions did not. Both Anglophone and Francophone institutions agreed that the following aspects are inadequate: opportunities of employees to learn about specialized accessible computer technologies; the availability of a specialist in adaptive hardware and software on campus; the ability of computer support personnel to service computers with adaptive hardware or software; being consulted when campus-wide computing decisions are made; availability of a multidisciplinary advisory committee that deals with computer accessibility; and the education of faculty concerning adaptive computer There was no clear linguistic or institution based pattern on any other items.

Table 1. *Adequacy in Meeting the Computer Related Needs of Students with Disabilities: Mean Scores for Actual Conditions Inside the Institution.*

Actual situation: adequacy in meeting the needs of students with disabilities	College						University					
	Anglophone			Francophone			Anglophone			Francophone		
	N	Mean[1]	SD	N	Mean[1]	SD	N	Mean[1]	SD	N	Mean[1]	SD
Overall rating about how well students' computer related needs are met	62	**4.10**	1.34	40	**4.36**	1.29	25	**4.04**	1.59	11	**4.55**	1.75
Average		**4.10**			**4.36**			**4.04**			**4.55**	
Inside & outside the institution factors												
Funding												
Funding for institution's adaptive computer technologies	67	**3.19**	1.72	26	**4.04**	1.89	44	**3.31**	1.65	10	**5.00**	1.15
Average		**3.19**			**4.04**			**3.31**			**5.00**	
Inside the institution factors												
Access to adaptive computer technologies												
Hours of access to computers	52	**4.15**	1.42	21	**4.05**	1.72	41	**4.34**	1.30	9	**5.33**	1.00
Computer technologies up-to-date	55	**3.98**	1.41	23	**4.13**	1.58	41	**4.56**	1.42	10	**4.90**	1.20
Off-campus loan program	32	**3.66**	1.58	17	**3.41**	1.91	21	**3.81**	1.54	6	**5.00**	0.63
Availability in specialized labs/centres	48	**3.63**	1.67	18	**3.78**	1.77	40	**3.63**	1.58	9	**4.78**	1.09
Physical space available for computer technologies	52	**3.33**	1.76	21	**3.81**	1.94	41	**3.57**	1.59	9	**4.56**	1.33
Training for students on adaptive computer technologies	52	**3.10**	1.67	19	**3.21**	1.75	39	**3.05**	1.70	8	**4.13**	1.36
Availability in mainstream computer labs	67	**2.72**	1.58	22	**4.09**	1.72	42	**2.19**	1.50	9	**3.33**	2.06
Average		**3.51**			**3.78**			**3.59**			**4.58**	
Internet/library & adaptive computer technologies												
Enough adapted computers with internet access	51	**3.37**	1.84	23	**4.30**	1.64	40	**3.55**	1.84	9	**4.67**	1.41
Library's computers accessible	62	**3.05**	1.49	26	**3.92**	1.70	45	**3.42**	1.75	11	**4.45**	1.57
Internet-based distance education accessible	44	**2.40**	1.35	14	**2.43**	1.79	24	**2.52**	1.56	7	**3.71**	1.60
Average		**2.94**			**3.55**			**3.16**			**4.28**	
Support for adaptive computer technologies												
Administration reacts positively concerning computer accessibility	68	**4.09**	1.40	23	**4.91**	1.68	40	**4.03**	1.25	9	**4.78**	1.20
Technical support	54	**3.44**	1.61	21	**3.57**	1.60	41	**3.33**	1.79	9	**4.11**	1.45
Opportunities for employees to learn about adaptive technologies	69	**3.39**	1.63	24	**2.67**	1.81	45	**3.40**	1.78	11	**2.91**	1.97
Specialist in adaptive computer technologies on campus	64	**3.41**	1.92	26	**2.12**	1.40	43	**3.37**	2.08	10	**2.00**	0.94
Computer support people can service adaptive technologies	60	**2.96**	1.55	24	**3.21**	1.93	41	**2.85**	1.86	10	**3.30**	1.95
Consulted when computer infrastructure decisions made	66	**2.06**	1.62	24	**2.29**	1.81	44	**2.18**	1.62	11	**3.64**	1.96
Advisory/steering committee deals with computer accessibility	67	**2.06**	1.62	25	**1.76**	1.42	42	**2.64**	2.16	10	**2.40**	2.27
Average		**3.06**			**2.93**			**3.11**			**3.30**	
Faculty and computer accessibility												
Computer-based teaching materials used by professors accessible	51	**2.84**	1.36	24	**4.00**	1.69	36	**2.85**	1.50	10	**3.60**	1.71
Faculty trained in adaptive computer technologies	61	**2.03**	1.40	25	**2.56**	1.53	38	**1.51**	1.08	11	**1.73**	1.49
Average		**2.41**			**2.71**			**2.46**			**2.93**	
Outside the institution factors												
Rehabilitation agencies provide students with appropriate equipment	67	**4.19**	1.34	27	**4.41**	1.39	39	**4.13**	1.36	8	**5.13**	0.83
Rehabilitation agencies provide students with adequate training	64	**3.09**	1.52	26	**3.54**	1.53	42	**3.29**	1.81	9	**4.22**	1.30
Average		**3.64**			**3.97**			**3.71**			**4.67**	

Note. Boxed values refer to scores which indicate inadequate accessibility (i.e., scores below the scale's mean of 3.50)

[1] Based on a 6-point scale, with higher scores indicating stronger agreement with the statement.

Provincial/regional computer technology loan programs to institutions. Of the 132 institutions that indicated that they had computer technologies on campus for their students, 35 (27%) indicated that a provincial/regional loan program supplied some of the technologies on campus. Mean response to the question inquiring about perceptions about the adequacy of resources provided by the loan program in meeting the needs of students with disabilities was 4.72 (SD = 1.43) on a 6-point scale, with higher scores indicating greater satisfaction. This indicates considerable satisfaction. Indeed, only 16% of respondents indicated that the equipment provided failed to meet students' needs. There was no significant difference on this variable between community/junior colleges and universities or between Anglophone and Francophone institutions.

Table 2. *Adequacy in Meeting the Computer Related Needs of Students with Disabilities: Test Results for Actual Conditions Inside the Institution.*

Actual situation: Adequacy in meeting the needs of students with disabilities	df	Main Effect F		Interaction F
		Language	Institution	
Overall rating about how well students' computer related needs are met	(1,134)	**0.04**	1.70	0.18
Average				
Inside & outside the institution factors				
Funding				
Funding for institution's adaptive computer technologies	(1,143)	**12.67*** **	2.27	1.42
Average				
Inside the institution factors				
Access to adaptive computer technologies				
Hours of access to computers	(1,119)	**1.95**	5.39*	2.99+
Computer technologies up-to-date	(1,125)	**0.63**	4.80*	0.10
Off-campus loan program	(1,72)	**1.15**	3.89+	2.64
Availability in specialized labs/centres	(1,143)	**3.06+**	1.79	1.79
Physical Space Available for Computer Technologies	(1,119)	**3.63+**	1.67	0.42
Training for students on adaptive computer technologies	(1,114)	**2.26**	1.21	1.47
Availability in mainstream computer labs	(1,136)	**1.49**	0.33	0.77
Average	MANOVA (7,61)	**1.01**	1.83+	1.16
Internet/library & adaptive computer technologies				
Enough adapted computers with internet access	(1,119)	**6.65***	0.46	0.05
Library's computers accessible	(1,140)	**8.28****	1.87	0.06
Internet-based distance education accessible	(1,85)	**2.40**	3.17+	2.16
Average	MANOVA (3,70)	**1.39**	1.32	0.57
Support for adaptive computer technologies				
Administration reacts positively concerning computer accessibility	(1,136)	**6.55***	0.10	0.01
Technical support	(1,121)	**1.49**	0.33	0.77
Opportunities for employees to learn about adaptive technologies	(1,145)	**2.92+**	0.12	0.11
Specialist in adaptive computer technologies on campus	(1,139)	**11.77*** **	0.04	0.01
Computer support people can service adaptive technologies	(1,131)	**0.87**	0.00	0.07
Consulted when computer infrastructure decisions made	(1,141)	**5.94***	4.49*	3.13+
Advisory/steering committee deals with computer accessibility	(1,140)	**0.50**	2.55	0.01
Average	MANOVA (7,88)	**4.73*** **	1.09	0.65
Faculty and Computer Accessibility				
Computer-based teaching materials used by professors accessible	(1,117)	**8.56****	0.37	0.38
Faculty trained in adaptive computer technologies	(1,131)	**1.73**	5.76*	0.31
Average	MANOVA (2,111)	**4.96****	1.61	0.32

Outside the institution factors				
Rehabilitation agencies provide students with appropriate equipment	(1,137)	**4.05***	1.18	1.70
Rehabilitation agencies provide students with adequate training	(1,137)	**3.97***	1.61	0.48
Average	MANOVA (2,130)	**3.33***	1.13	0.87

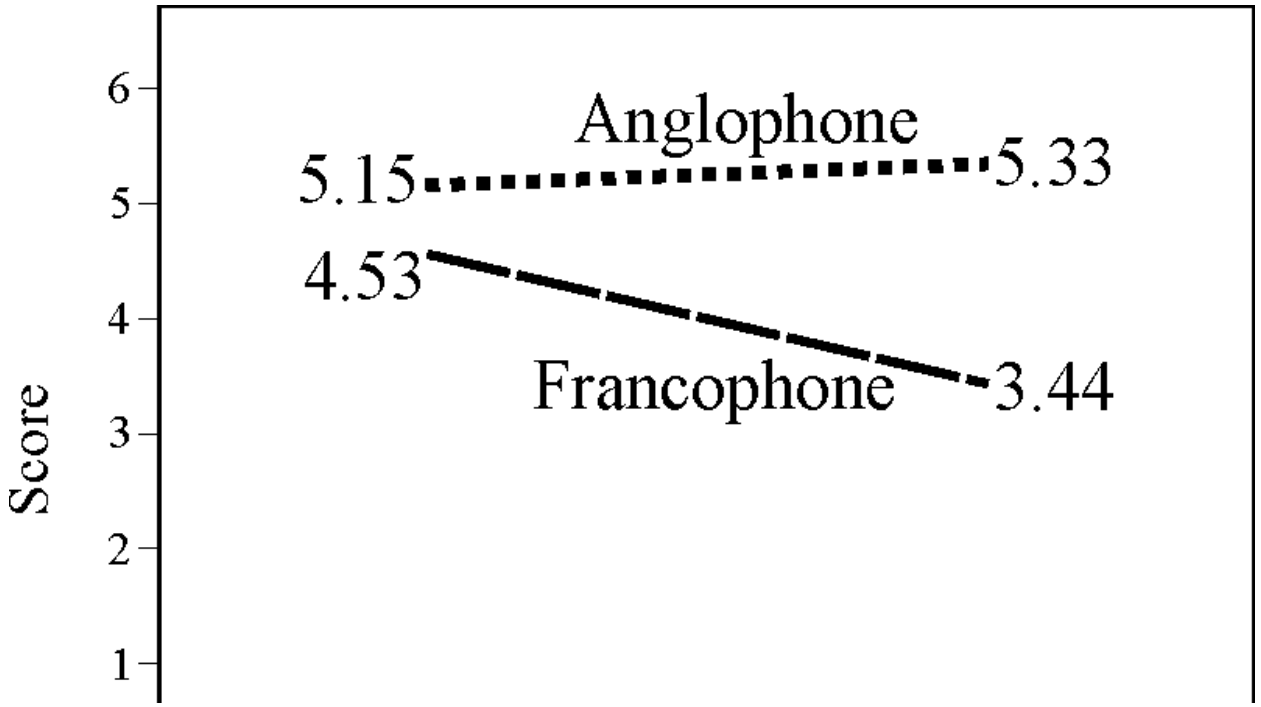
*** p<.001; ** p<.01; * p<.05; + p<.10

Institutions with and without specialized computer equipment for students with disabilities on campus. Of the 154 non-distance education respondents, 132 (86%) indicated that they had equipment for students with disabilities and 22 (14%) indicated that they did not. While colleges (81%) were significantly less likely than universities (93%) to have computers for their students with disabilities, $c^2(1)=4.00$, $p<.05$, there were no significant differences between comparable Anglophone and Francophone institutions. Surprisingly, there was no significant difference on the rating of the overall adequacy of computer services in meeting the needs of students with disabilities between institutions that did (M=4.26, SD=1.36) and those that did not (M=3.55, SD=1.81) have specialized equipment on campus for their students, $t(136)=1.63$, $p>.05$.

Priority of computer related services. The priority placed upon computer related services was average when weighted against all other disability-related support services, with a mean of 2.25 (SD =.87) on a 4-point scale where 1 indicates very high priority and 4 indicates very low priority). The difference between universities (72% rated computer related services as high or very high priority) and colleges (61%) was not significant. Similarly, Francophone (colleges M=2.33, universities M=2.27) and Anglophone (colleges M=2.32, universities M=2.09) institutions did not differ significantly on priority rating.

What is Lacking

A 2-way between groups MANOVA (2 Institution (College/University) x 2 Language (Anglophone/Francophone) on all "desired situation" items was conducted to compare wish lists of Anglophone and Francophone service providers from colleges and universities. Test results show that both main effects and the interaction were significant. Univariate ANOVAs shows that the main effect of language was significant for all 16 variables. Given the higher "actual" scores of Francophone institutions, we expected participants from Anglophone institutions to have higher "desired" scores than those from Francophone institutions (i.e., Anglophone service providers wanted more services/resources _ Francophone services providers were generally more satisfied with their actual situations). The main effect of institution was significant on 8 comparisons. Here the results are inconsistent, with some comparisons showing colleges to have higher scores while others showing that universities have higher scores. This is explained, in part by the finding that 12 of the 16 interaction effects were significant. These all show that while Francophone institutions had lower scores than Anglophone institutions, this was especially true of universities. Figure 1 presents these data most clearly.



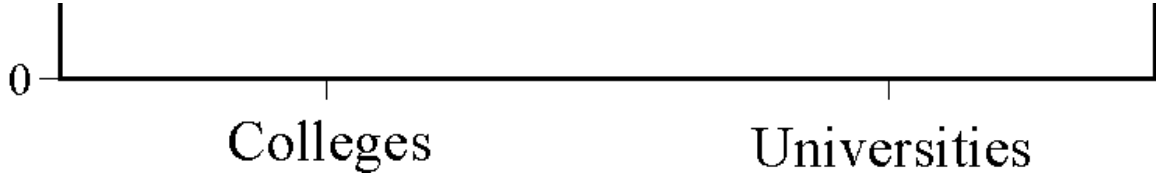


Figure 1. *Wish lists: interaction between language and institution type*

Spearman rank order correlations show that there is very high agreement between Anglophone and Francophone colleges on the ranking of the 16 "desired" items, Rho =.903, p<.001. The correlation between Francophone colleges and universities is also very high, Rho =.838, p<.001, as is the correlation between Francophone universities and Anglophone colleges, Rho =.759, p<.001. Scores from Anglophone universities, however, are not related significantly to Francophone universities, Rho =.388, p>.05, or to either Anglophone, Rho =.388, p>.05, or Francophone, Rho =.426, p>.05, colleges.

Because of discrepancies in language and institution type, Table 3 presents the wish lists of Anglophone and Francophone colleges and universities separately. It can be seen in Table 3 that, overall, disability service providers wish that students were better equipped and prepared for the postsecondary experience. For example, among the highest ranked items for Francophone and Anglophone colleges and universities was the wish for students to be more knowledgeable computer users, for students to be able to get subsidized computer technologies for home use more easily; and for students to have better access to computers off campus. The next group of highly ranked items relates to the need for accessibility of computer based teaching materials used by professors and for support services.

Table 3.*What Personnel Providing Services to Students With Disabilities in Anglophone and Francophone Colleges and Universities Want in Rank Order.*

Desired Situation (It Would Make My Job Easier If...)	University		College	
	Anglophone	Francophone	Anglophone	Francopl
If computer-based teaching materials used by professors were more accessible	1	8	7	9
If consulted when computer infrastructure decisions made	2	7	9	6
A person to train students	3	12	10	11
If there were a specialist in adaptive computer technologies on campus	4	1	5	3
If students were knowledgeable computer users	5	5	1	2
If computer support people took responsibility for adaptive technologies	6	9	6	8
If students were able to get subsidized computer technologies for home use more easily	7	3	2	1
If administration were to react more positively concerning accessibility of computers on campus	8	11	15	16
Equipment available in more computer labs	9	15	11	13
If students had adequate access to computers off campus	10	6	3	4
Professional development time to learn about adaptive technologies	11	4	4	5
If organizations that provide students with technologies were to work cooperatively	12	2	8	7
More funding for institution's adaptive computer technologies	13	13	13	10
More physical space for equipment	14	10	14	14
Have multidisciplinary advisory/steering committee for adaptive computer technologies	15	14	16	12
More equipment available in specialized labs/centres	16	16	12	15

Note. Spearman rank order correlations show very high agreement between: anglophone and francophone colleges; francophone colleges and universities; and francophone

universities and anglophone colleges. Scores from anglophone universities are not related significantly to any other group.

Results: Study 2

Important differences were found between colleges and universities, suggesting that data from colleges and universities should be analyzed separately. In addition, there were substantial differences between Anglophone and Francophone institutions. Because the number of Francophone institutions in Study 1 was relatively small, a larger sample was needed. There are few Francophone universities, and most were represented in Study 1. Therefore, in Study 2 we examined the totality of Quebec's public Francophone junior/community college system: the CEGEPs.

Expertise of Quebec'S Campus Based Disability Service Providers

Participants indicated that they were not especially knowledgeable about adaptive computer technologies: the mean was 3.00 on a 6-point scale, with higher scores indicating being more knowledgeable. This is similar to the score of 2.97 for all Francophone institutions in Study 1. Indeed, 59% of participants' answers indicated that they were not very knowledgeable, with only 9% indicating that they were reasonably expert.

Correlates of Good Institutional Computer and Adaptive Computer Technologies

Overall, the data indicate that participants felt that the computer related needs of students were moderately well met at their CEGEPs (mean = 4.34 on a 6-point scale, SD = 1.54). This too, is similar to scores in Study 1. Pearson product-moment correlation coefficients indicate that none of the demographic variables (i.e., size of the CEGEP, number of students with disabilities registered to receive disability related services, proportion of students with disabilities) was related significantly to the adequacy of meeting students' computer and adaptive computer technology needs.

Institutions With and Without Computer and Adaptive Computer Technologies on Campus for Students With Disabilities

Twenty-nine of 39 respondents who answered this question (74%) indicated having specialized equipment for students with disabilities on campus. To ascertain whether CEGEPs that did and did not have computer equipment for students with disabilities on campus differed in enrollment, we conducted a series of independent t-tests on enrollment statistics. Although the means suggest that the CEGEPs with equipment were larger than those that do not have equipment, had more students with disabilities, and had a larger proportion of students with disabilities, the t-tests on these variables were not significant. Given the enormous standard deviations and ranges in these scores (i.e., the number of students enrolled in the CEGEPs in the sample ranged from 100 to 8000, the number of students with disabilities ranged from 1 to 35, and the proportion of students with disabilities ranged from.01% to.83%), the absence of significance is neither meaningful nor surprising.

A MANOVA comparison of colleges with and without computers on campus for students with disabilities on 13 "actual situation" and personal factors variables was not significant.

The priority accorded to computer related services was average, with a mean of 2.25 (SD =.94) on a 4-point scale where 1 indicates very high priority and 4 indicates very low priority. CEGEPs with and without computer technologies on campus did not differ significantly.

Aspects of Computer Technologies at Colleges

Scores on how well various aspects of computer technologies met students' needs are presented in Table 4. These indicate very similar responses to those in Study 1, suggesting that Study 1 results adequately represent Francophone colleges.

Table 4.*Adequacy In Meeting the Computer Related Needs Of Francophone Cegep Students with Disabilities: Mean Scores for Actual Conditions Inside the Institution.*

Actual Situation: Adequacy In Meeting The Needs Of Students With Disabilities	Whole Sample		
	N	Mean [1]	SD
Overall rating about how well students' computer related needs are met	42	4.34	1.54
Average		**4.34**	
Inside & outside the institution factors			
Funding			
Funding for institution's adaptive computer technologies	36	3.81	2.04
Average		**3.81**	
Inside the institution factors			
Access to adaptive computer technologies			
Hours of access to computers	22	4.50	1.44
Computer technologies up-to-date	27	4.22	1.55

Computer technologies up-to-date	27	4.22	1.99
Off-campus loan program	21	4.14	1.71
Availability in specialized labs/centres	19	4.32	1.67
Physical space available for computer technologies	24	4.46	1.64
Training for students on adaptive computer technologies	18	3.50	2.07
Availability in mainstream computer labs	27	4.41	1.72
Average		**4.22**	
Internet/library & adaptive computer technologies			
Enough adapted computers with internet access	26	4.58	1.45
Library's computers accessible	38	4.21	1.61
Internet-based distance education accessible	18	2.89	1.84
Average		**3.89**	
Support for adaptive computer technologies			
Administration reacts positively concerning computer accessibility	34	4.76	1.62
Technical support	24	3.96	1.71
Opportunities for employees to learn about adaptive technologies	34	2.76	1.81
Specialist in adaptive computer technologies on campus	36	2.64	1.85
Computer support people can service adaptive technologies	35	3.49	1.98
Consulted when computer infrastructure decisions made	38	2.47	1.89
Advisory/steering committee deals with computer accessibility	35	1.71	1.30
Average		**3.11**	
Faculty and computer accessibility			
Computer-based teaching materials used by professors accessible	31	4.52	1.31
Faculty trained in adaptive computer technologies	37	2.95	1.67
Average		**2.95**	
Outside the institution factors			
Agencies provide students with appropriate equipment	38	4.92	1.15
Agencies provide students with adequate training	36	4.08	1.48
Average		**4.50**	

Note. Boxed values refer to scores which indicate inadequate accessibility (i.e., scores below the scale's mean of 3.50)

[1] Based on a 6-point scale, with higher scores indicating stronger agreement with the statement.

Discussion

Limitations of the Research

We were fortunate to obtain the participation of a very large proportion of the population of individuals who provide disability related services to students in both studies. Thus, our sample is truly representative of the geographic, linguistic and institutional characteristics of the Canadian postsecondary educational system. Nevertheless, there are limitations that should be kept in mind when interpreting the findings. First, the majority of our participants admitted to having limited knowledge of adaptive and computer based learning technologies. Therefore, we cannot be certain about how they interpreted certain concepts (e.g., computer-based teaching materials). A related problem involves interpretation of the term "accessibility" (e.g., available vs. usable by students with different impairments). Also, some participants consulted their institution's specialist in adaptive hardware/software. Most did not. This, too, could have influenced the findings.

Priority Placed Upon Computer Related Services

- Postsecondary institutions generally accorded moderate priority to computer related services.

- Universities accorded somewhat higher priority than colleges.
- There were no differences based on language.

In the future, we expect this function to gain in importance as all postsecondary institutions proceed along the road to greater integration of ICTs across the curriculum. In this regard, it should be noted that mean number of students with disabilities registered to receive disability related services in Canada's colleges (M=211) is very similar to the average in universities (M=217) (Fichten, et al., 2003). Thus, increased efforts will have to be made to ensure adequate access to computer technologies for students with disabilities in Canada's junior/community college system.

Computers and Adaptive Computer Technologies on Canadian Campuses

- Most institutions had specialized computer equipment for their students with disabilities and there were no significant differences between Anglophone and Francophone institutions.
- Colleges were less likely than universities to have specialized accessible computer technologies.
- Colleges with specialized equipment tended to be larger, to have more students with disabilities, and to have a larger percentage of students with disabilities, although these differences were not significant.
- Less than 1/4 of institutions had a multidisciplinary advisory/steering committee that deals with the accessibility of computer technologies for individuals with disabilities.

In previous research we showed that close to 1/2 of postsecondary students with disabilities need some type of adaptation to use a computer effectively (e.g., keyboard and input device modifications, screen magnification or voice output, dictation software) (Fichten et al., 2001a). Given the large numbers of students needing adaptations, it was not surprising to find that most institutions had some specialized accessible computer equipment for students with disabilities on campus. If computer and information technologies continue to be important institutional priorities, then having multidisciplinary committees with the necessary mix of expertise is vital to ensure that specific disability related concerns can be addressed when campus-wide computing decisions are taken.

Computer and Adaptive Computer Technologies on Canadian Campuses: Overall Evaluation

- The computer related needs of students with disabilities were moderately well met at their institutions.
- This was true for both Anglophone and Francophone colleges and universities.
- On the overall evaluation about how well students' computer related needs are met there was no significant difference between institutions that did and those that did not have specialized accessible equipment on campus for their students with disabilities.

Specific Aspects of Accessibility

- There were relatively few differences between colleges and universities.
- Where there were institutional differences, ratings at universities were generally more favorable than those at colleges.
- There were many linguistic differences, with ratings at Francophone institutions being generally more favorable than those at Anglophone institutions.

Aspects That Were Well Done at All Institutions

- The hours of access to specialized accessible computers were adequate.
- Specialized computer technologies were up-to-date.
- Computers with adaptive hardware and software in specialized labs were adequate.
- Administration was seen as reacting positively concerning access to computers for students with disabilities.
- Rehabilitation agencies were seen as providing students with appropriate computer equipment for personal use.

Aspects Rated Favorably at Francophone, but Unfavorably at Anglophone Institutions (there were no instances of the converse)

- Funding for computer technologies was adequate.
- The library's computers were accessible.
- Technical support was available.
- Computer based teaching materials used by professors were accessible.
- External rehabilitation agencies provided appropriate training for students in the use of adaptive technologies.

Aspects Rated Unfavorably by All Institutions

- Opportunities for employees to learn about specialized accessible computer technologies were seen as inadequate.
- There was often no specialist in adaptive hardware and software on campus.
- Computer support personnel were not available to service computers with adaptive hardware and software.
- Campus based disability service providers were rarely consulted when campus-wide computer infrastructure decisions were made.
- An advisory committee that deals with computer accessibility was generally not constituted.
- There was minimal training of faculty concerning access to computer technologies.

The Evaluations of Other Aspects of Campus Computing Evaluated Provided Equivocal Results

- Some institutions had an adequate off campus loan program that allows students to borrow adaptive technologies while others did not.
- In several institutions the physical space available for specialized computer technologies was adequate; in others it was not.
- Training for students on how to use adaptive computer technologies was adequate in some institutions but inadequate in others.
- There was great variability in the availability of computers with adaptive hardware and software in general use computer labs.
- Specialized computers with Internet connectivity were available in some institutions but not in others.
- Internet based distance education was sometimes seen as accessible and sometimes as inaccessible to students with disabilities.

There are several explanations for the surprising finding that computer related needs of students with disabilities are moderately well met regardless of whether the institution has computers with adaptive hardware/ software for their students or not. In general, institutions with no equipment were primarily smaller colleges with few students with disabilities. They were able to meet the computer related needs of their students with disabilities for three reasons:

1. Minimal integration of computer and learning technologies in the curriculum.
2. The ability of some students to use equipment in the college's general use computer labs.
3. Extensive human assistance on campus supplemented by students' own equipment for off campus use.

With growing enrollment and rapid deployment of computer technologies across the curriculum, we expect increased demand for computer and adaptive computer technologies for students with disabilities on campus. In this regard, many service providers noted problems with the availability of adaptive computer technology in general use computer labs and classrooms.

What is Lacking on Canadian Campuses

- Overall, service providers from Anglophone universities wanted more services/resources related to specialized accessible computers than those from Francophone universities; Anglophone and Francophone colleges were similar to each other in this regard.
- Respondents also generally wanted students with disabilities to come into postsecondary education equipped with the same level of computer literacy as their nondisabled peers.
- Another wish list item was better accessibility of computer based teaching materials used by professors for students with disabilities.
- Campus based disability service providers also wanted more extensive support services for computers with adaptive hardware and software.

Francophone colleges and universities generally had more favorable evaluations of the availability and accessibility of computers at their campuses. Yet, as noted earlier, the availability of adaptive software in English far outstrips what is available in French. So why, then, are Francophone institutions, especially universities, so satisfied with their situations? While we would like to think that the explanation relates to lavish budgets, an extensive choice of computers with adaptive hardware and software, and superb technical support and specialized accessible computer technology deployment systems, there are a variety of alternative possibilities. First, the number and proportion of postsecondary students with disabilities at Francophone campuses is only a fraction of that on Anglophone campuses: (Fichten, et al., 2001c; Fichten, et al., 2003). For example, we showed that the average proportion of Anglophone students with disabilities registered to receive disability related services at Canadian universities was 2.63%. It was 0.26% for Francophone universities. The same type of difference existed for the colleges (5.59% vs. 1.55%, respectively - see Table 6 in Fichten, et al., 2001c). Thus there may be fewer students requiring computers with adaptive hardware or software and Francophone institutions may be able to make do with extensive human assistance. Another possibility is related to the lesser expertise reported by Francophone on-campus professionals who provide disability-related services - they simply may not be aware of the possibilities.

Summary, Conclusions, and Recommendations

Overall, the results show that:

1. Most institutions had specialized adaptive computer equipment, although colleges were less likely than universities to do so.
2. Provincial and regional technology loan programs were seen as very effective.
3. Respondents believed they were not very knowledgeable about computer technologies.
4. Scores of respondents from Francophone institutions were lower than those from Anglophone institutions.
5. The computer related needs of students were seen as moderately well met, with ratings by respondents at Francophone institutions being generally more favorable than by those from Anglophone institutions.
6. Respondents from Anglophone universities indicated different needs than those from Anglophone colleges or Francophone institutions.
7. Overall, disability service providers wished that students were better equipped and prepared for the postsecondary experience.
8. Disability service providers wanted computer based teaching materials used by professors to be more accessible.
9. Disability service providers wanted more extensive support services for adaptive hardware and software.

These results suggest that although the current situation on Canadian campuses is seen as meeting the needs of students with disabilities moderately well, this may not remain so in the future. In this regard, the wish lists from Anglophone universities, with their large numbers of students with disabilities and their heavy campus-wide integration of computer and instructional technologies, should be paid special attention.

If new eLearning initiatives are to become the norm, then there is an increased need to address access for learners with disabilities. This has to happen in both the English and French speaking sectors. The implication of not doing this is that educational technologies become exclusionary technologies.

Universal Access

Over the years, those working to promote access for people with disabilities have learnt two important lessons. First is the cost-effectiveness of incorporating features that incorporate principles of universal design at the outset of a project (e.g., Node Networking, 1998). For instance, implementing accessibility features (e.g., elevators) in the initial layout of a building results in fewer design, construction and legal expenses (Falta, 1992). The data from both studies in this investigation makes it evident that specialized accessible computer technologies for learners with disabilities are and will continue to be a necessity on Canadian campuses. Nonetheless, environmental barriers are continually being created. This makes it imperative that solutions be identified and implemented while the integration of educational technologies in postsecondary institutions are still in a developing stage.

There have been numerous calls to consider learners' preferred modalities for obtaining information in different learning contexts (e.g., Caudill, 1998; Cohen & McMullen, 2000; Wislock, 1993). Many prefer a combination, for example hearing and seeing text simultaneously (Montali & Lewandowski, 1996). This suggests that it is time to give all learners choices from which they can select conditions for learning which are optimal for them. Thus, including features that promote accessibility in campus computing is likely to benefit all users. The belief that "designing educational programs, resources and events to be accessible to a diverse user base from the ground up, the educational offerings become better for everybody inclusively" is the motive behind a new universal instructional design project and listserv at the University of Guelph in Ontario (UID Project Homepage, 2003). These ideas are exemplified in the seven principles of universal design for computer technologies proposed by Connell et al. (1995), who show how these principles can be applied to both hardware and software design to ensure accessibility not just for people with disabilities but also for the safety and comfort of all.

For example, software designed for students with learning disabilities that highlights words as they are being read by a screen reader (text-to-speech) is likely to help second language learners as well. Allowing students the choice to turn closed captioning on and off (text appearing at the bottom of the screen, such as subtitles on foreign films) is also likely to benefit nonnative speakers as well as students who have difficulty making out specific words on video clips and those who wish to learn how to spell technical words or names. Allowing software to read what is on the screen, allowing alternative forms of input, such as dictation, and allowing people to choose auditory, written, or visual representations will allow students to choose their own preferred learning modality. Interesting descriptions of universal design applications in postsecondary education are available (e.g., Burgstahler, undated).

Specific Recommendations

To those involved in facilitating the increased use of technology in teaching and learning in postsecondary education we offer the following suggestions.

- Use universal (inclusive) design principles when planning or implementing campus-wide IT infrastructure.
- When involved in campus-wide computing decisions, make sure that there is representation from campus based disability service providers.
- In faculty computer training, make sure that issues related to computer accessibility are on the agenda.
- Facilitate opportunities for employees to learn about specialized accessible computer technologies.
- Try to ensure the availability of a specialist in adaptive hardware and software on campus and promote the training of computer support personnel to enable them to service computers with adaptations.
- When conducting formative/summative evaluations of courseware, web pages, and campus computing decisions in general, learners with disabilities should be included during pilot testing whenever possible.
- As a matter of course, subject matter experts in the area of accessibility for individuals with disabilities need to be drawn into the courseware design process.
- Authorware tools with builtin accessibility features (e.g., WebCT, Blackboard) should be selected when designing webbased applications.
- There are free webbased tools, such as the recently developed A-Prompt which functions in both English (A-Prompt, 2003a) and French (A-Prompt, 2003b). These can evaluate web pages for accessibility and provide suggestions for improvements. In addition, NCAM's (2003) recently released free software MAGpie (Media Access Generator) provides the facility to add captions to QuickTime, SMIL, and SAMI formats, and to incorporate audio descriptions into SMIL presentations.[1]

Why do designers fail to incorporate such seemingly obvious and inexpensive features? In some cases, their implementation is truly difficult. In most, however, designers, planners and developers simply do not think of accessibility issues. When alerted to problems, our experience has been that they often opt for, "Let's just finish developing the project, and then we'll add on the accessibility features later." Needless to say, by the time the product is finished, it is much too late to redesign the essentials to permit accessibility.

Computers can create access to information and education, thereby allowing individuals with disabilities freedom, independence, and access to the tools of the knowledge-based economy. The new technologies are changing the role of many sectors in society, including those of instructional designers and educational technologists. Meeting the challenges posed by these changes is a task for all individuals involved in designing campus computing.

Acknowledgments

This research was completed in partnership with the Canadian Association of Disability Service Providers in Post-Secondary Education (CADSPPE), the Service d'aide à l'intégration des élèves (SAIDE - Cégep du Vieux Montréal), le Services aux étudiants handicapés du Cégep de Sainte-Foy, the Association québécoise des étudiants ayant des incapacités au postsecondaire (AQEIPS), and the National Educational Association of Disabled Students (NEADS). Funding for the research was provided by grants from the Office of Learning Technologies (OLT), the Social Sciences and Humanities Research Council of Canada (SSHRC), FCAR, and Dawson College. We are grateful for their assistance and support. Special thanks go to our very active Advisory Board and the Adaptech online community for feedback, constructive criticism, and guidance. We are especially grateful to Joanne Senécal (Cégep du Vieux Montréal), Joan Wolforth (McGill University), Jean-Charles Juhel (Cégep de Sainte-Foy), Jane Drover (Mount Allison University), Alice Havel (Dawson College), and Frank Smith (NEADS). We also wish to thank all those who participated in the research as well as the dedicated members of our research team: Darlene Judd, Christian Généreux, Ray Tam, Jason Lavers, Daniel Lamb, Rachel Fima, and Jocelyne Côté for their substantial contribution to this research.

References

ADA. (1990). *Americans with Disabilities Act of 1990: Public Law 101-336*. Washington, D.C.: Government of the United States. Retrieved March 30, 2003, from http://www.usdoj.gov/crt/ada/adahom1.htm.

Adobe. (2003). *Access.adobe.com Adobe Acrobat software and Adobe Portable Document Format (PDF) files*. Retrieved March 30, 2003, from http://access.adobe.com

Angus Reid Group, Inc.(2000, March 21). *Face of the web study pegs global Internet population at more than 300 million.* Retrieved March 27, 2003, from http://www.angusreid.com/media/content/displaypr.cfm?id_to_view=1001

Apple (2003). *People with special needs*. Retrieved March 30, 2003, from http://www.apple.com/disability/

A-Prompt (Accessibility Prompt). (2003a). *A-Prompt Project: Accessibility-Prompt Toolkit*. Retrieved March 30, 2003 http://aprompt.snow.utoronto.ca/

A-Prompt: *Vérificateur d'accessibilité Web*. (2003b). Retrieved March 30, 2003, from http://aprompt.ca/french/index.html

Association of Canadian Community Colleges (ACCC). (2003). *Listing of members*. Retrieved March 27, 2003, from http://www.accc.ca/

Association of Universities and Colleges of Canada (AUCC). (2003). *Listing of members and total enrollment.* Retrieved March 30, 2003, from http://www.aucc.ca/

Bernstein, R., Caplan, J. & Glover, E. (2001). *America's 100 Most Wired Colleges _2000*. Yahoo! Internet Life. Retrieved March 30, 2003, from http://www.zdnet.com/zdsubs/yahoo/content/100mostwired/index.html

Burgstahler, S. (1992). *Computing services for physically disabled students in post-secondary institutions: Results of a survey in Washington state*. Unpublished manuscript. University of Washington, Washington, DC, USA.

Burgstahler, S. (1993). Computing services for disabled students in institutions of higher education *Dissertation Abstracts International: The Human and Social Sciences, 54* (1), 102-A.

Burgstahler, S. (undated). *Universal design in the classroom and computer lab.* Retrieved April 1, 2003, from http://staff.washington.edu/sherylb/univ_pacer.html

Burris, G.L. (1998, January). *Assistive technology support and strategies _ A summary*. Unpublished Manuscript. Southwest Missouri State University, Springfield, Missouri, 65804.

Caudill, G. (1998). Matching teaching and learning styles. *Technology Connection, 4*(8), 11, 24-25.

CNS (Computerized Notetaking System). (2003). *C-Note System - Computerized Notetaking System*. Retrieved March 30, 2003, from http://www.globaladaptive.com/itm00068.htm

Cohen, S. & McMullen, B. (2000). Shifts in thinking: A primer of the foundations of instructional technology assessment. *Syllabus, 13*(6), 12-14.

Connell, B. R., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M., & Vanderheiden, G. (1995). *The principles of universal design (Version 1.1 - 12/7/95)*. Retrieved April 1, 2003, from http://web.archive.org/web/19991008040849/http://trace.wisc.edu/text/univdesn /ud_princ/ud_princ.html

Coomber, S. (1996). *Inclusion: Strategies for accommodating students with disabilities who use adaptive technology in the classroom*. Vancouver: Human Resources Development Canada, Disabled Persons Participation Program.

EDUCAUSE Online Guide to Evaluating Information Technology on Campus (2002). Retrieved March 30, 2003, from http://www.educause.edu/consumerguide/academic.asp#

Epp, M.A. (1996*). A study of the use of Braille and electronic texts in B.C. colleges and institutes - Braille survey.* Unpublished manuscript, Langara College, British Columbia.

Falta, P.L. (1992, November). *Vers l'accessibilité universelle*. Presented at the Colloque scientifique international "10 ans de recherche à partager." Montreal, Quebec.

Fichten, C.S., Asuncion, J., Barile, M., Fossey, M.E., & Robillard, C. (2001a). Computer technologies for postsecondary students with disabilities I: Comparison of student and service provider perspectives. *Journal of Postsecondary Education and Disability, 15*(1), 28-58.

Fichten, C.S., Asuncion, J., Barile, M., Généreux, C., Fossey, M., Judd, D., Robillard, C., De Simone, C., & Wells, D. (2001b). Technology integration for students with disabilities: Empirically based recommendations for faculty. *Educational Research and Evaluation, 7,* 185-221.

Fichten, C.S., Asuncion, J.V., & Barile, M. with the Collaboration of: Robillard, C., Fossey, M.E., Judd, D., Guimont, J.P., Tam, R., & Lamb, D. and Partner Representatives: Généreux, C., Juhel, J.C., Senécal, J., & Wolforth, J. (2001c). Computer and information technologies: Resources for the postsecondary education of students with disabilities. Final Report to the Office of Learning Technologies. Hull, Québec: Office of Learning
Technologies. *Resources in Education* and *ERIC Document Reproduction Service* (ED 458 733 and EC 308 679). Retrieved March 30, 2003, from http://adaptech.dawsoncollege.qc.ca/pubs/olt01pdf.exe. Abstracted in *EDUCAUSE* (ID Number CSD1700).

Fichten, C.S., Asuncion, J.V., Barile, M., Robillard, C., Fossey, M.E., & Lamb, D. (2002). *Canadian postsecondary students with disabilities: Where are they?* Submitted for publication.

Fichten, C.S., Barile, M., Robillard, C., Fossey, M., Asuncion, J., Généreux, C., Judd, D., & Guimont, J.P. (2000). Access to college for all: ITAC Project - Computer and adaptive computer technologies in the CEGEPs for students with disabilities / L'accessibilité au cégep pour tous: Projet ITAC - informatique et technologies adaptées dans les cégeps pour les étudiants handicapés. Final report to PAREA (Programme d'aide à la recherche sur l'enseignement et l'apprentissage). Québec: Ministère de l'Éducation. *Eric Document Reproduction Service* (ED445457). Retrieved March 30, 2003, from http://adaptech.dawsoncollege.

qc.ca/pubs/itacallpdf.exe

Fougeyrollas, P., Cloutier, R., Bergeron, H., Cote, J., & St Michel, G. (1998). *The Quebec classification: Disability creation process.* Available address: International Network on the Disability Creation Process. P. O. Box 225, Lac St. Charles, Quebec G3G 3C1. Available email: pfougeyrollas@irdpq.qc.ca

Freedom Scientific. (2003). *JAWS for Windows*. Retrieved March 30, 2003, from http://www.hj.com/fs_products/software_jaws.asp

Government of Canada (1999). *Future directions*. Ottawa, Hull: Human Resources Development Canada. Catalogue number MP80-2/11-1999E. Retrieved March 30, 2003, from http://www.statcan.ca/english/Pgdb/imdb/sddseduc02a.htm

Green, K. C. (2002). *The 2002 National Survey of Information Technology in US Higher Education: Campus portals make progress; technology budgets suffer significant cuts*. Retrieved March 30, 2003, from http://www.campuscomputing.net/

Horn, C.A. & Shell, D.F. (1990). Availability of computer services in postsecondary institutions: Results of a survey of AHSSPPE members. *Journal of Postsecondary Education and Disability, 8* (1), 115-124.

Human Resources Development Canada. (2002). *Advancing the inclusion of persons with disabilities. A Government of Canada Report* (Cat. No.: RH37-4/1-2002E). Ottawa: Authors. Retrieved March 29, 2003, from http://www.hrdc-drhc.gc.ca/hrib/sdd-dds/odi/documents/pdfs/fdr.pdf

IBM. (2003). *Accessibility center guidelines.* Retrieved March 30, 2003, from http://www-3.ibm.com/able/guidelines.html
Jackson, K., Morabito, S.M., Prezant, F.P., & Michaels, C.A. (2001, July). *The current status of technology on campus for students with disabilities: The DSS perspective*. Presentation at the Annual AHEAD (Association on Higher Education And Disability) Conference, Portland, Oregon.

Jacques Joly Consultant Inc. (1999). *Étude des besoins du réseau d'enseignement collégial en matière de matériel didactique. Rapport présenté au Centre collégial de développement de matériel didactique (CCDMD).* Montréal: Centre collégial de développement de matériel didactique (6220, rue Sherbrooke Est, bureau 416, Montréal (Québec) H1N 1C1.

Killean, E. & Hubka, D. (1999, July). *Working towards a coordinated national approach to services, accommodations and policies for post-secondary students with disabilities: Ensuring access to higher education and career training. Report to the National Educational Association of Disabled Students.* Ottawa: NEADS. Available address: 426 Unicentre, Carleton University, Ottawa, Ontario, K1S 5B6.

Labrèche, S. (2000). *Les Québécois sont encore réticents à acheter en ligne*. March 4, 2000. Les Affaires, p.42.

Lance, G. D. (1996). Computer access in higher education: A national survey of service providers for students with disabilities. *Journal of College Student Development, 37*(3), 279-288.

Lemieux-Brassard, L. (2000). *Another step toward independent living: Montreal independent living resource centre (ILRC) feasibility study - Report prepared for the Canadian Association of Independent Living Centres*. Available June 15, 2000 via e-mail: Deborah Kennard, Co-chairperson, Montreal ILRC Feasibility Study, d.kennard@videotron.ca

Michaels, C., Prezant, F., Morabito, S., & Jackson, K. (2001). Assistive and instructional technology for college students with disabilities: A national snapshot of disabled student providers. *Journal of Special Ed Technology 17*(1), 5-14. Retrieved March 30, 2003, from http://jset.unlv.edu/17.1/michaels/first.html

Microsoft Corporation (2003). *Overview of Microsoft's commitment to accessibility*. Retrieved March 30, 2003, from http://www.microsoft.com/enable/microsoft/default.htm

Ministère de l'éducation - Enseignement supérieur (Gouvernement du Québec). (2002a). *Nombre d'élèves inscrits au collégial à l'enseignement ordinaire et à temps plein, selon le type de formation et la classe : réseau public*. Retrieved March 30, 2003, from http://www.meq.gouv.qc.ca/stat/Sipeec/Reseau_public.htm
Ministère de l'éducation - Enseignement supérieur (Gouvernement du Québec). (2002b). *Données par nom d'établissement*. Retrieved March 30, 2003, from http://www.meq.gouv.qc.ca/stat/Sipeec/Etabl_nom.htm

Montali, J. & Lewandowski, L. (1996). Bimodal reading: Benefits of a talking computer for average and less skilled readers. *Journal of Learning Disabilities, 29*(3), 271-279.

NCAM (National Center for Accessible Media). (2000). *Media access generator (MAGpie). Retrieved March 30, 2003, from* http://www.wgbh.org/wgbh/pages/ncam/webaccess/magindex.html

NODE Networking. (1998, August). *Universal design for the information highway*. Retrieved March 27, 2003 from http://node.on.ca/networking/august1998/feature1.html

Pettigrew, P.S. (1998, November). *Notes for remarks by the Honourable Pierre S. Pettigrew of Human Resources Development Canada to the National Educational Association of Disabled Students.* Presentation at the National Educational Association of Disabled Students (NEADS) Biannual Conference, Ottawa, Canada.

PricewaterhouseCoopers. (2000). *Canadian consumer technology study*. Retrieved March 18, 2000, from http://www.pwcglobal.com/extweb/ncsurvres.nsf/0cc1191c627d157d8525650600609c03/8945bb1ee560f32d852568600078c099 /$FILE/ccts_99.pdf

Statistics Canada. (1999). *Canadian statistics: Education enrollment*. Retrieved August 11, 1999, from http://www.statcan.ca/english/Pgdb/People/educat.htm

Statistics Canada. (2003). *Participation and Activity Limitation Survey, 2001: Disability supports in Canada, 2001 - Government of Canada Report* (Catalogue no. Catalogue no. 89-580-XIE). Retrieved March 25, 2003 from, http://www.statcan.ca/english/freepub/89-580-XIE/free.htm

UID Project Homepage. (2003). Retrieved March 29, 2003, from http://www.tss.uoguelph.ca/uid/

Wislock, R.F. (1993, Fall). What are perceptual modalities and how do they contribute to learning? *New Directions for Adult and Continuing Education, 59*, 5-13.

Endnotes

1. A listing of helpful English and French organizations and resources is available via email from the first author: catherine.fichten@mcgill.ca

---

ISSN: 1499-6685