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Computer Technologies For Postsecondary Students With Disabilities I: Comparison of Student And Service Provider Perspectives

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Abstract

In a series of three studies conducted between fall 1997 and spring 1999 we explored the computer, information and adaptive computer technologies needs and concerns of Canadian postsecondary students. To obtain an overview of the important issues, in Study 1 we conducted focus groups with 6 postsecondary personnel responsible for providing services to students with disabilities and 12 postsecondary students with various disabilities. In Study 2 we obtained in-depth information from Canada-wide structured interviews with individuals responsible for providing services to students with disabilities (n=30) and with 37 postsecondary students with various disabilities. In Study 3 we collected comprehensive information via questionnaire from a Canada-wide sample of 725 junior/community college and university students as well as data about the proportion of students with disabilities from 162 campus based disability service providers. Here we report on the scientific aspects, including the methods used and the findings. In a companion article (Fichten, Asuncion, Barile, Fossey, Robillard, & Wolforth, 2001) we use the findings to generate wide-ranging recommendations and provide resources and tools for practitioners.

"Does CMC (computer mediated communication) present individuals with disabilities opportunities or barriers?" This is the provocative title of Gold's (1997) article in CMC Magazine, a query echoed in a recent U.S. College Board report (Gladieux, & Swail, 1999). In the past, computer technologies have worked to empower people with disabilities. There is a concern, however, that today's computer and newly emerging technology-driven curricula may become barriers rather than facilitators for students with disabilities. It is clear that in the near future "e-learning" will proliferate both on and off campus (e.g., Web-Based Education Commission, 2001). For example, if a department decides to teach the majority of its courses

online, and these courses are developed using inaccessible web sites and authoring tools, what are the educational implications for the 5% to 11% of postsecondary students who have disabilities (CADSPPE, 1999; Disabled Students in Postsecondary Education, 1997; Greene & Zimbler, 1989; Henderson, 1999; Horn & Berktold, 1999).

There is much discussion about computer and information technologies for postsecondary students with disabilities in both the mainstream and the specialized literatures. With the exception of learning disabilities, however, there is virtually no published empirical research which evaluates how these are used by students with disabilities or how useful they are. To the best of our knowledge, only a handful of investigations have explored computer technology needs of postsecondary students with disabilities (Coomber, 1996; Killean & Hubka, 1999; NCSPES, 2000; Roessler & Kirk, 1998). Although these are important and timely investigations, a variety of concerns about each study set limits on their generalizability.

The investigation by Coomber (1996) was really an incidental aspect of an applied project designed to provide "…a curriculum guide that would facilitate educational access for students with disabilities who use adaptive technology" (p. 5). Here, "postsecondary students with disabilities were hired to interview students who use adaptive technology, disability service coordinators, and instructors who had had students using adaptive technology in their classes" (p. 5). Although the questions asked are provided, neither sample sizes nor data gathering or analysis techniques are reported. Presumably, the sample sizes were very small and it is clear that this was not intended to be an empirical evaluation. Similarly, assistive technologies were only a minor part of the extensive focus groups conducted by the NCSPES (2000) at 10 postsecondary institutions.

The focus of another investigation was on computer related needs and services in the early and mid 1990s by 40 "recent" graduates (i.e., graduated after 1991) of a single university (Roessler & Kirk, 1998). This was a sophisticated evaluation which used a structured interview to assess students' attitudes and experiences with computer technologies and training. However, as the authors themselves point out, the sample consisted only of graduates, the impairment and disability related technological accommodations needed by participants was diverse, and most respondents received their postsecondary education "during the early to mid 90s" (p.52). Moreover, the primary emphasis in this investigation was on employment related needs and concerns.

Computer technology related questions comprised only a minor component of the single large scale study which involved 349 postsecondary students with various disabilities and 70 campus based individuals who provide disability related services to students (Killean & Hubka, 1999). The goal of this questionnaire study was to review, "…services, accommodations, and policies in place at post-secondary institutions for students with disabilities" (p1). Also a Canadian investigation, this study was carried out between 1997 and 1999. Both students and disability service providers were asked to evaluate, among large numbers of questions unrelated to technology, the same 15 adaptive computer related items (e.g., voice recognition, Braille printers) on a scale with the following points: "Excellent," "Good," "Fair," "Poor," "Not Available," "Don't Know".

Because computer technologies were not the primary focus of this investigation, data were not presented for specific disability groups separately. This resulted in some difficulties with the interpretation of the findings. For example, students' modal answer for 14 of the 15 items was "Don't Know." This was followed in popularity by "Not Stated" for 13 items. Most of those who actually evaluated the items rated these favorably. However, it should be noted that there was a

very substantial proportion of "Not Available" responses (about 20% of the students whose answers did not fit the "Not Stated" or "Not Answered" categories). The only exception to this was "Internet Access," which almost 50% of students rated as Good or Excellent. What is not clear, here, however, is whether it is Internet on the school's general use, non-adapted computers that was rated highly or whether it was access to the Internet on computers with needed adaptations.

Similarly, "Not Available" was the most popular response of disability service providers on 12 of the 15 items. Here, also, the rating of those who evaluated valence was mainly favorable (i.e., "Excellent" or "Good"). Nevertheless, as was the case with the students' responses, the proportion of respondents who fell into the "Don't Know" or "Not Stated" categories was high. As with the students' ratings, Internet access was clearly rated favorably. However, the same concerns as those noted about the student sample apply. Overall, because the main focus of this investigation was not on computer and adaptive computer technologies, it is difficult to make definitive conclusions about how students use computers, what equipment is needed and used, or about how well students' computer related needs are met by the institution.

There are several American (Burgstahler, 1992, 1993; Burris, 1998; Coomber, 1996; Horn & Shell, 1990; Jackson, Morabito, Prezant, & Michaels, 2001; Lance, 1996) as well as Canadian studies (Epp, 1996; Fichten et al., 2001a, 2001d; Killean & Hubka, 1999) on the views of individuals responsible for providing services to students with disabilities about computer, information and adaptive technologies. Several of these have relatively large samples (Burgstahler, 1992, 1993; Fichten et al., 2001a; Horn & Shell, 1990; Killean & Hubka, 1999; Lance, 1996). Taken together, these provide a reasonably comprehensive picture of disability service providers' views about computer and adaptive computer technologies. With the exception of the Killean and Hubka (1999) study, however, these investigations did not examine student views. As noted earlier, given the objectives of their study, neither student nor disability service provider views were examined in a detailed manner. Clearly, a more comprehensive look at the computer and adaptive computer technologies needs and concerns of postsecondary students with a variety of disabilities is needed. In particular, similarities and differences between students' and service providers' views need to be evaluated.

To ensure that information needed by students is furnished quickly and accurately, it is imperative that staff working in offices providing services to students with disabilities be aware of new developments and have a basic understanding of how to operate adaptive computer technologies. In turn, they can transmit the knowledge to both students and professors. They also need to investigate what steps are being taken on campus to phase in new educational technologies, and to advocate with college bodies to sensitize them to the importance of making these accessible to all learners. To accomplish this, both research and practical recommendations are needed. Here, we provide the "science" part of the equation. In a companion article (Fichten et al., 2001b) we use the findings to generate wide-ranging practical recommendations and provide resources and tools for practitioners.

Present Investigation

To obtain an overview of the important issues we first conducted two focus groups. One with 12 postsecondary students with various disabilities and one with 6 disability service providers (Study 1). In Study 2 we obtained in-depth information from structured interviews with larger and more diverse samples of these groups (n=37 and 30, respectively). In Study 3 we collected comprehensive information via questionnaire from a Canada-wide sample of 725 university and junior/community college students. Although the data were collected in Canada,

the implications of the findings have broad-based applications to other countries. The following key questions guided our studies:

- What computer technologies do students with various disabilities need and use?
- What advantages and disadvantages do these have?
- What factors help or prevent students from using needed computer technologies?
- What can be done to enhance opportunities and remove barriers to the use of computers?

Study 1

Method

To obtain an overview of issues and concerns we held focus groups in a large metropolitan area in the fall of 1997. A group was held for postsecondary students with a variety of impairments/disabilities, (n=12: 7 female, 5 male). Another was held for university and junior/community college personnel responsible for providing services to students with disabilities (n=6: 4 female and 2 male). Additional details about the samples are available in Table 1. Our team contacted offices for students with disabilities to recruit students from English and French postsecondary institutions in the Montreal area. The same approach was used for personnel responsible for providing services to students with disabilities.

Students were asked about advantages and disadvantages of computer, information and adaptive computer technologies for students with disabilities; their personal experiences with these technologies; and factors which prevent or help students access these technologies. Personnel responsible for providing services to students with disabilities were asked about: funding sources for these technologies, for both on and off campus use; how both service providers and students learn to use these; who provides the technological supports and training; the role of other departments, such as audio-visual and the library, in providing adaptive computer services; how decisions are made at their institutions about what adaptive computer technologies students use on campus; and how they obtain the most current information on new technologies. Questions asked of focus groups are available in Fichten, Barile, and Asuncion (1999b).

Focus group sessions were tape recorded and transcribed. In addition, two research team members took notes of the proceedings. We examined the responses to each question in each focus group. Notes taken during the meeting were reviewed along with the verbatim transcriptions. Elements of focus group analysis - how the data were handled, how categories were developed, how the data were verified, as well as systematic analysis - followed Morgan's (1988) recommendations. Responses in each focus group were grouped into categories. Some of these were based on the questions themselves while others were derived from responses. Thus, categories may or may not be the same in the two groups. The data within each focus group were reviewed, one question at a time, by subcategories. Additional methodological details are available in Fichten, Barile, & Asuncion (1999a).

Results and Discussion

Students. All students had experience using computers in the context of their studies. In general, they felt that computers were beneficial. Advantages of computers were noted in the following categories: computers assist with writing, help surmount barriers caused by specific impairments, help organize and speed up work, and promote personal growth. Students also noted disadvantages in four major areas: academic work, the need for training and assistance,

attitudinal and classroom problems, and disability-specific concerns. The high cost of computer technologies and training were frequently noted challenges to using computers effectively, as were compatibility problems between needed software and

Table 1
Respondent Characteristics

Variable	Study 1 Students (n=12)		Study 1 Disability Service Providers (n=6)		Study 2 Students (n=37)		Study 2 Disability Service Providers (n=30)		Study 3 Students (n=725)	
	#	%	#	%	#	%	#	%	#	%
Academic Activity										
Community College (Diploma)	6	50%	2	33%	17	46%	14	52%	335	46%
University (Degree)	6	50%	2	33%	20	54%	13	48%	294	41%
Student During Past 2 Years But Not Currently Taking Courses/Other			2	33%					67	9%
Gender										
Female	7	58%	4	67%	20	54%	18	60%	425	59%
Male	5	42%	2	33%	17	46%	12	40%	300	41%
Age (Mean)					29				30	
Students' Disabilities										
Visual Impairment	4	33%			15	41%			172	24%
Totally Blind	2	17%			6	16%			35	5%
Low Vision	2	17%			9	24%			137	19%
Medical Impairments	2	17%			13	35%			109	15%
Psychiatric Impairments	0	0%			0	0%			87	12%
Other					0	0%			91	13%
Learning Disability	2	17%			12	32%			271	37%
Mobility Impairment &/or Wheelchair User	4	33%			11	30%			196	27%
Wheelchair User	2	17%			8	23%			104	14%
Mobility Impairment	2	17%			3	8%			92	13%
Problems Using Arms Or Hands	4	33%			12	32%			162	22%

Table 1
Respondent Characteristics

Variable	Study 1 Students (n=12)		Study 1 Disability Service Providers (n=6)		Study 2 Students (n=37)		Study 2 Disability Service Providers (n=30)		Study 3 Students (n=725)	
	#	%	#	%	#	%	#	%	#	%
Hearing Impairment	2	17%			8	22%			108	15%
Deaf	0	0%			2	5%			30	4%
Hearing Impaired	2	17%			6	16%			78	11%
Speech Impairment	3	25%			4	11%			59	8%
Number of Different Impairments Per Student (1)										
1 Impairment	8	67%			19	51%			410	57%
2 Impairments	0	0%			8	22%			171	24%
3 Impairments	3	25%			7	19%			84	12%
4 Impairments	1	8%			2	5%			37	5%
5 Impairments	0	0%			1	3%			13	2%
6 Impairments	0	0%			0	0%			5	1%
7 Impairments	0	0%			0	0%			0	0%
8 Impairments	0	0%			0	0%			1	<1%

1) Data available for only 721 students.
2) Only 35 of 37 students used computers.

hardware. Students also noted the absence of appropriate technologies to assist them and indicated that there were problematic attitudes about using computers in class, both on the part of faculty and other students. They also cited lack of information about existing funding programs and policy related problems. More extensive information about students' responses can be found in Fichten, et al. (1999a).

Individuals responsible for providing services to students with disabilities. Participants felt well informed about funding for on campus computer equipment for students with disabilities. When it came to how students can obtain funding for computer technologies for off campus use, however, they generally had much less precise and up-to-date information. In general, individuals responsible for providing services to students with disabilities did not feel that assisting students with obtaining equipment for off campus use fell within their job description ("The rehabilitation agencies assist them with that."). This is consistent with results reported by others (Lance, 1996).

When asked how they learned to use computer, information and adaptive technologies, all group members indicated that they learned in an informal way ("sitting down with the manual" "students are a great resource"). Service providers also noted problems related to training students and technical support ("One discovers things after a product is bought; it doesn't come out of the box and work." "There's no funding (for training) and the companies charge $600 a day… We fill in where the (rehabilitation) organizations have not provided service.").

Involvement of other departments such as computer support services, the library, or audio visual services was seen as minimal, and these departments were perceived as relying on the know-how of the office providing services to students with disabilities to learn and service specialized equipment ("We are the only ones with extensive knowledge about the technology." "The staff doesn't remember how to use the equipment. …the library has a constant change of staff… by the time they are needed, they've forgotten the information." "The real issue is how to fit together all the systems that are available. We need to decentralize.").

In response to the question about how decisions about equipment acquisitions are made responses fell into two categories: formal and the more popular informal process. Formal decisions were based on the "literature" ("Decisions are made in the office providing services to students with disabilities - keeps itself on (electronic) mailing lists, EASI discussion list, e-mail, snail-mail"). More common was a casual approach ("We listen to students about what they use and what they've heard and then we make recommendations," "call other service providers, network, consult each other, get opinions," "students with expertise"). Service providers indicated keeping up-to-date by "word of mouth" followed by "exchange of information by e-mail" and "the Web."

Other topics raised include concerns about equipment loans, difficulties with information sharing, and centralized versus decentralized equipment. A recurring theme related to service providers' frustration with limited time and the subsequent low priority accorded to learning about new developments ("When we learn … (by) ourselves about the adaptive technology, it feels like students are getting the short end of the stick." "We don't have enough time to network."). One individual summarized the feeling expressed by most participants in the session, "Would it not be nice if we had more time, money, trained staff, and the latest equipment?"

Overall. The most prominent element was the view that computers have tremendous potential but that they also can pose barriers. The most notable advantage was the potential of the new computer technologies to create access to information - the currency of learning and the new economy.

Study 2

In Study 2 we conducted structured telephone interviews with larger, more diverse samples of students with disabilities and campus based disability service providers in order to obtain more comprehensive views. In particular, we wanted to find out about what equipment was used by students with different disabilities, how equipment was obtained, how participants learned to use these, and what were the advantages and disadvantages of computer technologies for students with disabilities in post-secondary education. An additional goal was to obtain student and service provider perspectives about the same issues. The final sample consisted of 30 campus based individuals who provide disability related services and 37 students with various disabilities from all Canadian provinces and territories.

Method

In the spring 1998 semester we conducted structured telephone interviews concerning the computer, information and adaptive computer technology needs and concerns of postsecondary students with disabilities. Interview questions are available in Fichten, Barile, and Asuncion (1999b). Participants were a convenience sample of 37 postsecondary students with various disabilities as well as 30 postsecondary personnel responsible for providing services to students

with disabilities. Students were recruited through personal contacts, our student group partner (National Educational Association of Disabled Students, NEADS), and personnel responsible for providing services to students with disabilities. Interviews were conducted by telephone. A TDD (telecommunications device for the deaf) was used when necessary.

Respondents represented all regions of Canada and came from 49 different institutions: 20 universities, 26 junior/community colleges, and three distance education institutions. Interviews were taped and responses quantified using predetermined categories. Participants were told that they would be identified only by a numerical code and that their responses would never be linked to them or their institution.

Interviews with students consisted of 17 sets of questions based on findings from Study 1. Interviews typically lasted between 20 minutes and 1-1/2 hours. Participants provided demographic information and indicated: the types of computer technologies used at home and at school; whether they had difficulty using computer equipment; how they obtained their computer technologies and learned to use these, as well as about problems and solutions. They also noted advantages and disadvantages of using computer technologies, indicated how they found out about new equipment and software, and specified their computer technology "wish list."

Interviews with personnel responsible for providing services to students with disabilities consisted of 18 groups of questions. Many were identical to questions asked of students. We also inquired about the number of students registered to receive services and asked about the computer technologies available at respondents' institutions and hours of access. Participants were also asked to comment on how specialized computer technologies are obtained at their institution, funding issues, and how they, the students, and the staff who oversee the specialized technologies learned to use the equipment. We also inquired about possible problems and solutions in these areas.

Participants

Our original intent was to interview, by telephone, 32 postsecondary students with disabilities and 32 personnel responsible for providing services to students with disabilities from all 10 provinces, the two territories that existed at the time, and Canada's 4 postsecondary distance education institutions. Where possible, we planned to avoid selecting students and disability service providers who were affiliated with the same institutions. We planned on 24 interviews in English and 8 in French. English interviews were to represent one junior/community college and one university from each province (20), two interviews from junior/community colleges in the two territories, and two from distance education institutions (one university, one junior/community college). Of the eight interviews in French, four were expected in Quebec (one distance education and one non-distance education junior/community college and university, respectively) and four from the provinces where francophone postsecondary institutions with students who have disabilities were identified. It should be noted that both territories have junior/community colleges but no universities and that there are four Canadian postsecondary distance education institutions. No attempt was made to ensure that the sample was representative either in size or the institution, the city or the type of disability students had. The objective was merely to achieve a cross-Canada perspective.

Students. We intended to interview 32 students who fit the following criteria: (1) currently enrolled at a post-secondary institution or graduated or left school less than 12 months prior to the interview; (2) for each province, one student was to come from a college and one from a university (duplicated where relevant to include both English and French speaking students); (3)

one student from each province had to be male and the other female; (4) two male and two female distance education students (one English, one French).

In the final sample of 37, 29 of the participants fit these criteria. We were unable to recruit the three participants needed in the following categories: a French speaking student in one province and in a French distance education college, and an English speaking distance education university student. In addition, while we would have preferred an even balance between male and female distance education students, both distance education students in the final sample are female.

In the process of obtaining the sample, we interviewed eight "extra" students. This occurred for a variety of reasons including: cancelled but subsequently rescheduled appointments, availability of complete data from pretest participants, a deliberate attempt to secure interviews with non-users of computers (these students were difficult to find), and interviews arranged directly by personnel responsible for providing services to students with disabilities where we had no control over the gender of the respondent. While this upset the systematic sampling procedure, a larger more diverse group of students appeared to warrant the decision to include the eight "extra" interviews in the sample.

Sixteen of the 37 participating students (20 females and 17 males) were enrolled at a junior/community college, 19 at a university, and 2 at distance education institutions (1 college, 1 university). Ninety-five percent of participants were students at the time of the interview; the remainder had graduated or taken a leave during the previous year. The majority (73%) were enrolled full-time. Of non-distance education students, 95% were attending school in the day. Almost half of the sample was pursuing a Bachelor's degree,14% a postgraduate degree, and the rest a certificate or diploma. Six interviews were conducted in French and 31 in English. Two interviews were conducted using a TDD and one was conducted with the assistance of an intervener. It can be seen in Table 1 that half of the sample had multiple impairments. The mean was 1.86 impairments per student.

Mean age of students was 29 with most (62%) falling into the 17 to 28 age range. Students had a variety of impairments/disabilities. Table 1 shows that these represent all major disabilities, including severe mobility, communication and speech impairments (Atanasoff, McNaughton, Wolfe, & Light, 1998). Table 1 also presents data that show that half of the sample had multiple impairments. Approximately 3/4 of the sample had their disabilities since childhood (age less than 10) and only 8% had acquired their disability recently (past 5 years). Students were enrolled in a variety of programs, with the majority in social science, commerce, and science. Additional details are available in Fichten, Barile, and Asuncion (1999a).

Personnel responsible for providing services to students with disabilities. Our main task in selecting participants was ensuring that they could provide us with the most global perspective possible concerning available services to students with disabilities at their institutions. For both English and French interviews we selected respondents from a directory published by our student organization partner, the National Educational Association of Disabled Students (NEADS). To get the most comprehensive and diverse data possible an attempt was made to obtain respondents from junior/community colleges and universities other than those contacted to recruit students. This goal was accomplished in all but nine instances. In three of these cases the individual responsible for providing services to students with disabilities was not involved in the selection of the students. In the remaining six instances there simply was no other choice (e.g., only one college in the Yukon Territory). In addition, we were unable to interview personnel responsible for providing services to students with disabilities from one English college in one province,

from French speaking distance education institutions or from French speaking institutions in provinces outside Quebec. Thus, 25 of the 30 participants in the final sample fit the selection criteria. As in the case of students, five "extra" interviews are included in the final sample; this is because of cancelled but subsequently rescheduled appointments and pretest participants who provided complete data.

It can be seen in Table 1 that approximately equal numbers of service providers in our sample worked at a university and a junior/community college. Only 3 of them worked in a postsecondary distance education institution. Eighteen of the 30 participants were female and 12 were male. Two interviews were conducted in French and 28 in English. The average official full-time enrollment in institutions represented by personnel responsible for providing services to students with disabilities was 8,890 (*SD* = 8,443, range 220 to 34,000, *Mdn*= 7,256). Approximately equal numbers of participants came from small (population under 100,000; n=11), medium (population between 100,000 and 1,000,000; n=9), and large (population over 1,000,000; n=10) cities.

Results And Discussion

Use of computer technologies. Thirty-five of the 37 student participants (95%) indicated they used a computer. Most used computers both at home (86%) and at school (80%). A substantial number, 80% of computer users, used the Internet, accessing this both from home (79%) as well as school (71%). Almost half of the sample (43%) had difficulties using the monitor as well as the mouse. In addition, a substantial number of students had problems with the keyboard (23%), diskette manipulation (14%), and the printer (9%). Several students had difficulties with two or more components (e.g., most students who are blind had problems with both the monitor and the mouse, students with difficulties using their hands or arms often had problems with keyboards, mice, diskette manipulation and the printer).

Ninety percent of personnel responsible for providing services to students with disabilities indicated that there were students on their campuses who could have benefited from computer technologies but were not using them. The most popular reason, given by 2/3 of respondents, was lack of comfort with computers. Other reasons provided by at least 20% of respondents were: cost, lack of awareness about what equipment is available, time, concerns about looking different from other students, and poor skills.

Advantages and disadvantages of computers for students with disabilities. Both groups agreed that advantages of computer technologies outweighed any disadvantages. For example, all 35 computer user students indicated advantages. Six students, however, indicated that they experienced no disadvantages. Similarly, all 30 personnel responsible for providing services to students with disabilities indicated advantages, while only 28 indicated disadvantages. Visual inspection of items listed in Table 2 show that there was good agreement between students and service providers that: word processing eliminates the need to handwrite and results in neat presentations; computer technologies allow access to an abundance of information; students can work faster; computers provide independence, empowerment, and autonomy; they can provide access to otherwise inaccessible activities; and they allow students to easily edit and revise their work.

Overall, however, the Spearman rank correlation coefficient shows that students and personnel responsible for providing services to stu-

Table 2
Advantages and Disadvantages of Computer Technologies: Comparison of Student and Service Provider Responses

Factors	Students		Service Providers	
	#	%	#	%
Advantages				
Word processing means no need to handwrite or retype, neat presentation, cut & paste	19	54%	6	20%
Access to lots of information opens up the world	16	46%	8	27%
Can work faster, easier, saves time	13	37%	7	23%
Independence, empowerment and autonomy	8	23%	12	40%
Provides access to otherwise inaccessible activities	8	23%	11	37%
Editing work is easier: easy corrections, multiple copies, can check work, can reprint work	8	23%	4	13%
Can work at one's own pace and schedule	8	23%	1	3%
Spell check, grammar check, dictionary and thesaurus	7	20%	7	23%
Communication is made easy	6	17%	5	17%
Needed to proceed in education and for the job market – provides opportunities	3	9%	4	10%
Gives confidence, no writer's block, reduces stress	3	9%	1	3%
Allows one to work like others	3	9%	1	3%
Internet is cheaper than long distance telephone calls	3	9%	0	0%
Fun	2	6%	1	3%
Keeps students organized, allows them to find things quickly	2	6%	0	0%
Don't lose ideas because they can get them down on paper fast enough	2	6%	0	0%
Cost effective	1	3%	5	17%
Students can perform at their full potential, levels the playing field	0	0%	14	47%
Allows students to take their own notes in class	0	0%	3	10%
Helps student learn material	0	0%	2	7%
Disadvantages				
Long to learn, unfriendly, frustrating	13	37%	10	33%
Need to keep up-to-date, obsolescence, continual upgrading, not knowing what's available	10	29%	9	30%
Cost	10	29%	8	27%
Crashes, breakdowns, repairs take long, lost work, unhelpful help lines, products not supported	9	26%	8	27%
Doesn't meet disability related needs well (inaccurate, works poorly, can't operate it)	8	23%	2	7%
Dependence on technology – what if it breaks down; there is no computer available; no electricity	2	6%	3	10%
Health concerns (eye strain, voice strain)	2	6%	1	3%
Not available at school	2	6%	1	3%
Interferes with social activities	1	3%	3	10%

Table 2
Advantages and Disadvantages of Computer Technologies: Comparison of Student and Service Provider Responses

Factors	Students		Service Providers	
	#	%	#	%
Compatibility problems	1	3%	2	7%
Problems with bilingual use	1	3%	0	0%
Hard to use on public transit	1	3%	0	0%
False sense that computer will solve all problems	0	0%	4	13%
Lack of adequate on-campus training and tech support	0	0%	3	10%
Campus technology unavailable elsewhere (home, work)	0	0%	3	10%
Students made uncomfortable by computers are forced to use them	0	0%	2	7%
Over-dependence on technology by instructors, lose personal touch, lack of human contact	0	0%	2	7%

Note: All respondents listed at least one advantage. Only 29 students and 28 service providers indicated disadvantages; the rest said there were none. Boxed areas indicate the greatest discrepancies between students and service providers.

dents with disabilities' lists were not correlated significantly, (rho) $r(20) = .34$, $p > .05$. This is because substantial numbers of individuals in both groups noted advantages that members of the other group did not mention. For example, students, but not service providers, noted that computers allowed them to work at their own pace and schedule - this was especially important for students with medical conditions whose energy levels fluctuated during the day. Some students also noted that the Internet was cheaper than long distance telephone calls. Similarly, personnel responsible for providing services to students with disabilities mentioned advantages that students did not indicate: computer technologies were cost-effective, as these allowed the Office for Students with Disabilities to free up human resources; they allow students to perform at their full potential; and they allow students to take their own notes in class, rather than having to rely on others' notes or having to audiotape.

Inspection of disadvantages, also listed in Table 2, indicates that, generally, students and personnel responsible for providing services to students with disabilities were in reasonably good agreement. Results of a Spearman rank correlation, which indicates a significant coefficient, (rho) $r(20) = .46$, $p < .05$, confirm this conclusion. Both groups agreed that computer technologies take a long time to learn, and that they are frustrating and not user-friendly. Similarly, both groups mentioned the need to keep up-to-date, rapid obsolescence, the need for continual upgrading, and not knowing what is available. Cost, crashes, break downs, lengthy repair times, lost work, unhelpful help lines, and unsupported products are also frequently noted disadvantages.

However, students also indicated that computers often fail to adequately meet their disability related needs because products: are inaccurate (e.g., dictation software), work poorly (e.g., grammar checkers), cannot cope with certain tasks (e.g., screen readers cannot read

graphics), and are inaccessible (can't control mouse with shaky hands). Personnel responsible for providing services to students with disabilities also mentioned some disadvantages that students did not indicate. They noted that computer technologies interfere with social activities, provide a false sense that the computer will solve all problems, and that use of these technologies by instructors will cause loss of human contact with students. They also mentioned lack of adequate on-campus training and tech support and expressed the concern that students can become accustomed to using equipment that is available on campus but unavailable elsewhere (e.g., home, workplace). They also noted that some students who are uncomfortable with computers are being forced to use them.

Equipment for students with disabilities. Overall, service providers indicated that 83% of institutions sampled had some specialized computer equipment for their students with disabilities. Impairments of students at service provider participants' institutions are reported in Table 3. These indicate that almost all had students with hearing, learning, visual and neuromuscular impairments. Within each of these groupings, fewer institutions had students with more severe impairments, although they were more likely to have specialized equipment for them. As in the past (Horn & Shell, 1990), institutions were most likely to have specialized equipment for their students with visual impairments. Nevertheless, it appears that software and hardware for Braille users is limited (Epp, 1996; Killean & Hubka, 1999). When it came to students with hearing impairments, however, while 97% of institutions reported having students with this disability, less than 1/3 reported that they had any specialized computer equipment for them. This is similar to findings reported by Killean & Hubka (1999), who also found that computer technologies for students with hearing impairments were least likely to be available on campus. Both students and service providers gave a listing of the types of equipment often used by students with specific disabilities. This is supplemented by information from Study 3 and reported in the companion article to this report (Fichten et al., 2001b).

Table 3
Types of Students and Equipment of Personnel Responsible for Providing Services to Students With Disabilities

	Institutions W/ Students Who Have This Disability		**Institutions W/ Specialized Computer Equipment**	
	#	**%**	**#**	**%**
Visual Impairment	**26**	**87%**	**21**	**81%**
Low Vision	26	87%	21	81%
Totally Blind	19	63%	16	84%
Learning Disability	28	93%	21	75%
Mobility and Neuromuscular Impairments	**26**	**87%**	**19**	**73%**
Mobility Impairment &/Or Wheelchair User	26	87%	16	62%
Problems Using Arms or Hands	23	77%	18	78%
Hearing Impairment	**29**	**97%**	**7**	**24%**
Use Oral Approach	27	90%	4	15%
Use Sign Language	22	73%	7	32%
Other Impairments	**22**	**73%**	**5**	**23%**

Data provided by personnel responsible for providing services to students with disabilities indicate that all universities represented in the sample had specialized computer technologies for their students for on-campus use. However, only 79% of junior/community colleges had equipment. Colleges with few students with disabilities were the ones most likely to have no equipment for their students. Government or institutional funds paid for the computer equipment need by the students on campus, although 67% of service providers reported experiencing serious funding problems.

Generally, purchase decisions were made by the Office for Students with Disabilities after informal consultation with staff and students (71%). Only about 1/3 (29%) of institutions made purchase decisions after broad-based consultation (i.e., intersectorial committees including students, computing services, audio-visual, the library, learning center, physical plant representatives, faculty, student affairs, and adaptive technologists). Approximately half (52%) of the service providers indicated that equipment was centralized in one main location. The remaining half (48%) indicated that the equipment was decentralized (e.g., library, general use computer labs). All institutions which had equipment made this available to students during business hours, including lunch time. The vast majority (90%) also provided access during the evening, and 81% provided weekend access. All institutions studied had Internet access. However, only 54% had adapted computer work stations with Internet connectivity. This is an important issue for students with all types of disabilities.

Half of the personnel responsible for providing services to students with disabilities (50%) indicated that they had a technology loan program. There was no single model for loan programs. Duration of loans varied from, "a few hours or a day" to "duration of their studies." Most service providers indicated that equipment loans were flexible and based on individual need and availability of equipment. Generally, the loan was for a short (1-4 week) period, typically for a specific activity or for temporary replacement of students' own equipment.

Acquisition of computer technologies for home use. Approximately half (47%) of the students indicated that paying for their computer technologies was problematic. Indeed, of the 30 students who indicated that they use a computer at home, 27 (90%) indicated that either they themselves or their families paid for most of the equipment. A little more than half (n = 17) of the student sample indicated that they benefited from a government grant. A third of the students (n = 9) had some or all of their equipment purchased or loaned by their postsecondary educational institution (mostly Internet access from home). Ten percent of students (n = 3) had equipment donated by a foundation or organization, and 2 students had equipment given to them by friends.

Learning to use computer, information and adaptive technologies. It can be seen in Table 4 that most students indicated that they learned to use computer technologies by themselves or through mainstream courses. Service providers, however, believed that students learned from an adaptive technology trainer or from personnel responsible for providing services to students with disabilities. It is evident both from these data, as well as from the nonsignificant results when students' and service providers' responses were correlated, (rho) $r(6) = -.10$, $p > .05$, that these two groups do not agree on how students learn to use computer technologies. This is likely due to service providers focusing mainly on those students who use adaptive, rather than general use technologies. As the data in Table 4 indicate, most students felt that their method of learning works reasonably well.

Table 4
How Students Learn to Use Computer Technologies

	Students' Responses			Personnel Responsible for Providing Services to Students with Disabilities Beliefs (1)		
Variable	Indicated #	Responses %	Indicated %	Believed Responses #	Believed %	
How Learned (1)						
Self Taught	28	38%	80%	8	17%	33%
Mainstream Course	18	25%	51%	6	13%	25%
Adaptive Technology Trainer	12	16%	34%	14	29%	58%
Friends/Family	9	12%	26%	3	6%	13%
Disability Service Provider	1	1%	3%	9	19%	38%
Other	5	7%	14%	8	17%	33%
Adequacy of Learning Method for Students (2)						
Method Works Poorly	4		11%	6		18%
Method Works Moderately Well	9		26%	6		27%
Method Works Well	22		63%	12		55%

1) 35 students and 24 persons responsible for providing services to students with disabilities responded to this question.
2) 35 students and 22 persons responsible for providing services to students with disabilities responded to this question.

Personnel responsible for providing services to students with disabilities concurred with this evaluation.

Students who use computers indicated an average of 2.26 sources of learning about new computer technologies. These show that word of mouth, the Internet and mainstream magazines are their most popular sources of information. Several students also mentioned an adaptive technology trainer as well as television. It should be noted that some students thought of general use computers while others thought of adaptive equipment when answering this question.

When asked about how they themselves learned about specialized computer technologies, most service providers indicated at least two different modalities, with 75% of respondents indicating that they were at least partially self taught and 50% indicating that they learned from an adaptive technology trainer. Learning from the students was also mentioned by a substantial number of respondents (21%). The Internet has become the most widely used source of information. Conferences, equipment manufacturers and distributors, and word of mouth were also popular resources. Most campus personnel felt that their method of learning works well (96%). The significant Pearson correlation coefficient, $r(28) = .42$, $p < .05$, reveals that service

providers were more likely to indicate that their method of learning worked poorly if their institutions enrolled larger numbers of students with disabilities.

Wish lists. Students generally wanted more, better, and more up-to-date specialized hardware, software, and ergonomic and adaptive computer furniture both at home and at school. Students who did not have home computers or who did not have adaptations at home wanted these. Similarly, students who did not have Internet access at home wanted this, while those who already had it wanted faster connections. Students also indicated that they wanted user friendly voice software to control the computer and do dictation. Students also noted a variety of important items about computers at school. In particular, they indicated that they wanted more computers at school and in the library, and that they wanted accessible library catalogues with printing capability. If they did not have this, they wanted a laptop for use at school.

Personnel responsible for providing services to students with disabilities also wanted more, better, and more up-to-date specialized hardware and software for their institutions. Half of the respondents wanted user friendly multi-user voice software to control the computer and do dictation. They also wanted students to be able to work autonomously in the library. While many mentioned that there was an adapted computer work station in the library, they also indicated that these had serious limitations. For example, they did not permit students to get assistance from librarians on Internet resources or to print information retrieved from library catalogues or Internet and CD-ROM resources. Another issue noted by approximately 1/3 of respondents was decentralization of adaptive equipment: service providers wanted accessible work stations in various buildings on campus, and they wanted adaptive equipment in general use computer labs. Laptops, mainly for use in loan programs, were also popular.

When asked about successful aspects of their programs, personnel responsible for providing services to students with disabilities most often mentioned aspects related to available equipment and services. They also mentioned good access to general use computer labs and the Internet as well as helpful and supportive computer and technology experts at their institutions. Unsuccessful features included inadequate funding and equipment as well as outdated software and hardware. On the human side, lack of interest and collaboration from other departments was cited. Problems also included lack of space, problematic evening access to adaptive computer technologies and lack of equipment for loans.

Study 3

The goal here was to obtain information about computer technologies from a large and diverse sample of postsecondary students. To accomplish this a large number of questionnaires were distributed to Canadian postsecondary institutions in three ways: campus based personnel responsible for providing services to students with disabilities, mailed distribution by our student partner organizations: NEADS and AQEIPS (Association québécoise des étudiants ayant des incapacités au postsecondaire), personal contacts and, in a very limited way, through e-mail. The final sample consisted of 725 students with various disabilities from all Canadian provinces and territories.

Method

Questionnaires were distributed in the spring of 1999 primarily through bulk mailings to 204 college and university personnel responsible for providing services to students with disabilities who agreed to make these available to students at their institution. Research team members phoned the 268 individuals responsible for providing services to students with

disabilities at institutions which appeared on one of the following lists: (1) the directories of campus based disability service providers published by our student organization partners NEADS, and (2) AQEIPS, (3) by our service provider partners the Service d'Aide à l'Intégration Des Élèves (SAIDE), and (4) le Services aux étudiants handicapés du Cégep de Sainte-Foy, (5) universities that are member institutions of the Canada-wide AUCC (Association of Universities and Colleges of Canada), and (6) junior/community colleges which are members of the Canada-wide ACCC (Association of Canadian Community Colleges) or the Québec based Fédération des Cégeps. These listings include distance education institutions.

Once someone was reached, this individual was provided with an explanation of the goals of our project and asked if they would be willing to assist us by distributing our questionnaires to students with disabilities attending their institution. It was explained that: we were looking for both users and non-users of computers, that we were interested in hearing from the largest cross-section of students with disabilities, and that we had questionnaires available in a variety of alternative formats. Of the 268 institutions contacted, 25 indicated that they had no students with disabilities (9%), 2 declined to participate (1%), and 37 were left telephone messages but failed to return our calls (14%). The remaining 204 agreed to participate. Thus, of the 243 institutions which indicated that they had students with disabilities, 204 (84%) agreed to participate by distributing our questionnaires.

Personnel responsible for providing services to students with disabilities who agreed to make questionnaires available at their institutions were asked how many questionnaires in each of the alternate formats they were willing to receive (regular print, large print, audiotape, Braille, diskette - available in EvNet, 2000 or from the authors). Questionnaire packages included a stamped, self addressed envelope, cover letter, consent form, and a "tear-off" form to complete if students wanted a copy of the findings. All non-print versions distributed were packaged together with a regular print version of the questionnaire (available in Fichten, Barile & Asuncion, 1999b).

Once the packages reached the institutions, we left it to the discretion of the personnel responsible for providing services to students with disabilities how they would make questionnaires available to students. A cover letter was included with each package that directed those receiving the questionnaires to make them available to the "widest cross-section" of students with disabilities, and to make them available to both computer users and non-users, if possible. Although there was great diversity in the distribution systems, for the most part, questionnaires were made available in a manner similar to the way in which "free" advertiser supported newspapers are distributed (i.e., placed in public areas such as counters in offices providing services to students with disabilities or in computer labs). All participating institutions were recontacted four months later. At this time we reminded service providers to make questionnaires available and asked them about how many students with disabilities were registered to receive services for students with disabilities at their institution.

Questionnaires were also mailed to the membership of our two student consumer group partners: NEADS and AQEIPS. At the request of a distance education disability service provider we also prepared an e-mail version of the questionnaire. This was distributed to a limited number of students. The number of schools using specific distribution methods is unknown. Similarly, because of anonymous responding, it is not known how many of the questionnaires distributed to the membership of NEADS and AQEIPS were returned, making it impossible to calculate a "return rate."

Questionnaire. Questionnaires contained 29 groups of questions. Most were closed-ended and used a 6-point Likert scale with 1 indicating strongly disagree and 6 indicating strongly agree (available in Fichten, Barile, & Asuncion, 1999b). These were made available in various alternate formats in French and English (i.e., regular print, large print, audiotape, Braille, diskette - available in EvNet, 2000 or from the authors). Topics included demographic and postsecondary institution related variables, field of study, qualifications pursued, nature and duration of disabilities/impairments, computer information and adaptive technologies used, comfort expertise and time spent using computers, computer related attitudes, adaptive computer technologies that could be useful to the respondent in getting work done, reasons for not using a computer or the Internet, and problems caused by computer technologies. Once completed questionnaires were received, open-ended responses (e.g., name of adaptive equipment used, program of study) were quantified using predetermined categories.

Demographic characteristics of institutions. To obtain information about the cities where respondents' educational institutions were located, chambers of commerce, almanacs, and web pages were consulted. For the purposes of the present investigation, cities and towns were grouped into three categories: small (population under 100,000), medium (population between 100,000 and 1,000,000), and large (population over 1,000,000).

To get a sense of the size of each postsecondary institution, data concerning total student enrollments from the Association of Universities and Colleges of Canada's (AUCC) web site were obtained. This included undergraduate and graduate students, both full- and part-time. We summed these numbers to obtain the total population of each participating institution. For junior/community colleges, the web sites did not contain enrollment information. Therefore, registrars of the various junior/community colleges were contacted for all provinces, except Quebec, where the AQEHPS (1999) report contained 1998 enrollment statistics for all junior/community colleges.

For all institutions outside Québec, the number of students with disabilities at each institution was provided by our contact people - the personnel responsible for providing services to students with disabilities. These individuals were asked how many students with disabilities were currently registered/identified at their institution ("Approximately how many students with all types of disabilities, documented or not, including learning disabilities, are enrolled at your institution?"). In some cases, actual figures were supplied. In other cases approximations were made. In Quebec, data on the number of students with disabilities were obtained from a study conducted during 1998 by AQEHPS (1999) where personnel responsible for providing services to students with disabilities were contacted and asked to provide the information; information for 64 institutions are provided. Data from a recently completed investigation shows that data provided by individuals responsible for providing services to students with disabilities and by AQEHPS are very highly correlated (Fichten, Barile, Robillard, Fossey, Asuncion, Généreux, Judd, & Guimont, 2000).

Participants. Of the 736 questionnaires returned, 11 were excluded because the respondents had not been students during the past 2 years. This left a total sample size of 725 (425 females and 300 males).

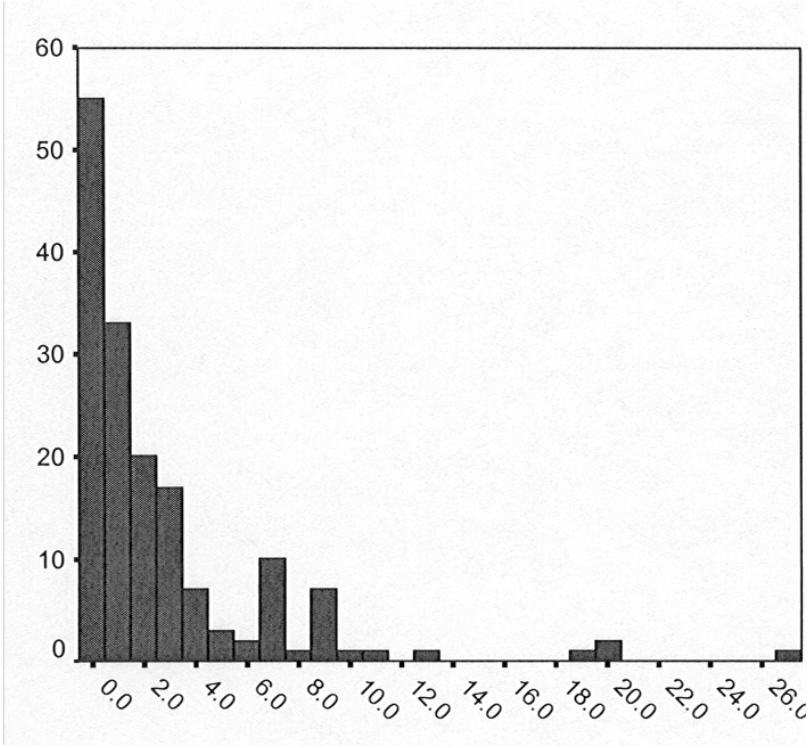
Participants represent all Canadian provinces and territories and comprise current junior/community college (n=335) and university students (n=294), including 11 from distance education. Twenty-nine participants were not currently enrolled in a postsecondary educational institution but had been students during the past 2 years. Responses were obtained from students at 154 Canadian universities and junior/community colleges; these represent 176 autonomous

campuses, many of which are located in cities different form the parent institution. The majority of students were enrolled in arts (67%). Slightly less than a third (29%) were enrolled in science and technology programs. The programs of the remaining students could not be classified. Additional information about the sample is available in Table 1.

Mean age of students was 30 (*SD* = 10, range = 17 to 75). The distribution was skewed in favor of younger students. Students had a variety of impairments/disabilities. These are detailed in Table 1. Consistent with the North American trend (Jackson et al., 2001; Roessler & Kirk, 1998; Scott, 1997), the largest group of students had a learning disability (this includes attention deficit disorder). It can be seen in Table 1 that close to half of the sample had multiple impairments; the mean number of impairments was 1.74 per student. Half of the responses (50%) indicated that

Figure 1

Percentage of Students with Disabilities in Canadian Colleges and Universities



(Transcriber's note: The x axis = Frequency, y axis = Percentage of Students with Disabilities. Std. Dev = 4.09, Mean = 2.7, N = 162.00)

Note: Frequency refers to number of colleges and universities. Only institutions enrolling at least 1 student with a disability are included. Thus, 0% represents less than .5%.

the student's disability was present since childhood (age less than 10), and only 11% of responses reflected a recently acquired disability (past 5 years), with the remaining responses indicating somewhere in between.

Results and Discussion

Proportion of students with disabilities. Information concerning the percentage of students with disabilities registered with the Office for Students with Disabilities on campus is available for 162 junior/community colleges and universities (institutions which had no students with disabilities were excluded). The average enrollment at these 162 institutions was 8,520 (*SD* = 9,344, range = 200 to 50,000, *Mdn*= 5,103). The mean number of students with disabilities at these institutions was 202 (*SD* = 275, range = 1 to 1,830, *Mdn*= 100). As was the case in Study 2, the distribution of the scores suggests that there were many small and a few very large schools in our sample and that discrepancies among institutions were substantial. The mean percentage of students with disabilities at these institutions was 2.74% (*SD* = 4.09, range = <.01% to 27.27%, *Mdn*= 1.13%). Thus, in most institutions fewer than 2% of students were registered with offices responsible for providing services to students with disabilities (see Figure 1).

It should be noted that an alternate form of calculation of the percentage of students with disabilities at the same 162 institutions can results in a different, lower value. The computation above is based on calculating the percentage of students with disabilities for each institution and taking the mean. An alternate technique is to divide the average number of students with disabilities at the 162 schools (*M* = 202) by the average overall enrollment in those schools (*M* = 8,520). This results in the percentage dropping by approximately 1/3% to 2.38%. This occurs because there are more colleges in the sample. While smaller than universities, these have a larger proportion of students with disabilities. Therefore, the two types of averages are likely to be different. To ensure that comparable figures are used when comparing studies, it is important to ascertain which computational method was used.

The average number of students registered to receive disability related services at universities (*M* = 194) and junior/community colleges (*M* = 186) did not differ significantly, $t(159)=.18$, $p>.05$, although total enrollment in universities (*M* = 13,745) was significantly greater than in junior/community colleges (*M* = 4,968), $t(170) = 5.31$, $p<.001$. Thus, it is not surprising that there was a significant difference in the proportion of students with disabilities, with colleges enrolling a significantly larger proportion (*M* = 3.43%, *SD*=4.84) than universities (*M* = 1.38%, *SD*=1.38), $t(158)=4.12$, $p<.001$. Both analysis of variance (ANOVA), $F(2,159)=2.05$, $p>.05$, and correlational results, $r(160)= -0.067$, $p>.05$, show that city size was not related significantly to the percentage of students with disabilities. The nonsignificant correlation coefficient, $r(160)= -.089$, $p>.05$, indicates that the size of the institution was also unrelated to the proportion of students with disabilities.

Experiences with computer technologies. The overwhelming majority of respondents, 692 of the 725 participants (95%), indicated that they used a computer. The proportion was the same in junior/community colleges and universities. As reported in detail elsewhere, neither gender nor age were related significantly to the nature of students' experiences with computer and adaptive computer technologies (Fichten et al., 2001c).

Thirty-three students (5%) indicated that they did not use a computer. When asked why, their answers reflected neither computer anxiety nor difficulties in learning. Students indicated

that: computers cost too much; were unavailable to them; were too expensive to maintain; and that it was impossible for them to get computer technologies through a subsidy program.

All students indicated the types of computer technologies that could be useful in getting their work done. The findings show that the most popular computer technologies were sophisticated or adapted versions of general use equipment (Fichten et al., 2001c). A comprehensive listing of equipment used by students with different disabilities is presented in the companion to the present article (Fichten et al., 2001b).

Two hundred and eighty-four of the 692 computer user students (41%) indicated that they needed special adaptations to use a computer effectively (e.g., screen magnification, dictation software, Braille output). It is noteworthy that only 166 of the 284 students who indicated that they needed adaptations (58%) used them. When asked why they did not use adaptations, the overwhelmingly endorsed answer was that it costs too much (mean rating was 5.50 on a 6-point Likert scale). Other reasons with scores above the mid-point of the scale include: it is unavailable to students, they are uncertain about where to buy these, they don't know how to use the equipment, and equipment is too expensive to maintain.

How computer technologies are used. Ninety-three percent of computer users had a computer at home and 95% used a computer at school. These figures are slightly greater than 1998 data presented by Campbell (1999), which showed that 85% of students at Mt. Allison University had a computer. Eighty-seven percent of students in our sample used the Internet: 64% at home and 77% at school. These figures, too, are somewhat greater than Campbell's (1999) data, which show that between 24% and 68% of students at three Canadian postsecondary educational institutions used e-mail in school and between 42% and 53% used it at home. Most (62%) of the respondents who did not have a computer or Internet access (78%) at home wished that they did. Similarly, although relatively few students indicated using a laptop either at home (20%) or at school (23%), large numbers of students who did not have a laptop wished that they had one.

Students indicated spending approximately 13 hours during a typical school week using a computer (exclusive of the Internet) and 7 hours using the Internet. Most students used an IBM compatible (93%). Only 15% used a Macintosh (some students used several types of computers) and several used another type of computer. Students used computers at school in a computer lab (78%) or in the library (61%). A significant minority (43%) used computers in an Office for Students with Disabilities or in a specialized lab. Only about 1/3 of students used computers during class lectures.

The most frequently cited reason for using the Internet was research (M = 5.42 on a 6-point Likert scale). Other popular reasons included e-mail (friends, family and professors), accessing library materials, and entertainment. These findings are similar to those reported by the UCLA's Higher Education Research Institute (Cooperman, 1999; CIRP Press Release, 1999) for American college freshmen, 83% of whom reported using the Internet for research. Our findings also show that 66% of students used the Internet for e-mail, and slightly more than half (54%) participated in chat rooms. E-mail was also the most popular use for the Internet in Clark's (1999) survey of people with disabilities; this was followed by listservs, discussion groups, newsgroups and chat rooms. Her participants also indicted that the Internet helps them do research, communicate with friends and get computer related advice. Sixty-nine percent of participants in her survey used adaptive computer technologies. Data from other laboratories also indicate that Internet use has a variety of important benefits for people with disabilities (Hopps & Pepin, 1999).

When computer users who did not use the Internet were asked why, their responses indicate that using the Internet ties up the phone line; that they had no access to a computer that is equipped to go on line; and that it costs too much. No student indicated that it was unavailable in their area, and very few indicated that it was unavailable at their school.

The most common problem noted by students was that computer technologies cost too much (M = 4.80 on a 6-point Likert scale). Other problems included: the need for continual upgrading (M = 3.87), few opportunities for training on adaptive technologies (M = 3.59), hardware and software compatibility problems (M = 3.44) (e.g., document saved on one computer does not work on another), and computer labs where courses are held lacking suitable adaptations (M = 3.38) (e.g., no dictation software). The most common problem with computers at school was that both general use and specialized labs are overcrowded.

Acquiring computer and adaptive computer technologies for off campus use. By far the most common way for students to obtain computer technologies was to buy it for themselves (34%) or to have their families buy it for them (30%). Government was also a likely source (34%), and many students borrowed equipment from family or friends (14%). Many students indicated several funding sources.

Students who had taken advantage of a government program to obtain at least some of their technologies were generally pleased with the equipment. They felt that: the equipment they received was up-to-date (M = 5.04 on a 6-point scale); that it met their needs (M = 4.86); the program was flexible in accommodating their requirements (M = 4.27); and that contacting the necessary people to discuss one's needs was easy (M = 4.11). On the other hand, students also felt that: there were many restrictive rules and regulations (M = 4.10), waiting periods were long (M = 3.60), the process for applying was complicated (M = 3.25), and they did not receive good training on the technology (M = 3.22).

The majority of students, approximately 2/3 of the sample, did not avail themselves of a government program to obtain a computer or adaptive computer technologies. When asked why, the most common answer (M = 5.01 on a 6-point scale) was that students were not aware that there were any programs out there for them. In fact, when students were invited to write additional comments, many spontaneously mentioned that now that they knew that there were programs where they could apply, they would be sure to investigate their options. Students who chose not to apply even though they knew about the availability of programs, indicated that there were too many restrictions (M = 3.57) or that their family income (M = 3.33) or the nature of their disability (M = 3.27) excluded them from existing programs.

General Discussion

Proportion of Students with Disabilities

Our data indicate great discrepancies among the 162 institutions surveyed in the percentages of students with disabilities registered to receive services. The mean was less than 3% (2.74% when calculating the mean of percentages and 2.38% when dividing the mean of the number of students with disabilities by the mean overall student enrollment). Proportions ranged from close to 0% to more than 27%. In most institutions, the percentage of students with disabilities was under 1%. In general, junior/community colleges had a higher percentage of students with disabilities than universities (approximately 3-1/2% and 1-1/2%, respectively). Neither overall size of the institution or the town in which the institution is located was related to the percentage of students with disabilities.

Data on the number of students with disabilities on campus are affected by the definition of disability used, what question is asked, of whom it is asked, and how percentages are calculated. Most research is based on self-reports by probability samples. Estimates of the number of North American postsecondary students with some disability have ranged from 5% to 11%, with junior/community colleges having a larger proportion of students with disabilities than universities (CADSPPE, 1999; Disabled Students in Postsecondary Education, 1997; Greene & Zimbler, 1989; Henderson, 1999; Horn & Berktold, 1999). For example, the 1995-96 National Postsecondary Aid Study (cited by Horn & Berktold, 1999) indicates that approximately 6% of 21,000 American university undergraduates surveyed indicated that they had a disability. The 1994 freshman survey conducted by the Cooperative Institutional Research Program studied 237,777 students attending 461 American universities and 2 year colleges (Henderson, 1995). The 1998 freshman survey examined responses at 469 American colleges and universities. In both the 1994 and 1998 surveys, approximately 9% of students reported at least one disability (Henderson, 1995, 1999). Large scale American results also show that between 1996 and 1998, 72% of postsecondary educational institutions enrolled students with disabilities (Lewis, Farris, & Greene, 1999). Comparable data for Canadian institutions do not exist, although a recent survey indicates that 6% of junior/community college graduates and 4% of university graduates in 1995 indicated that they had a disability (Taillon & Paju, 2000).

When comparing our findings to those of American studies it is important to note that we studied only institutions which had at least 1 student with a disability, and that our data reflect the number of students registered to receive disability related services from their institutions. Data about the number of students "known" to individuals who provide disability related services has been obtained in both Canadian and American studies. Our findings are surprisingly similar to these. For example, the mean number of full time students with disabilities reported by the 66 service providers in Killean and Hubka's (1999) study was 163 (range: 0-1200). The overall full-time enrollment for the same institutions was 7,507 (range: 200-50,000). Dividing the number of students with disabilities by the overall enrollment yields 2.17%. American studies using similar methodologies also yield comparable percentages. For example, Lance's (1996) study of 87 campus based disability service providers showed a value of 2.15% (students with disabilities: M = 287, range: 10-2,100; overall enrollment M = 13,361, range: 100-60,000). Similarly, a very recent investigation by Jackson et al. (2001) showed a value of 2.67% (students with disabilities: M=276, overall enrollment M = 10,329).

Our findings, as well as those of Canadians Killean & Hubka (1999), closely resemble those reported in the American Lance (1996) and Jackson et al. (2001) studies. Thus, the proportion of students with disabilities in American and Canadian postsecondary institutions appear to be similar. As noted earlier, large scale epidemiological self-report surveys show that the percentage of students with disabilities in American postsecondary institutions varies somewhere between 5% and 11%. Individuals who provide disability related services to students with disabilities report only 2% to 3%. Therefore, it seems safe to say that between 1/2 and 3/4 of students with disabilities do not register with their Office for Students with Disabilities either in Canada or the United States.

Equipment for Students with Disabilities

Adaptations. Almost half of the students indicated they needed some type of adaptation to use a computer effectively, making it important to find out what computer and adaptive computer technologies students with different disabilities use and need. Common problems

involved reading information on the monitor, manipulating the mouse, using the keyboard, handling diskettes, and using the printer. Both service providers and students provided listings of the types and brand names of equipment used by students with specific disabilities. This is presented in a companion article (Fichten, Asuncion, Barile, Fossey, Robillard, & Wolforth, 2001). What is also interesting is indications from service providers that the adapted computer equipment available in specialized labs can be used to accommodate some of the learning needs of nondisabled students, including foreign students who do not speak English well.

The most popular computer technologies used by students were sophisticated features already available in popular software or general use equipment. For example, the most valued technology was spelling and grammar checking, followed by a scanner and a portable note taking device. Dictation software (voice recognition) and the availability of materials in electronic format (e.g., textbooks, course hand-outs) were also seen as especially useful. Much of this is likely to be useful for all students. For students with disabilities, however, such technologies are a necessity. Best stated by IBM's Mary Pat Radabaught, "For people without disabilities, technology makes things easier. For persons with disabilities, technology makes things possible" (cited by Seelman, 1999).

Given the large numbers of students needing adaptations, it was not surprising to find that most institutions had some specialized computer equipment (all universities and about 90% of junior/community colleges - in general smaller institutions, junior/community colleges in particular, were less likely to have equipment). This is markedly different from American data collected in the late 1980s and early 1990s which showed that only 60% to 70% of institutions provided computer equipment for their students with disabilities (Burgstahler, 1992, 1993; Horn & Shell, 1990). Nevertheless, most service providers in our sample indicated serious problems with funding for computer, information and adaptive technologies.

As was the case in the United States at the beginning of the 1990s (Burgstahler, 1992, 1993), most acquisition decisions were made by the personnel responsible for providing services to students with disabilities after informal consultation with staff and students. Nevertheless, the data also show a trend toward multidisciplinary and multisectorial decision making.

There was an even split among institutions that keep their adaptive technology in one central location and those that decentralise their equipment. As has been reported by others (Burris, 1998; Killean & Hubka, 1999) many institutions in our sample too were moving toward a "dual" model, with adaptive computer equipment being available both in general use as well as in specialized facilities. About half of all institutions had an equipment loan program and the vast majority of institutions made equipment available during evenings and weekends. This proportion is similar to Killean and Hubka's (1999) findings and substantially higher than numbers reported in the early 1990s (Burgstahler, 1992, 1993; Lance, 1996). Although Internet access is rapidly becoming a key component in the delivery of postsecondary education, only half of the institutions studied had adapted computer workstations with Internet connectivity. This is an area which needs urgent attention.

Students' Experiences

The overwhelming majority of respondents in all three studies indicated that they used a computer, mainly IBM compatibles, both at home and at school. Only about 1/3 of students used computers during class lectures to take notes. There were very few differences between females and males, younger and older students, and junior/community college and university students on any aspects of computer use or attitudes.

Students indicated spending approximately 13 hours a week using a computer and 7 additional hours using the Internet, with somewhat more students accessing the Internet from school than home. Similar to findings on American nondisabled students (CIRP Press Release, 1999), the main uses of the Internet were research, e-mail, accessing library materials, and entertainment.

When computer users who do not use the Internet were asked why, their responses indicate that using the Internet ties up the phone line, that they had no access to a computer that is equipped to go on line, and that it costs too much. Cost has also been found in other investigations of non-student computer users with disabilities as a major barrier to persons with disabilities (Sinks, 1998).

Funding equipment for home use. Most students in all three studies indicated that paying for their computer technologies was problematic. Yet, by far the most common way for students to obtain computer technologies was to buy it for themselves or to have their families buy it for them. Governments were also a likely source and many students borrowed equipment from family or friends. Somewhat less than half of the students in Study 3 who used a computer at home took advantage of a government program to obtain at least some of their technologies. In general, students were pleased with equipment obtained this way although students also felt that: there were many restrictive regulations, waiting periods were long, the process for applying was complicated, and they did not receive good training on the technology.

The majority of students did not avail themselves of a program to obtain a computer or adaptive computer technologies, mainly because they were unaware that there were any programs out there that could help them. Students who chose not to apply, even though they knew about the availability of government programs, indicated that there were too many restrictions or that their family income or the nature of their disability excluded them from existing initiatives. Service providers in Study 1 echoed this concern.

Similarities and Differences Between Student and Service Provider Views

While there were many similarities between the views of students and service providers, there were also important differences. Our results are consistent with those of others who have noted significant discrepancies between postsecondary students' and rehabilitation professionals' views about the suitability of adaptive technologies (e.g., Goodman, 2000).The findings on personnel responsible for providing services to students with disabilities indicate that they have needs and concerns that are often different from those of the students. Because of the nature of their tasks, issues that affect them frequently relate to institutional concerns, budgets, relations with other sectors and departments, etc. It is clear that more focused investigation comparing students' and disability service providers' views and experiences with computer and adaptive technologies is called for.

Advantages and disadvantages. Both students and service providers noted substantially more advantages of computer and adaptive computer technologies than disadvantages. This is consistent with findings reported by many others (e.g., Coomber, 1996; Killean & Hubka, 1999; Lance, 1996; NCSPES, 2000). There was good agreement between the two groups on many of these. Key commonalties, agreed upon by participants in all three studies were problems with cost, upgrades, and the need for training and/or retraining. These findings are similar to other investigations of learners with disabilities (e.g., Jackson et al., 2001; Killean & Hubka, 1999; Lee, 1999) as well as with economic realities of persons with disabilities (Fawcett, 1996; Harris Interactive Inc., 2000). Students in Study 2 also indicated that computers often failed to

adequately meet their disability related needs, a finding which echoes results obtained by Roessler and Kirk (1998) for students who attended university in the early and mid 1990s. For example, dictation programs need clear speech and high end computers, programs which use graphics are difficult for students who are blind, grammar checkers for students with learning disabilities do not work well.

Yet, differences between student and service provider perspectives were also apparent. For example, students noted that computers allowed them to work at their own pace, a factor especially important to students with fatigue concerns. They also mentioned that the Internet was cheaper than long distance telephone calls. Similarly, personnel responsible for providing services to students with disabilities mentioned advantages that students did not indicate. They noted that computer technologies were cost-effective, as these allowed them to free up human resources. They also indicated that computers level the playing field by allowing students to perform at their full potential, and that computers allow students to take their own notes in class, rather than having to rely on others or audiotaping. On the other hand, service providers also mentioned some disadvantages that students failed to indicate. They noted that computer technologies interfere with social activities and that they provide a false sense that the computer will solve all problems. They also mentioned lack of adequate on-campus training and tech support as disadvantages and expressed the concern that students can become reliant on using equipment on campus that is unavailable elsewhere. Findings related to differences between student and service provider views underscore the importance of student participation in the acquisition of equipment for campus use.

Learning to use computers. Both students and service providers were primarily self taught and obtained much of their information from the Internet and word of mouth. Students also learned about computers in mainstream courses. Those who used adaptive equipment also learned from an adaptive technology trainer. Service providers, too learned from an adaptive technology trainer as well as from the students themselves. Nevertheless, consistent with findings reported by others (e.g., Coomber, 1996; Lance, 1996), participants did not feel that they were well informed about what computer technologies could be beneficial.

Why computers are not used. Almost all service providers in Study 2 indicated that there were students on their campuses who could have benefited from technologies but who were not using these. The most popular reason cited was students' discomfort with computers. This is markedly different from reasons provided by the 33 Study 3 student participants who did not use computers. Their answers reflected not computer anxiety or difficulties with learning. Instead, students indicated that: computers cost too much, were unavailable to them, were too expensive to maintain, and it was impossible for them to get computer technologies through a subsidy program.

Wish lists. Here the two groups' perspectives were quite similar. Both students and service providers generally wanted laptops, and more, better, and more up-to-date specialized hardware and software. Both groups also wanted user friendly voice software to control the computer and to do dictation; service providers addend a "multi-user" caveat to this. Both groups also wanted accessible library catalogues and more adapted computer work stations in the library, preferably with printing capability. Service providers, who also wanted students to be able to work autonomously in the library, indicated that adapted computer workstations located in libraries had serious limitations. A related issue noted by substantial numbers of service providers was the need for decentralized adaptive equipment.

Students who did not have home computers or Internet or who did not have adaptations at home wanted these. That such a wish is highly relevant for students with disabilities is illustrated by Lee's (1999) findings which show that lack of availability of home computers to participants contributed to poor outcomes in an experimental education, career, and information technology training program for adults with disabilities.

Trends in how Computer Technologies are Used by Students with Disabilities

Cross-use of equipment. Our findings revealed three important trends: (1) shared use of the same adaptations by students with different disabilities, (2) the need for adapted work stations which can accommodate the needs of the large number of students who have two or more impairments, and (3) "general use" computer technologies as disability accommodations. Multiple uses of adaptive technologies seems to be an important development, and the increasing number of accessibility features built into widely available general use products are of considerable interest to students with disabilities. Nevertheless, recent developments in sophisticated adaptive technologies have underscored the increasing importance of ensuring that different types of adaptive equipment be able to work together. In particular, the video card requirements of magnification software, the heavy hardware and training demands of voice recognition programs, and compatibility problems between voice technologies (i.e., dictation/voice recognition and screen reading software) should be taken into consideration.

Universal Design. Designing for accessibility from the outset always results in better, less expensive, and more timely solutions than retrofits (e.g., Coombs, 1998; Ekberg, 1999; Falta, 1992; Jacobs, 1999; Node Networking, 1998). For instance, implementing accessibility features in the initial layout of a building results in fewer design, construction and legal expenses (Falta, 1992). An important element in ensuring universal accessibility is the need to consult with progressive and sophisticated consumer groups. These individuals' diverse backgrounds make them uniquely qualified to think of creative solutions to environmental barriers created by lack of access. A good description of the application of Universal Design principles to computer technologies can be found in Connell, Jones, Mace, Mueller, Mullick, Ostroff, Sanford, Steinfeld, Story, and Vanderheiden (1997).

Conclusions and Implications

In this investigation we deliberately used several different methods to obtain data: focus groups, structured interviews, and broadly distributed questionnaires. We took precautions to ensure that students with all types of disabilities had the opportunity to participate. The number of participants is large: more than 800 individuals in the three studies reported. This is unprecedented in research on computer needs and concerns of postsecondary students with disabilities. All regions of Canada and both the junior/community college and university sectors are represented along with distance education. The data gathering and evaluation of the proportion of students with disabilities involved more than 150 different postsecondary educational institutions. The student samples are diverse in a variety of ways: age, academic program, disabilities, and computer experiences.

Nevertheless, the samples are neither random nor, we believe, fully representative of the populations studied. Given self-selection biases, we expect that the proportion of computer user students as well as of individuals who are in contact with their institutions' offices for students with disabilities are over-represented in all three studies. In addition, when it comes to the large

numbers of students in Study 3, it should be emphasized that we mailed questionnaires to the memberships of two large consumer-based groups of students with disabilities. Yet, most students with disabilities do not belong to such organizations. Perhaps even more troubling, we are unable to calculate a "return rate" because of the manner in which questionnaires in Study 3 were made available to students.

Yet, those indices which are available suggest that the samples in our studies have characteristics which resemble the realities of postsecondary students with disabilities. The age range of students is normative for studies of students with disabilities/impairments (e.g., Amsel, & Fichten, 1990; Fichten, et al., 1991; Henderson, 1999; Hill, 1992, 1996; Horn & Berktold, 1999; Killean & Hubka, 1999). The sample contains more female than male students; this is characteristic of postsecondary students in Canadian institutions (Statistics Canada, 1999). The majority of students use IBM compatible computers. Again, this, is typical of postsecondary students. Even the proportion of arts and science students as well as the high proportion of students with learning disabilities are similar to other studies (Jackson et al., 2001; Horn & Berktold, 1999; Roessler & Kirk, 1998; Scott, 1997). Where findings are comparable, our results are similar to those reported in smaller samples (Coomber, 1996, Roessler & Kirk, 1998).

In spite of the limitations, the nature and implications of our findings are clear and unambiguous. Students with disabilities can and do use the Internet and computer and adaptive computer technologies in the context of their postsecondary education. Also, computer technologies are changing the role of professionals working in academic institutions. Computers are best seen as enabling technologies - "electronic curb-cuts" - that allow students with disabilities to prepare for and to participate in the new economy of tomorrow.

Our findings show that the potential of computer and adaptive computer technologies to remove barriers for students with disabilities is enormous. Nonetheless, electronic environmental barriers are continually being created. It is imperative that solutions are identified and implemented while the technologies and infrastructures in postsecondary educational institutions are still in a developing stage. The data presented here show several important differences between the views of students and postsecondary disability service providers. We suspect that these pale in comparison to differences between individuals concerned with accessibility and the professionals, administrators and technicians who make decisions and policies about new campus wide computer systems and networks. To ensure accessibility, we recommend that the broadest based consultations take place at colleges, universities and organizations and agencies which provide equipment and training for students with disabilities. Such consultations must involve members of several stakeholder groups: students, personnel responsible for providing services to students with disabilities, professors, academic computer staff, adaptive technology and computer specialists, librarians, audio-visual specialists, rehabilitation professionals, college and university administrators, and representatives of various government agencies.

Postsecondary education is the key for training a labour force ready to meet the challenges of the new economy. Computer-based knowledge will soon be a necessity to secure employment. Yet, results of all three studies converge on one point: concern over inadequate funding for computer, and adaptive technologies, both for the students themselves and for the institution. The argument that, "granting equality to the disabled population group is not justifiable because of the cost… or because of the inconvenience to mainstream society" (Nagler, 1993, p. 33) is often made in this context. We contend that this type of short-sighted argumentation needs to be rebutted wherever it surfaces. Students with disabilities who receive adequate services have been shown to persist in their studies and to graduate at the same rates as

their nondisabled peers (Miller, 2001). University and college graduates with and without disabilities have better employment outcomes than people without postsecondary education (Horn & Berktold, 1999; Government of Canada, 1996). A small investment of time and money today will pay handsome dividends in the long run.

References

Amsel, R., & Fichten, C.S. (1990). Interaction between disabled and nondisabled college students and their professors: A comparison. *Journal of Postsecondary Education and Disability, 8*(1), 125-140. Abstracted in *Higher Education Abstracts*, 1990, *26*,(1), 45.

Atanasoff, L.M., McNaughton, D., Wolfe, P.S., & Light, J. (1998). Communication demands of university settings for students using augmentative and alternative communication (AAC). *Journal of Postsecondary Education and Disability, 13*(3), 32-47.

AQEHPS (Association Québécoise des Étudiants Handicapés au Postsecondaire). (1999, January). *Les étudiants ayant des incapacités, un regard statistique*. Montreal, Quebec: Author.

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.

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

CADSPPE/ACCSEHP. (1999). *Towards developing professional standards of service: A report on support for students with disabilities in postsecondary education in Canada*. Retrieved October 9, 1999 from http://www.cadsppe.cacuss.ca/english/CADSPPE-Standards/CADSPPE-Standards.html

Campbell, B. (1999, March). *Diffusion of computer technologies into university teaching*: Professional practices. Presentation at Concordia University's Educational Technology Department, Montréal.

CIRP Press Release (1999, January). *Most of the nation's college freshmen embrace the Internet as an educational tool, UCLA study finds*. Retrieved March 13, 1999 from http://www.gseis.ucla.edu/heri/press98.html.

Clark, J. (1999). *Internet utilization by persons with disabilities*. Presentation at the annual conference of CSUN (California State University, Northridge): Technology and persons with disabilities - Where assistive technology meets the information age. Los Angeles.

Connell B. R., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M., & Vanderheiden, G. (1997). *The principles of Universal Design* (Version 2.0 - 4/1/97). Retrieved April 13, 2001 from http://www.design.ncsu.edu:8120/cud/univ_design/principles/udprinciples.htm

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.

Coombs, N. (1998, Feb.). *The underprivileged and universal access to distance learning: Disabilities and beyond*. Presentation at the 1998 EvNet Conference, Montréal, Québec. Retrieved May 20, 1999 from http://socserv2.mcmaster.ca/srnet/confabstracts/coombsab.htm

Cooperman, K. (1999, January). *Most of the nation's college freshmen embrace the Internet as an educational tool, UCLA study finds*. Retrieved August 25, 1999 from Web: http://www.uclanews.ucla.edu/docs/KC010.html

Disabled students in postsecondary education. (1997). *Digest of Education Statistics*, Table 211.

Ekberg, J. (1999). *A step forward: Design for all*. Helsinki, Finland: Include. Available from the author at STAKES, PO Box 220, SF-00531, Helsinki, Finland.

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

EvNet (2000). *EvNet Evaluation Toolkit*. Retrieved April 13, 2001 from http://socserv2.mcmaster.ca/srnet/tools/tktoc.htm

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

Fawcett, G. (1996). *Living with disability in Canada: An economic portrait*. Hull, Quebec: Human Resources Development Canada, Office for Disability Issues.

Fichten, C.S., Asuncion, J.V., & Barile, M. (2001a). *Computer and information technologies: Resources for the postsecondary education of students with disabilities. Final report to the Office of Learning Technologies*. Hull, Quebec: Office of Learning Technologies. Available: http://omega.dawsoncollege.qc.ca/adaptech/pubs/olt01doc.exe

Fichten, C.S., Asuncion, J., Barile, M., Fossey, M.E., Robillard, C., & Wolforth, J. (2001b). Computer technologies for postsecondary students with disabilities II: Resources and recommendations for postsecondary service providers. *Journal of Postsecondary Education and Disability, 15(1)*, 59-83.

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

Fichten, C.S., Asuncion, J., Fossey, M., Robillard, C., Barile, M., Judd, D., Généreux, C., Guimont, J.P., Senécal, J., Wolforth, J., Juhel, J.C., & Lamb, D. (2001d, July*). "Accessibility of Campus Computers: Disability Services Scale" (ACCdss): Adaptech's Canadian self-evaluation tool.* Presentation at the Annual AHEAD (Association on Higher Education And Disability) Conference, Portland, Oregon.

Fichten, C.S., Barile, M., & Asuncion, J.V. (1999a). *Learning technologies: Students with disabilities in postsecondary education / Projet Adaptech : L'Utilisation des technologies d'apprentissage par les étudiant(e)s handicapé(e)s au niveau postsecondaire*. Final report to the Office of Learning Technologies, 1999, Spring. Ottawa: Human Resources Development Canada. Eric Document Reproduction Service (ED 433625 EC 37369).

Fichten, C.S., Barile, M., & Asuncion, J.V. (1999b). *Learning technologies: Students with disabilities in postsecondary education – Final report to the Office of Learning Technologies*. Ottawa: Human Resources Development Canada. Retrieved September 23, 1999 from http://omega.dawsoncollege.qc.ca/pubs/olt99app.pdf

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), July, 2000. Québec: Ministère de l'Éducation. Available at: http://www.omega.dawsoncollege.qc.ca/cfichten/itacallpdf.exe

Fichten, C.S., Robillard, K., Tagalakis, V., & Amsel, R. (1991). Casual interaction between college students with various disabilities and their nondisabled peers: The internal dialogue. *Rehabilitation Psychology, 36*(1), 3-20.

Gladieux, L.E., & Swail, W.S. (1999, April). *Policy perspectives: The virtual university and educational opportunity - Issues of equity and access for the next generation*. [booklet]. The Washington Office of the College Board. Available address: 1233 20th St. NW, Suite 600, Washington, DC 20036-2304. Retrieved August 17, 2001 from http://www.collegeboard.org/policy/html/April.pdf

Gold, J. A. (1997, November). Does CMC present individuals with disabilities opportunities or barriers? *CMC Magazine*. Retrieved August 17, 2001 from http://www.december.com/cmc/mag/1997/jan/gold.html.

Goodman, G. (2000). Factors that influence post-secondary students with disabilities to adopt or reject assistive technology for computer access. *Proceedings of the CSUN 2000 Conference*. Retrieved August 17, 2001 http://www.csun.edu/cod/conf2000/proceedings/0015Goodman.html Available: Cleveland State University HS 119, 2501 Euclid Ave., Cleveland Ohio 44115.

Government of Canada. (1996, October). *Equal citizenship for Canadians with disabilities: The will to act: Federal Task Force on disability issues*. Ottawa: Minister of Public Works and Government Services, Canada.

Greene B. & Zimbler, L. (1989). *Profile of handicapped students in postsecondary education, 1986: National postsecondary aid study survey report*. Washington: Superintendent of documents, Us Government Printing office, Washington DC 20402.

Harris Interactive Inc., (2000). *2000 N.O.D./Harris survey of Americans with disabilities*. N.Y.: Harris Interactive.

Henderson, C. (1995). *College freshmen with disabilities: A triennial statistical profile, 1995*. Washington DC: HEATH Resource Center.

Henderson, C. (1999). *College freshmen with disabilities: A biennial statistical profile (Statistical Year 1998)*. Washington DC: HEATH Resource Center. Retrieved April 13, 2001 from http://www.acenet.edu/bookstore/pdf/CollegeFresh.pdf

Hill, J.L. (1992). Accessibility: Students with disabilities in universities in Canada. *Canadian Journal of Higher Education*, *22*(1), 48-83.

Hill, J.L. (1996, Summer). Speaking out: Perceptions of students with disabilities regarding adequacy of services and willingness of faculty to make accommodations. *Journal of Postsecondary Education and Disability*, *12*(1), 22-43.

Hopps, S. & Pepin, M. (1999). Self-reported impact of the Internet on people with physical disabilities. Presentation at the American Psychological Association annual Convention, August, Boston. Abstracted in *Rehabilitation Psychology*, 1999, *44*(3), 304.

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.

Horn, L. & Berktold, J. (1999). *Students with disabilities in postsecondary education: a profile of preparation, participation and outcomes*. (NCES 1999-187). Washington, DC: U.S. Department of Education - National Center for Education Statistics.

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.

Jacobs, S. (1999). Section 255: Fueling the creation of new electronic curbcuts. *TIA (Telecommunications Industry Association) Access*, 07/16/99. Retrieved April 13, 2001 from http://www.tiaonline.org/access/news.cfm?ID=37

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.

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.

Lee, L. (1999). *On line, in business, at home: Final report to the Office of Learning Technologies* Ottawa: Human Resources Development Canada. Retrieved August 17, 2001 from http://olt-bta.hrdc-drhc.gc.ca/publicat/69029exesum_e.html

Lewis, L., Farris, E., & Greene, B. (1999, August). *An institutional perspective on students with disabilities in postsecondary education. National Center for Education Statistics: Statistical Analysis Report*. Retrieved August 17, 2001 from http://nces.ed.gov/pubs99/1999046.pdf U.S. Department of Education. Office of Educational Research and Improvement. NCES 1999-046.

Miller, E.F. (2001, July). *Supporting students with disabilities to achieve success in higher education.* Presentation at the Annual AHEAD (Association on Higher Education And Disability) Conference, Portland, Oregon.

Morgan, D.L. (1988). *Focus groups as a qualitative method*. (pp. 15-39) London: Sage Publications.

Nagler, M. (1993). The disabled: The acquisition of power. In M. Nagler (Ed.), *Perspectives on disability* (2nd. Edition) (pp. 33-36). Palo Alto, CA: Health Markets Research.

NCSPES (National Center For The Study Of Postsecondary Educational Supports). (2000). *Postsecondary education and employment for students with disabilities: Focus group discussions on supports and barriers in lifelong learning*. Hawaii: University of Hawai'i.

Node Networking. (1998, August). *Universal Design for the information highway*. Retrieved August 17, 2001 from http://node.on.ca/networking/august1998/feature1.html

Roessler, R.T. & Kirk, H.M. (1998). Improving technology training services in postsecondary education: Perspectives of recent college graduates with disabilities. *Journal of Postsecondary Education and Disability*, *13*(3), 48-59.

Scott, S. (1997). Accommodating college students with learning disabilities: How much is enough? *Innovative Higher Education, 22* (22). Retrieved August 17, 2001 from http://www.coe.uga.edu/ldcenter/r_accommodations.html

Seelman, K.D. (1999). *Persons with disabilities in science, engineering, and technology. A white paper prepared for the Commission on Advancement of Woman and Minorities in Science,*

Engineering, and Technology Development. Washington, D.C.: National Institute on Disability and Rehabilitation Research (NIDRR), U.S. Department of Education.

Sinks, S. (1998, March). *Adults with disabilities*: Perceived barriers that prevent Internet access. Available August 17, 2001 from http://www.dinf.org/csun_98/csun98_152.htm

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

Taillon, J. & Paju, M. (2000). *The class of '95: Report of the 1997 national survey of 1995 graduates*. Human Resources Development Canada. Hull, Quebec. Catalogue No. SP-137-04-99. [Internet]. Retrieved August 17, 2001 from http://www.hrdc-drhc.gc.ca/stratpol/arb/publications/books/class95/class95.pdf

Web-Based Education Commission (2001). *The power of the Internet for learning: Moving from promise to practice - Report of the web-based education commission to the president and the congress of the United States*. Washington, D.C.: Web-Based Education Commission.

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