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Dialoguing with developers and suppliers of adaptive computer technologies: Data and recommendations

Jennison V. Asuncion, Catherine S. Fichten*, Myrtis E. Fossey, Maria Barile

Dawson College, 3040 Sherbrooke St. West, Montreal, Quebec H3Z 1A4, Canada

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Abstract. The authors report on findings on computer technology needs and concerns of 725 Canadian college and university students with a wide range of disabilities. The vast majority of this sample population uses computers and almost half need an adaptation to use computers effectively. The authors provide information about computer technologies used by students with different disabilities, describe adaptations/adaptive computer technologies that students find useful, report issues faced by users and non-users of computers in postsecondary education, and discuss reasons why students are not using needed adaptations/adaptive technology. Based on these findings, the authors provide recommendations for adaptive computer hardware and software developers and vendors.

Keywords: Postsecondary students with disabilities – Computers – Adaptive technologies – College – University

1 Introduction

The authors address the findings of a large scale Canadian study concerning how computers and adaptive computer technologies are used by postsecondary students with disabilities. The authors conclude with recommendations for the adaptive technology industry that are based on the results of the study. The underlying goal is to initiate a meaningful dialogue between the students as consumers on the one hand, and the broad spectrum of individuals in the adaptive computer industry on the other hand. This spectrum includes designers, developers, and suppliers of computer hardware and software. Both students and those in the adaptive computer industry have a vested interest in ensuring the successful development and marketing of quality computer products. In recent research work (Fichten et al. 2000), students indicated how vital computer, information and adaptive computer technologies are. As consumers, students have much to say about what types of approaches and initiatives would be helpful. There is much to be learned from these end users who are at the leading edge of a forthcoming successful college educated community of consumers with disabilities. The authors share the students' views and make recommendations to industry that are likely to be useful and profitable for both sides.

The technological revolution in postsecondary education in North America is still in its early stages of development (cf. The 1998 National Survey of Information Technology in Higher Education 1998). Nevertheless, the shift from traditional classroom teaching to education that features the use of instructional technologies (e.g., virtual classrooms, online learning) is very noticeable on North American campuses (Campus Computing Project 2000; Farrell 1999; UCLA Graduate School of Education and Information Studies 1999; Web-Based Education Commission 2001).

A key reason for exposing postsecondary students to technology today is to ensure that they will be comfortable learning and using information technology (IT) once they graduate and join the workforce in the new knowledge-based economy. Therefore, it is vital for those who develop, manufacture, and distribute adaptive computer technologies for persons with disabilities to be aware of the following: (1) the trend of instructional technology integration taking place in higher education; (2) the needs and concerns of the growing group of students with disabilities in postsecondary educa-

* *Correspondence to:* C.S. Fichten
(E-mail: catherine.fichten@mcgill.ca)

tion who depend on access to computer technologies to pursue their studies; and (3) problems and solutions related to ensuring that adaptive technologies work seamlessly with the newly emerging instructional technologies. The consequences of failing to meet these three conditions are clear: students with disabilities in postsecondary education will be excluded from acquiring the necessary computer literacy skills to participate in the new knowledge based economy. The adaptive computer industry is a vital partner in ensuring that new policies, software, and hardware reflect the needs and concerns of postsecondary students with disabilities, their professors, and the college and university personnel responsible for providing disability-related services on campus.

2 Postsecondary education and students with disabilities

The 1980s and 1990s have seen an increase in the recognition of the need to grant disability-related accommodations in postsecondary education (Fichten et al. 1987; Hill 1992, 1996; Leblanc 1999; Roessler and Kirk 1998). At the same time, the number of students with disabilities studying at this level in North America has dramatically increased (Henderson 1992, 1999; Horn and Berktold, 1999; Louis Harris and Associates 1994; Wolforth 1995). Estimates of the number of North American postsecondary students with some disability have ranged from 5% to 11% (CADSPPE 1999; Henderson 1995, 1999; Horn and Berktold 1999; Greene and Zimbler 1989; Disabled Students in Postsecondary Education 1997). In the United States, a poll in 1999 by Louis Harris and Associates (cited by the National Organization on Disability 1999) indicated that "by 1998 more than half of adults with disabilities (51%) had completed some college – a proportion almost identical to that for the non-disabled population."

What does this growing segment mean to the adaptive computer industry in the short and long term? In the short term, it means that there is a critical need for computer and adaptive technologies for these students. Moreover, these technologies must be able to interface with the evolving IT infrastructure and newly emerging instructional technologies increasingly used in North American postsecondary education. In the long term, it means that an educated and technologically sophisticated market of consumers who have disabilities will emerge and will be accustomed to making decisions and purchases for themselves based on their experience with different brands and technologies (cf. Fichten 1995). Moreover, this segment means increased demand for adaptive computer technologies and increased integration of these products in the workplace. As in the case of postsecondary education, there will be greater need for compatibility between adaptive and general use computer technologies.

3 Universal access

The characteristics of some general use and instructional computer applications prevent independent access by people with various disabilities (cf. Waddell 1999). For example, some educational CD-ROMs have small print or very light backgrounds that cannot be changed. Those who have trouble using their hands or arms may encounter difficulties using programs that require a lot of mouse movement or diskette manipulation. Most online audio and video clips do not have closed captioning for individuals with hearing impairments. Some people have difficulties accessing Internet web sites because of locked screen sizes and colors (e.g., Schoffro 1996). Others, most notably people who are blind, have difficulties with some designs because many web sites that are rich in graphics lack descriptive tags for text-based browsers and screen readers (Vanderheiden et al. 1996).

The next decade will be marked by increased use of computer technologies. In the case of people with disabilities, these may involve new products or familiar products used in new ways. For example, videos and CD-ROMs are well-known methods that, for a long time, rendered computer-based instruction inaccessible to students with hearing impairments. Today, both of these teaching techniques can be made accessible in two ways. First, there has been an increased use of closed and open captioning (these are similar to subtitles – see Encarta 98 for an example of a CD-ROM with captions). Second, companies that produce assistive technologies, such as hearing aids and FM systems, are now including components that facilitate access to computer generated sound via computer output compatible FM systems (e.g., Phonak 2000). Companies such as Microsoft, Apple, and IBM have built in adaptations for people with disabilities in their mainstream products. These companies have also made substantial investments in designing accessible software and hardware for people with disabilities (e.g., Adobe 2001; Apple 2001; IBM 2001; Microsoft 2001).

Increasingly, specialized adaptive products are taking advantage of new developments in the industry. This makes them less expensive and more compatible with mainstream software and hardware. For example, the latest versions of popular screen reading software use sound cards and speakers bundled with computers (e.g., Freedom Scientific, Inc. 2001). This makes expensive external speech synthesizers unnecessary in many cases. Similar advances are occurring with respect to other computer technologies that benefit people with other types of disabilities. This is true both for hardware and software. In addition, a variety of less sophisticated, free, and inexpensive programs of interest to students with disabilities have become available (e.g., Fichten et al. 1999).

With all these developments in mind, the question remains of whether the adaptive computer technology industry can develop products to address the changes

outlined above in the technology-driven delivery of postsecondary education and employment, and whether the industry can make those products accessible to the average consumer with a disability.

4 Present research

The goal of this research was to explore how computer and adaptive computer technologies are used in postsecondary education in Canada. As a result, a pioneering empirical national investigation was undertaken into whether students are using computer and adaptive technologies. This study aimed to answer questions such as which adaptive technologies are used, how they are acquired, which specific technologies are found beneficial for different disabilities/impairments, how satisfied users are, and, in case they are not satisfied, what the reasons are. Finally, the study aimed to draw conclusions about what software and hardware developers, manufacturers, and distributors could do to ensure the success and the accessibility of their products. Note that the term adaptive computer technologies refers, in the context of this paper, to items such as software that reads what is on the screen, magnification software, and adapted mice. Adaptive computer technologies will also be referred to as adaptations.

College and university students with disabilities who participated in the study had the following disabilities: physical, sensory, motor, psychological/psychiatric, medical, learning, or other self-identified disabilities/impairments. In addressing learning disabilities, the definition of the Learning Disabilities Association of Canada (1996) was adopted. This definition refers to difficulties in attention, memory, reasoning, co-ordination, communicating, reading, writing, spelling, calculation, social competence, or emotional maturation which can affect learning and behavior in any individual, including those with average or above average intelligence.

5 Method

5.1 Overview

The goal of this study was to obtain information about computer technologies from a large and diverse sample of postsecondary students. To accomplish this, the authors distributed questionnaires to Canadian postsecondary institutions in four ways: through campus-based personnel responsible for providing services to students with disabilities, mailed distribution by our student partner organizations: NEADS (National Educational Association of Disabled Students) and AQEIPS (Association québécoise des étudiants ayant des incapacités au postsecondaire), personal contacts, and, in a very limited way, e-mail. The final sample consisted of 725 students with various disabilities, from all Canadian provinces and territories. Additional methodological details are available in Fichten et al. (1999a, b).

5.2 Procedure

Questionnaires were distributed in the spring of 1999 to 204 college and university personnel who are responsible for providing services to students with disabilities and who had agreed to make these questionnaires available to students at their institution. Bulk mail was the primary method of distribution.

Research team members had phoned the 268 individuals responsible for providing services to students with disabilities at institutions that had 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 Community Colleges of Canada) or the Québec based Fédération des Cégeps. These listings include distance education institutions.

Once someone was reached, a brief explanation was given of the project goals. They were then asked if they would be willing to assist in distributing the questionnaires to students with disabilities attending their respective institutions. It was explained that the research concerned both users and non-users of computers, that there was interest in hearing from the largest cross-section of students with disabilities, and that the questionnaires were available in a variety of alternative formats. Of the 268 institutions contacted, 25 indicated that they had no students with disabilities (9%), two declined to participate (1%), and 37 were left telephone messages but failed to return calls (14%). The remaining 204 agreed to participate. Thus, of the 243 institutions that had indicated that they had students with disabilities, 204 (84%) agreed to participate by distributing the questionnaires.

Personnel responsible for providing services to students with disabilities who agreed to make questionnaires available at their institutions were asked how many of them in each of the alternative 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 (see Fichten et al. 1999b). All non-print versions distributed were packaged together with a regular print version of the questionnaire (see Appendix).

Once the packages reached the institutions, it was left to the discretion of service providers to decide 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, if possible, to both computer users and non-users. Although there was great diversity in the methods of distribution, for the most part, questionnaires were made available in a manner similar to the way in which "free" advertiser-supported publications in North America 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.

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 an e-mail version of the questionnaire was also prepared. 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. This makes it impossible to calculate a "return rate."

5.3 Questionnaires

Questionnaire items were based on findings from two smaller scale studies. One involved a series of focus groups. The other involved structured interviews with 37 college and university students with disabilities and with 30 personnel responsible for providing services to students with disabilities (Fichten et al. 1999a, Studies 1 and 2). Questionnaires went through multiple drafts; two previous versions were examined by the Adaptech Project Advisory Board and by members of the Adaptech online electronic community. These two versions were also pretested by 35 students with various disabilities before the third and final version was completed. Pretesting included the various adapted versions of the questionnaire in English and French. Students had the option of responding in the modality of their choice.

The questionnaires contained 29 groups of questions. Most of the questions were closed-ended and used a 6-point Likert scale with 1 indicating strongly disagree and 6 indicating strongly agree (see the Appendix). These were made available in various alternative formats in French and English (i.e., regular print, large print, audiotape, Braille, diskette – alternative formats 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, 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, problems caused by computer technologies, and recommendations to adaptive computer hardware and software companies. Once completed questionnaires were received, open-ended responses (e.g., name of adaptive equipment used, program of study) were quantified using predetermined categories.

5.4 Participants

Responses from 736 current or recent students with disabilities were received. The authors excluded 11 questionnaires because the respondents had not been students during the past 2 years. The final sample consisted of 725 students (425 females and 300 males), representing more than 150 colleges and universities in all of the Canadian provinces and territories.

They were currently enrolled as college ($n = 335$) and university ($n = 294$) students. This included 11 subjects who were attending distance education institutions. Twenty-nine participants were not currently pursuing a postsecondary education, but they were included because they had been students during the past 2 years.

The mean age of the students was 30 (standard deviation $= 10$, range $= 17 - 75$). The distribution was skewed in favor of younger students. Students had a variety of self-reported impairments/disabilities. The classificatory system used in the questionnaire is the one used in much of the postsecondary students with disabilities literature (e.g., Hill 1992, 1996; Henderson 1999; Horn and Berktold 1999; Hubka and Killean 1999). Here, the focus is generally not on diagnosis but on the functional abilities and limitations of the student in accomplishing tasks needed for academic work.

Consistent with the North American trend (e.g., Roessler and Kirk 1998; Scott 1997), the largest group of students (37%) self-identified as having a learning disability. This includes attention deficit disorder. Of the sample, 27% had a mobility impairment, 24% had a visual impairment, 22% had problems using their hands or arms, 15% had a medical impairment (such as arthritis, cancer, epilepsy), 15% had a hearing impairment, 12% had a psychological/psychiatric impairment, and 8% had a speech/communication impairment. Almost half of the sample had more than one impairment. In these cases, the mean number of impairments was 1.74 per student. The majority of students were enrolled in arts programs (67%). Less than a third (29%) were enrolled in science and technology programs. The programs of the remaining students could not be classified.

Limitations of the investigation. Before presenting the results, the limitations of the adopted methodology should be noted. First, the sample was neither random nor fully representative of the populations studied. Given self-selection biases, the proportion of computer users,

those who are in contact with their institution's office for students with disabilities, and those who belong to associations of students with disabilities are over-represented. Perhaps even more troubling is the fact that it is impossible to calculate a "return rate." This is because of the diverse means through which the questionnaires were distributed. There are also difficulties with generalizing the results to other countries where technology integration into the postsecondary curriculum is not as advanced as in Canada and the United States.

Notwithstanding the sampling biases, those indices which are available suggest that the samples in the studies have characteristics which resemble the realities of postsecondary students with disabilities in North America. The age range of students is normative for studies of students with disabilities/impairments (e.g., Amsel and Fichten 1990; Fichten et al. 1991; Hill 1992, 1996; Henderson 1999; Horn and Berktold 1999; Hubka and Killean 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 personal 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 (about 33%) are similar to other studies (e.g., Horn and Berktold 1999).

6 Results

The authors present the results that are relevant to the topics presented in this paper. Additional aspects of the results are available elsewhere (Fichten et al. 1999a).

The overwhelming majority of respondents (95%) indicated that they used computers .Of the sample, 87% used the Internet. Of those that are computer users, 93% reported using a personal computer, 15% a Macintosh, and 7% reported using another type of computer. There is an overlap in IBM and Macintosh users, indicating that students use both types of computers. Ninety-three percent of computer users indicated that they had at least some computer technologies available at home. Of those who did not, most indicated that they wish they did. Students indicated spending approximately 13 hours using a computer during a typical school week. This excluded the use of the Internet. Students indicated that they spent 7 hours using the Internet.

7 Reasons why students do not use a computer

Although only 5% of our sample indicated that they do not use a computer, it is still important to understand why. Table 1 indicates that the cost of purchasing equipment, lack of availability, and expense of maintaining the computer were viewed as the three top reasons.

8 Adaptations needed to access computers

All students indicated the types of adaptive computer technologies that could be useful in getting their work done. The students indicates that the most popular computer technologies were sophisticated or adapted versions of mainstream equipment which students thought they needed to accommodate their disabilities. For example, the most valued technology was spelling and grammar checking. This was followed by a scanner and a portable note-taking device that could be taken to class.

Looking at adaptations used by students with specific disabilities also yielded interesting results. For example, spell checking and grammar checking were ranked highest by students with learning disabilities. The use of scanners was ranked highest by students who are totally blind. Finally, portable note-taking devices were ranked highest both by students who are blind as well as by those

Table 1. Why students do not use a computer

Reasons	Mean[1]	Std. deviation
It costs too much	5,03	1,83
It is unavailable to me	4,28	2,02
It is too expensive to maintain	3,48	2,08
It is impossible for me to get through a gouvernment programm or an educational institution lending program	3,32	2,13
Available computers don't have appropriate hardware/software on them	3,08	1,94
The tecnoligy makes me anxious	2,93	2,12
I don't know how to use it	2,93	2,15
It is too difficult to learn	4,77	2,19
I am uncertain about where to by it	2,72	1,88
I am not interested in using it	2,42	1,93
Adaptive tecnology I need to access a computer works poorly for me	2,19	1,74

Note: 33 students (5% of the sample) indicated that they did not use a computer.
[1] Responses were made on a 6-poin Likert scale with, 1 = strongly disagree and 6 = strongly agree

with problems using their hands or arms. A closer examination of the data reveals that in some cases, students with one disability value certain adaptations as much as students with a different disability. For example, screen readers were ranked high by students who are blind but also by those with learning disabilities.

9 Access problems and perceived limitations of today's adaptive computer technologies

Forty-one percent of computer users indicated that they needed adaptive computer technology (e.g., screen magnification, voice dictation software, adapted mouse) to use a computer effectively. However, slightly more than half (58%) actually used these technologies. Yet, data from a previous study (Fichten et al. 1999, Study 2) indicated that almost half of a smaller sample of postsecondary students indicated that they had problems with the monitor (43%), with the mouse (43%), and with the keyboard (23%). Smaller numbers of students had problems with diskette manipulation (14%) and the printer (9%).

The authors thought that it important to examine the reasons why many students who needed adaptations were not using them. Table 2 indicates that the top three reasons cited were as follows: the cost to purchase the adaptation, its unavailability, and uncertainty about where to buy these.

Table 3 shows that computer users, whether they used adaptive computer technologies or not, also indicated that the cost of computer technologies is problematic. The top three problems, in order, were cost, the need to constantly upgrade, and the few opportunities for training on adaptive technologies.

Table 2. Reasons why The 42% of computer user students who need adaptions are not using these

Reasons	Mean[1]	Standard deviation
It costs too much	5,50	1,10
It is unavailable to me	4,98	1,46
I am uncertain about where to by it	4,85	1,82
I don't know how to use it	4,13	1,92
It is too expensive to maintain	3,92	1,81
Available computers don't have appropriate hardware/software on them	3,86	2,11
It is impossible for me to get through a gouvernment programm or an educational institution lending program	3,76	1,74
Adaptive tecnology I need to access a computer works poorly for me	3,03	1,75
It is too difficult to learn	2,70	1,73
The tecnoligy makes me anxious	2,53	1,83
I am not interested in using it	1,77	1,40

Note: 284 of the 692 (41%) computer user students who responded to this question indicated that they needed special adaptions to use a computer. Only 166 of them (58%) indicated that they used adaptions.
[1] Responses were made on a 6-poin Likert scale with, 1 = strongly disagree and 6 = strongly agree

Table 3. Problems with computers noted by computer user students

Problems	Mean[1]	Standard deviation
They cost too much to by	4,80	1,50
They have to be upgraded contiuously	3,87	1,75
There are few opportunities for training on adaptive technologies	3,59	1,88
There are hardware and software compatibility problems (e.g., document saved on one computer does not open on another)	3,44	1,78
Computer labs where my courses are held lack suitable adaptions for me (e.g., no dictation software)	3,38	2,14
They are frustrating/difficult to use	3,03	1,68
They crash	3,03	1,65
Manufacturers fail to support their products	2,99	1,72
They are difficult to learn	2,80	1,72
They make me dependent on them	2,74	1,81
They need to be repaired often	2,47	1,52
Using them causes me physical discomfort	2,32	1,68
They are inadequate in meeting my needs	2,27	1,51

[1] Responses were made on a 6-poin Likert scale with, 1 = strongly disagree and 6 = strongly agree

Table 4. Suggestions for adaptive computer hardware and software companies in rank order

Suggestion	% of students
Provide student discounts	79%
Make adaptive hardware and software less expensive to purchase	70%
Provide grants to educational institutions to purchase equipment	64%
Make product more userfriendly	48%
Ensure that advertising reaches students with disabilities	47%
When designing a piece of hardware or software, include accessibility features for a variety of users	41%
Provide trial periods	40%
Make manuals/tutorials easier to understand	38%
Provide training	38%
Provide better technical support	35%
Make manuals/tutorials available in alternative formats	23%

10 Envisaged improvements to the situation

One of the goals of the study was to know what students, as a growing and important segment of the adaptive computer technologies market, would suggest to companies that develop or sell the equipment. See Table 4 for the following three suggestions that the students gave: providing a student discount, lowering the cost of these technologies, and providing grants to educational institutions to purchase the. Making sure that products are user-friendly, ensuring that advertising reaches students, ensuring accessibility features for users with a variety of disabilities, and providing trial periods were also popular suggestions.

11 Discussion

These data suggest that the large majority of college and university students with disabilities can and do use computer technologies to help them with their studies, regardless of gender, age, program of study, or type of disability. More than likely, this is a slight overestimate of the population parameters because computer users may have been more inclined to answer the questionnaire. Nevertheless, by the time this study is published, the proportion of computer users will have increased in the general population (Angus Reid Group 2000; PricewaterhouseCoopers 2000). This will also be true of postsecondary education (Campus Computing Project 2000) and includes students with disabilities (Horn and Berktold 1999).

The results of the study echo Roulstone's (1998) views about using technology to break down barriers. The most notable advantage is the potential of the new computer technologies to create access to information – the currency of learning and the knowledge-based economy. The data also show that these technologies do have limitations. Prominent limitations included cost, the need for training and/or retraining, and compatibility issues related to software and hardware.

11.1 The key problem: Cost

Nearly half the students in our sample reported needing some type of adaptation to enable them to use computers effectively. However, only a little more than half of them actually had these. As previously mentioned, the primary reason for not using adaptive computer technologies is cost. Indeed, the most noteworthy finding relates to students' concerns over the financing of computer and adaptive computer technologies. Regardless of what question was asked or how it was formulated, the high cost of acquiring and maintaining computer technologies was the most important issue that computer users and non-users alike had indicated. This was in reference to both mainstream and adaptive computer technologies. As shown elsewhere (Fichten et al. 2000), the majority of students who had computer equipment at home indicated that they or their families had paid for it. This makes the cost issue especially relevant. Given these findings, it is not surprising that the top two recommendations made by students to companies who develop or supply the technology is to lower costs and to provide discounts for students.

11.2 "Cross-use" of technologies and the need for adapted workstations that can accommodate the needs of students with various disabilities

About half of the students in our sample had two or more impairments or disabilities. This suggests a need for adapted workstations that can accommodate the needs of students with various disabilities. In fact, students indicated that they "cross-used" technologies, which means that students with one kind of disability use technologies intended for students with a different type of impairment. For example, screen reading software is used by students with visual impairments and also by students who have learning disabilities. Use of large screen monitors and voice recognition (dictation) software provide additional instances of this trend. Multiple uses of adaptive technologies seem to be an important development.

Additionally, the increasing number of accessibility features built into widely available mainstream products are of considerable interest to students with disabilities. See Fichten et al. (2000) for a detailed discussion of the types of computer technologies used by students with different disabilities.

11.3 Three types of computer technologies: General use, adaptive, and "adaptable"

The authors asked students what computer and/or adaptive computer technologies they considered could be useful in getting their work done. The students, regardless of disability, indicated that the four following technologies, in order, would be the most helpful: a spell checker or grammar checker, a scanner, a portable note-taking device, and voice dictation software. It is evident from this list that technologies that are typically considered as widely used, are, in fact, used as adaptive aids by students with certain disabilities. For example, most students use spell checkers. For students with certain types of learning disabilities, the spell check is used as an adaptive technology to help compensate for the disability. Voice dictation software, such as Dragon and Via Voice, originally intended for professionals and executives, is now used as an adaptive technology by students with a variety of hand or arm impairments and some types of learning disabilities. The same is true for widely used scanners and optical character recognition software that are used as adaptive technologies by students with visual and other print impairments.

Some technologies have remained disability specific (e.g., Braille printers, captioning on video portions of web pages and CD-ROMs, magnification programs for students with visual impairments, and head or foot mice).

Thus, there appears to be three categories of computer technologies used by students with disabilities. The first includes widely used computer hardware and software (e.g., mouse, word processing software). The second includes adaptive computer technologies (e.g., Braille printer). The third includes those technologies that are "adaptable" (e.g., scanner, dictation software). Students also use certain computer technologies in idiosyncratic or highly creative ways. This further clouds distinctions.

11.4 Universal access

Although the lines between adaptive and general use computers are blurred in some areas, not all technologies can be considered accessible for all students with disabilities. As long as software and hardware are designed and built without consideration for their accessibility there will be "issues of accommodation" in areas of technology, as is the case in architecture. Thus, a general rule still applies: computer technologies must serve as tools to facilitate the execution of daily activities, and their use must be determined by the users' needs. This can only happen if users have access to the computer technologies they need.

The International Congress on Inclusion by Design (2001) in its Montreal International Declaration On Inclusion, noted that "accessible and inclusive design of environments, products and services increases efficiency, reduces overlap, results in financial savings and contributes to the development of cultural, economic and social capital. All sectors of society derive benefits from inclusion and are responsible for the promotion and advancement of inclusive planning and design." The cost effectiveness of incorporating universal accessibility features at the outset of a project are well-known (e.g., Connell et al. 1997; Ekberg 1999; Jacobs 1999; Node Networking 1998). The seven principles of universal design for computer technologies proposed by Connell et al. (1997) can be applied to both hardware and software design to ensure accessibility not just for people with disabilities but also for the safety and comfort of all.

There have been numerous calls to consider learners' preferred modalities for obtaining information in different learning contexts as well as in instructional design (e.g., Barnett 1992; Bradtmueller 1979; Caudill 1998; Cohen and McMullen 2000; Papineau and Lohr 1981; Reid 1987; Wislock 1993). Some students delight in visual-spatial learning, others prefer verbal representations, and others learn best by hearing information. Many prefer a combination, for example hearing and seeing text simultaneously (Montali and Lewandowski 1996). A substantial body of work by Mayer and his colleagues support the contention that multimedia learning (presenting information in two or more formats such as words and pictures) can be superior to single ways (Mayer and Moreno 1998; Mayer et al. 1996; Mayer and Sims 1994; Mayer and Gallini 1990; Mayer 1997). Thus, accommodating with the needs of students with disabilities results in good teaching practice that is appropriate for all students.

Use of accessible technologies is likely to benefit all students. For example, electronic text that can be read by a screen reader (synthesized speech) is likely to help second language students and students with print impairments. Giving students the option to turn closed captioning on and off (text appearing at the bottom of the screen, such as subtitles on foreign films), needed by students with hearing impairments, is also likely to benefit non-native speakers as well as students who have difficulty making out specific words on video clips and those who wish to learn how to spell technical words or names. Changing font sizes and color schemes on screen and providing a highlight tracking system, useful for those with visual and learning disabilities, could prove helpful for all learners who have difficulties managing large amounts of text on the screen. Enabling software to read what is on the screen, presenting alternative forms of input, such as dictation, and giving people the option to choose auditory, written, or visual

representations permit students to choose their own preferred learning modality, and therefore permit students with and without disabilities to gain control over their learning.

12 Recommendations to developers and sellers of adaptive hardware and software

The rich data set of our research team (see Fichten et al. 1999a) and the findings reported above highlight the importance of adaptive computer technologies. The list of recommendations provided below was formulated to make adaptive computer technologies more accessible to students with disabilities. Such recommendations are timely, given the number of students enrolled in postsecondary education across North America, the rapid evolution in computer and instructional technologies used to deliver postsecondary education, and ongoing changes in the computer industry.

The recommendations below are based, in part, on the findings of the study and are reflective of the newly emerging technologically rich postsecondary education environment. The list is neither exhaustive nor totally inclusive. Responsibility for the adoption of widespread changes to access to computer and adaptive computer technologies falls not only on the developers and suppliers of these technologies themselves. Rather, it must be a cooperative effort between government [e.g., Department of Justice of the United States (2001)], various disability-related advocacy groups, and other stakeholders (see Fichten et al. 2000 for recommendations to government agencies, and Fichten et al. 2000 and Fichten et al. 2001 for recommendations to educators and instructional technology professionals). It is also likely that some of the study's recommendations may not be immediate given constraints placed on the adaptive technology industry. With that said, these issues, at a minimum, need to be brought to the attention of the adaptive computer technology industry, if for no other reason than to build sensitivity to the needs of the postsecondary education community.

Several adaptive hardware or software companies are already addressing some of these issues (e.g., providing student discounts and trial periods). In these cases, these companies need to openly advertise so that the information gets to its intended audience (e.g., at conferences, in promotional literature, on web sites). This would, of course, direct business to such companies.

12.1 Provide student discounts

The most pervasive and troubling complaint heard in the research was the very high cost of much of the adaptive hardware and software that is currently on the market. Perhaps rehabilitation and government-funded institutions and agencies are in a better position to afford these technologies. However, there has to be an understanding that average students with disabilities simply cannot finance the purchase of many of these technologies. There may also be a misperception in the adaptive computer technology industry that students need access to their products only at school and that they have no need to purchase equipment for off-campus use. As the research clearly indicates, this is not the case.

Manufacturers and distributors of adaptive computer technologies are urged to adopt policies similar to those taken up by much of the general-use computer industry with respect to student and educational discounts or rebates. Not only is this intuitively appealing, it also makes good business sense. If a company wishes to tap into a market that is increasingly demanding its products, and will undoubtedly need them in the future, it must target the population early and make its products attractive in price.

Another misperception held by the industry, at least in Canada, is that government programs that subsidise equipment provide all necessary computer technologies for students with disabilities. The data show that this, too, is not the case. Most students or their families purchased the equipment; government subsidy programs provided equipment to only a minority of students. Not only that, some of the existing government programs can be restrictive, such as the instance that certain disabilities may not be recognized. In the case of other disabilities, eligibility criteria based on the severity of a person's disability may be very stringent. Also, government programs often eliminate the option of choice by selecting only one of several competing products, whereas a product not on the "approved" list may best meet students' needs. Thus, many students who could benefit from certain technologies simply do not have access to them for two reasons. First is cost. The other is that many manufacturers and distributors fail to make their products known to those who purchase the equipment.

Providing discounts for students will be beneficial in helping them independently purchase what they need. If a company commits to provide accessibility to consumers with disabilities, while ensuring product visibility, postsecondary students with disabilities must be targeted as an emerging market.

12.2 Provide educational grants and enter into partnerships with postsecondary institutions

Again, this concept is familiar to the mainstream computer industry. It is a matter of extending such practices to the adaptive computer technology industry. Personnel responsible for providing services to students with disabilities often work under severe budgetary constraints.

Adaptive computer technology manufacturers and suppliers are largely unaware of these constraints. Schools will frequently settle with older and out-of-date equipment because of lack of funds. For many, the necessary equipment is well beyond the cost that can be justified to administration. There are exciting new ways in which education is increasingly being delivered (cf. America's 100 Most Wired Colleges – 1999, 2000; EDUCAUSE Online Guide to Evaluating Information Technology on Campus 2000; Campus Computing Project 2000), and the study's findings clearly indicate the need for campus based computer supports for students with disabilities (Fichten et al. 2000). Therefore, manufacturers and suppliers need to play their part by providing educational grants to schools that wish to purchase equipment for on-campus use.

A possible suggestion is that the adaptive computer technology industry enter into partnerships with schools and provide equipment at an "educationally friendly" cost. This includes the necessary support in the form of comprehensive staff training and dedicated technical backup. Personnel responsible for providing services to students with disabilities need to become more familiar with adaptive technologies if they are going to make these available to their students.

As colleges and universities move toward adopting policies to ensure that their campuses are networked and as they experiment with new instructional technologies (e.g., adding computer lab components to courses, online distance education courses, educational CD-ROMs, using multimedia projection in class, and placing course materials on the web) and expertise from the adaptive computer technology industry on how their equipment can be interfaced with these new instructional technologies is urgently needed. Moreover the interface-related problems between adaptive technologies and instructional technologies exist need to be solved.

The anticipated benefits for companies are a generation of computer users who have mastered the company's products and valuable testing site for new adaptive technologies.

12.3 Target advertising to the students

One of the major concerns noted in the research is that students did not know what products are available or where to purchase them. This clearly speaks to the lack of visibility that manufacturers and suppliers of adaptive computer technologies have in the postsecondary education sector. In fact, the study's findings (Fichten et al. 1999, Studies 1 and 2) show that personnel who provide services to these students are not any more knowledgeable about new products than the students themselves.

To increase the products' exposure, companies need to put forth the effort to target the advertising specifically to this market, including not only the professionals, but also to the students who are the end users. A possible suggestion would be holding technical open houses that exhibit and demonstrate the adaptive computer technologies at the start of fall and winter academic terms in cities with colleges and universities. Another would be contacting schools to arrange for on site visits to demonstrate new products to students and staff. Another suggestion is making appearances at conferences, such as that of Canada's National Educational Association of Disabled Students (NEADS), where the intended market is likely to be reached. Visibility and integration of products into the postsecondary education community are needed. Again, companies would gain valuable feedback concerning the unique characteristics and needs of this emerging market. They would also see first hand some of the new instructional technologies that are being implemented on campuses. One research participant suggested specifically targeting students as beta testers. This could provide a good start, as it would bring about advertising through word of mouth.

12.4 Provide trial periods

If a student or institution is willing to invest in sophisticated technology, they should be given the opportunity to try out the product for a reasonable period (e.g., 2 weeks to 1 month) in their own "environment" before purchasing the technology. During a demonstration, equipment usually works well. But once used in an actual school setting (e.g., scanning course handouts, trying out voice recognition software in a busy adaptive technology lab), the results may be disappointing. By having a trial period, individuals can choose which product is best suited to their needs without having to make a sizeable or a potentially disastrous investment. This is how ill feelings are avoided and product loyalties are forged.

12.5 Provide superior, timely, and free training as well as technical support

The research shows the need for better training and technical support (Fichten et al. 2001). Some participants commented that there was a substantial initial expense in buying the equipment. On top of this, they had to pay for training and technical support. Receiving "on-site" assistance, such as installation from the suppliers, would be a considerable improvement over having to follow confusing written or telephone instructions.

The job of students is to keep up-to-date with their academic studies, not to act as computer technicians. Training and technical support should not be viewed as a privilege. Rather, it should be considered as a part of the responsibility a company has to its clients. As noted earlier, the postsecondary education community has unique requirements. One of these happens to be timeliness. Term paper and exam deadlines cannot be postponed or delayed because of adaptive computer technologies.

12.6 Make hardware and software more user friendly

The longer it takes to understand command sequences, equipment installation procedures, etc. the less likely it is that the equipment will be used. The easier a product is to use, the higher the customer's satisfaction. In essence, postsecondary students with disabilities and the staff who oversee the equipment are likely to remain with a company that provides equipment that is easy to use.

12.7 Make manuals/tutorials easier to understand, and make them available in a variety of alternative formats

Unintelligible manuals, tutorials, and guides once plagued the computer industry. In the field of adaptive computer technologies, the problem has, in many cases, remained. Students with disabilities rarely have leisure time to sort through complex and often cryptic instructions.

What is needed is clearly written material that is well organized to enable users to find information quickly and efficiently. Training tutorials could follow well-documented instructional design models (e.g., providing practice exercises to go along with the informational material). Simply providing sequences of commands is insufficient. Moreover, making manuals and tutorials available in alternative formats and adjusting the instructional material to suit such formats to meet the needs of the customers is vital. For example, it seems pointless to provide manuals for a screen reader on diskette when the individual will need to know how to use the screen reader to access the material. This is an area where companies can learn from the educational institutions themselves, which are, for the most part, committed to providing materials in suitable alternative formats. Companies that charge for providing materials in alternative formats should reconsider and revise this policy.

12.8 Stay current with the changing educational environment

As noted throughout this paper, there are major changes in how teaching and learning is conducted across postsecondary education curriculums. New and innovative means of delivering instruction using various technologies are quickly becoming a part of traditional classroom teaching. Distance education using online media is growing in popularity. One of the hidden agendas is to make sure that students graduate with the level of computer literacy demanded in our knowledge-based economy.

The adaptive hardware and software industry needs to play its part in ensuring that its products are compatible with these new methods of learning. If companies fail to follow new developments in the delivery of education, their products will be rendered useless because they will not be compatible with the hardware and software used in the schools. Because newly emerging technologies appear in workplaces, finding solutions in the postsecondary arena will have a trickle-down effect.

12.9 Continue to increase compatibility of adaptive computer products with general use hardware and software

Current efforts to integrate general use and adaptive products are to be encouraged. For example, new screen reading software that is compatible with existing sound cards decreased costs substantially. This trend needs to continue and expand to other types of adaptive computer products.

13 Conclusions

It is clear that students with disabilities use both mainstream and adaptive computer technologies to help them succeed in postsecondary education. Technology created for people with specific needs may be useful to other groups as well. The adaptive technology industry should consider, however, that its products will not be purchased if they are not affordable, if they are too complicated to operate or understand, if they do not interface with current instructional technologies, or if they are incompatible with the user's needs. What is the point of manufacturing specific technologies if these products are too expensive to be used by those for whom they were designed? Less expensive and out-of-the-box solutions will be purchased by more customers.

It is in the interest of the adaptive computer industry to spend the time to achieve a better understanding of the postsecondary education sector and, in particular, of its students with disabilities. The industry must become much more visible to these customers. By attending to the students' perspectives and understanding their unique educational demands, those in the industry can enhance development of and marketing of quality adaptive computer products intended for an emerging market of prosperous college educated consumers with disabilities. Industry practices that are "higher education friendly" will ensure access to postsecondary education for students with disabilities and a loyal customer base for the product in the future.

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Appendix

ADAPTECH PROJECT COMPUTER AND INFORMATION TECHNOLOGIES
SURVEY OF POSTSECONDARY STUDENTS WITH DISABILITIES
Dawson College, Montreal, Quebec Canada H3Z 1A4
1999

Help Desk. *If you have any problems or questions, feel free to call our Help Desk collect at (514) 488-2376 Monday through Thursday from 6 P.M. to midnight and Sundays from 3 P.M. to midnight Eastern time.*
You can also e-mail your questions to adaptech@concordia.ca .

1. Are you female or male? Check one. ____ female ____ male
2. How old are you? _____
3. Which language do you speak more often? Check one. ____ English ____ French
4. What province/territory are you considered a resident of? (e.g., for voting, income tax - if you are an international student, specify country) _____
5. What is the name of your educational institution and where is it located?
   Name of institution: _____
   City: _____ Province/Territory: _____
6. What is your field of study? _____
7. Which of the following are you currently pursuing? **Choose only one**.
   _____ a. college certificate/diploma
   _____ b. university degree
   _____ c. I have not been a student since 19____ (specify year)
   _____ d. other (e.g., just taking courses) - specify situation: _____
8. We would like to know what disabilities / impairments you have and how long you have had them. Please place a number beside **all that apply** from the list below using a 3-point scale as follows:

   1 = all or most of my life (before age 10)
   2 = part of my life
   3 = recent (past 3 years)

   For example, if you have been totally blind all of your life, you would write 1 in the space before item a.

   _____ a. totally blind
   _____ b. visually impaired / partially sighted
   _____ c. Deaf
   _____ d. hearing impaired / hard of hearing
   _____ e. speech or communication impaired
   _____ f. learning disabled
   _____ g. wheelchair user
   _____ h. mobility impaired (e.g., walk with difficulty, use a cane)
   _____ i. difficulty using hands/arms
   _____ j. health or medically related impairment (e.g., diabetes)
   _____ k. psychological or psychiatric disability
   _____ l. other (specify impairment / disability) _____
9. Please check yes or no for **all** items.

   At home I use:
   a. a desktop computer ____ yes ____ no
   b. a laptop computer ____ yes ____ no
   c. adaptive computer hardware (e.g., Braille display) ____ yes ____ no
   d. adaptive software (e.g., software that enlarges what is on the screen) ____ yes ____ no
   e. the internet ____ yes ____ no
   f. other computer technology ____ yes ____ no (specify technology) _____

10. Please check **all** items that apply.

I don't have the following technologies at home, but wish I did:
a. a desktop computer ____
b. a laptop computer ____
c. adaptive computer hardware (e.g., Braille display) ____
d. adaptive software (e.g., software that enlarges what is on the screen) ____
e. the internet ____
f. other computer technology ____ (specify technology) _____

11. Please check yes or no for **all** items.

At my educational institution I have used:
a desktop computer ____ yes ____ no
b. a laptop computer ____ yes ____ no
c. adaptive computer hardware (e.g., Braille display) ____ yes ____ no
d. adaptive software (e.g., software that enlarges what is on the screen) ____ yes ____ no
e. the internet ____ yes ____ no
f. other computer technology ____ yes ____ no (specify technology) _____

12. Please check **all** items that apply.

I have had no access to the following technologies at my educational institution, but wish I did:
a. a desktop computer ____
b. a laptop computer ____
c. adaptive computer hardware (e.g., Braille display) ____
d. adaptive software (e.g., software that enlarges what is on the screen) ____
e. the internet ____
f. other computer technology ____ (specify technology) _____

13. **Rate your level of agreement with the statements listed below.** Refer to your current situation. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree.

1 = strongly disagree
2 = somewhat disagree
3 = slightly disagree
4 = slightly agree
5 = somewhat agree
6 = strongly agree

_____ a. In general, I rarely use computer technologies.
_____ b. In general, I consider my level of expertise with computer technologies to be very good.
_____ c. Computer technologies that meet my needs are unavailable to me.
_____ d. Getting my work done more easily is important to me.
_____ e. I am a person who dislikes computers.
_____ f. There are opportunities for me to learn how to use computer technologies.
_____ g. Computer technologies are inadequate in meeting my needs effectively (e.g., too inaccurate or slow).
_____ h. I do not plan to become more knowledgeable about computers.
_____ i. What friends think about computers is unimportant to me.
_____ j. When I have problems with my computer technologies, I can get help easily.

_____ k. Computers crash often.
_____ l. Computer technologies I need cost too much.
_____ m. I think working efficiently on computers is unimportant.
_____ n. Using computer technologies effectively is likely to help me get my work done more easily.
_____ o. Friends don't think using computers is helpful.
_____ p. In general, there are good computer facilities for me to use.
_____ q. I can comfortably use computer technologies if I need to.
_____ r. There are people available to show me how to use computer technologies.
_____ s. My friends think I should use computer technologies.
_____ t. In general, my financial situation allows me to meet my needs.
_____ u. Overall, I am very dissatisfied with my experiences with computers.

14. Rate your level of agreement with the statements listed below. Use the six-point scale above, with 1 equalling strongly disagree, and 6 equalling strongly agree. Please do not leave any items blank. If an item is not applicable to you, write 9 in the space provided.

Please indicate the product names if you know them.

The following adaptive computer technologies are/could be useful in getting my work done:

_____ a. a screen reader (software that reads what's on the screen) - product name:_____
_____ b. software that enlarges what is on the screen - product name:_____
_____ c. a scanner - product name:_____
_____ d. Braille translation software - product name:_____
_____ e. a portable note taking device (not referring to a laptop) - product name:_____
_____ f. a large screen monitor - product name:_____
_____ g. a Braille printer - product name:_____
_____ h. a spell checker / grammar checker - product name:_____
_____ i. other specialized software for learning disabilities (e.g., word prediction) - product name:_____
_____ j. keyboard adaptations (e.g., "sticky keys") - product name:_____
_____ k. mouse adaptations (e.g., head mouse, track ball) - product name:_____
_____ l. dictation software (voice recognition software that types what you say) - product name:_____
_____ m. voice control software (you give voice commands like "file," "open," - e.g., VoicePad) - product :_____
_____ n. having material available in electronic format (e.g., books, hand-outs)
_____ o. other (specify adaptive hardware / software and product name) _____

15. Which of the following suggestions would you like to make to adaptive computer hardware and software companies? **Check 5 of the 12** suggestions listed below that are most important to you.

a. provide student discounts _____
b. provide trial periods _____
c. make product more user friendly _____
d. provide better technical support _____
e. ensure that advertising reaches students with disabilities _____
f. make adaptive hardware and software less expensive to purchase _____
g. make manuals/tutorials available in alternative formats _____
h. make manuals/tutorials easier to understand _____
i. when designing a piece of hardware or software, include accessibility features for a variety of users with disabilities _____
j. provide grants to educational institutions to purchase equipment _____
k. provide training _____
l. other (specify suggestion) _____

16. **Do you use a computer?** ____ yes ____ no

If you answered "YES," skip the rest of this question and go to number 17.

If you answered "NO," rate your level of agreement with each of the statements below. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree. Please do not leave any items blank. If an item is not applicable to you, write 9 in the space provided.

1 = strongly disagree
2 = somewhat disagree
3 = slightly disagree
4 = slightly agree
5 = somewhat agree
6 = strongly agree

I do not use a computer because:

_____ a. it is unavailable to me
_____ b. it costs too much
_____ c. I am not interested in using it
_____ d. it is too difficult to learn
_____ e. it is too expensive to maintain

_____ f. I don't know how to use it
_____ g. the technology makes me anxious
_____ h. I am uncertain about where to buy it
_____ i. adaptive technology I need to access a computer works poorly for me
_____ j. It is impossible for me to get it through a government program or an educational institution lending program
_____ k. available computers don't have appropriate adaptive hardware/software on them
_____ l. other (specify reason) _____

IF YOU **DO NOT USE** A COMPUTER, GO TO THE LAST QUESTION, NUMBER 29.
IF YOU **DO USE** ONE, CONTINUE WITH THE NEXT QUESTION.

17. Please check yes or no for **all** items.

What type of computer do you use?
a. IBM compatible ____ yes ____ no
b. Macintosh ____ yes ____ no
c. other type of computer ____ yes ____ no (if you answered yes, specify type) _____

18. Please check yes or no for **all** items.

I have used a computer:
a. at home ____ yes ____ no
b. during class lectures (e.g., writing lecture notes, in-class assignments) ____ yes ____ no
c. in the library (e.g., doing assignments on a computer located in the library) ____ yes ____ no
d. in a Disabled Student Services Office / specialized lab ____ yes ____ no
e. in a computer lab ____ yes ____ no
f. at work ____ yes ____ no
g. elsewhere ____ yes ____ no (specify location) _____

19. **Approximately** how much time during a typical school week have you spent:

a. using **a computer - not** including time spent on the internet (number of hours per week) _____
b. using **the internet** (number of hours per week) _____

20. **Do you use the internet?** ____ yes ____ no

If you answered " YES," skip the rest of this question and go to number 21.

If you answered "NO," rate your level of agreement with each of the statements below. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree. If an item is not applicable to you, write 9 in the space provided.

1 = strongly disagree
2 = somewhat disagree
3 = slightly disagree
4 = slightly agree
5 = somewhat agree
6 = strongly agree

I do not use the internet because:
_____ a. it costs too much
_____ b. I have no access to a computer that is equipped to go on-line
_____ c. the available browser / e-mail program (e.g., Netscape, Eudora) does not work well for me
_____ d. it is unavailable in my area
_____ e. I am not interested in using it
_____ f. some features of web sites are inaccessible to me
_____ g. it is not available at school
_____ h. it ties up the phone line
_____ i. other (specify reason) _____

IF YOU **DO NOT USE** THE INTERNET, SKIP THE NEXT QUESTION, AND GO TO NUMBER 22.
IF YOU **DO USE** THE INTERNET, CONTINUE WITH THE NEXT QUESTION.

21. Rate your level of agreement with each of the statements below. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree. If an item is not applicable to you, write 9 in the space provided.

1 = strongly disagree
2 = somewhat disagree
3 = slightly disagree
4 = slightly agree
5 = somewhat agree
6 = strongly agree

I use the internet for:

_____ a. doing research
_____ b. e-mailing friends/family
_____ c. entertainment
_____ d. accessing library materials
_____ e. looking for a job
_____ f. taking courses on-line
_____ g. e-mailing my professors
_____ h. participating in listservs/news groups
_____ i. participating in chat rooms
_____ j. banking/shopping
_____ k. getting software / updates / demos
_____ l. other (specify activity) _____

22. **Did you take advantage of a government program to obtain a computer or adaptive computer technologies?** ___ yes ____ no

If you answered " YES," skip the rest of this question and go to number 23.

If you answered "NO," rate your level of agreement with each of the statements below. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree. Please do not leave any items blank. If an item is not applicable to you, write 9 in the space provided.

I did not take advantage of a government program to obtain a computer or adaptive computer technologies (e.g., Braille display, software that enlarges the screen) because:

_____ a. there were too many restrictions
_____ b. my own /my family's income was too high for me to qualify
_____ c. my disability was excluded by existing programs
_____ d. the waiting period was too long
_____ e. I did not want to take the required evaluation
_____ f. I was unaware that there were any programs out there for me
_____ g. I / my family preferred to buy the equipment I needed
_____ h. the process for applying was too complicated
_____ i. the equipment I need was unavailable through existing programs
_____ j. other (specify reason) _____

IF YOU **DID NOT TAKE ADVANTAGE** OF A GOVERNMENT PROGRAM, SKIP THE NEXT QUESTION, AND GO TO NUMBER 24.

IF YOU **DID TAKE ADVANTAGE** OF A GOVERNMENT PROGRAM, CONTINUE WITH THE NEXT QUESTION.

23. Rate your level of agreement with each of the statements below. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree. Please do not leave any items blank. If an item is not applicable to you, write 9 in the space provided.

My experience with a government program has been that:

_____ a. there were many restrictive rules and regulations
_____ b. I had no say in what hardware/software I received
_____ c. the equipment I received met my needs
_____ d. I received excellent training on the technology
_____ e. the waiting period was very long
_____ f. the program's documentation was unavailable in a format I could read myself (e.g., no large print or tape)
_____ g. the program was flexible in meeting my needs
_____ h. contacting the necessary people to discuss my needs was easy
_____ i. the process for applying was complicated

_____ j. the equipment I received was up-to-date
_____ k. the evaluation process was unpleasant
_____ l. other (specify experience) _____

24. **Do you have a computer that you use at home?** ___ yes ____ no

If you answered " NO," skip the rest of this question and go to number 25.

If you answered "YES", answer the rest of the question.

How did you get your computer and/or your adaptive computer technologies as a student? Check **all** that apply.

a. through the Federal Government _____ (specify name of program) _____
b. through the Provincial Government _____ (specify name of program) _____
c. through a foundation/organization _____ (e.g., Kiwanis Club, Neil Squire Foundation - specify name of foundation / organization) _____
d. by borrowing it from my family/friends _____
e. from my family who bought it for me _____
f. by buying it myself _____
g. through my educational institution's lending program _____
h. other _____ (specify how you obtained it) _____

25. Rate your level of agreement with each of the statements below. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree. Please do not leave any items blank. If an item is not applicable to you, write 9 in the space provided.

Computer technologies cause problems for me because:
_____ a. they are difficult to learn
_____ b. they cost too much to buy
_____ c. using them causes me physical discomfort
_____ d. they are frustrating / difficult to use
_____ e. they crash
_____ f. they need to be repaired often
_____ g. there are hardware and software compatibility problems (e.g., document saved on one computer does not work on another)
_____ h. they are inadequate in meeting my needs
_____ i. they have to be upgraded continuously
_____ j. they make me dependent on them
_____ k. computer labs where my courses are held lack suitable adaptations for me (e.g., no dictation software)
_____ l. manufacturers fail to support their products
_____ m. there are few opportunities for training on adaptive technologies
_____ n. other (specify problem) _____

26. Rate your level of agreement with each of the statements below. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree. Please do not leave any items blank. If an item is not applicable to you, write 9 in the space provided.

I have had problems using computers at my educational institution because:
_____ a. using computer technology in class is disruptive (e.g., too noisy)
_____ b. my schedule and the hours of access to computers have been incompatible
_____ c. the computer programs I use at home are unavailable at my educational institution
_____ d. there has been insufficient technical support available to me
_____ e. using computer technologies in class makes me stand out
_____ f. computer labs/adaptive center have always been full
_____ g. there has been a lack of suitable adaptive technology for my disability
_____ h. I have received insufficient training on existing adaptive technology
_____ i. other (specify problem) _____

27. **Do you need any special adaptations to use a computer?** ____ yes ____ no

If you answered " NO," skip the next question and go to the last one, number 29.

If you answered " YES," go to the next question, number 28.

28. **Do you use adaptive computer hardware or software?** ____ yes ____ no

If you answered " YES," skip the rest of this question and go to the last one, number 29.

If you answered "NO," rate your level of agreement with each of the statements below. Use a 6-point scale with 1 equalling strongly disagree, and 6 equalling strongly agree. Please do not leave any items blank If an item is not applicable to you, write 9 in the space provided.

I do not use adaptive hardware/software (e.g., Braille display, software that enlarges what's on the screen) because:

_____ a. it is unavailable to me
_____ b. it costs too much
_____ c. I am not interested in using it
_____ d. it is too difficult to learn
_____ e. it is too expensive to maintain
_____ f. I don't know how to use it
_____ g. the technology makes me anxious
_____ h. I am uncertain about where to buy it
_____ i. adaptive technology I need to use a computer works poorly for me
_____ j. it is impossible for me to get it through a government program or an educational institution lending program
_____ k. available computers don't have appropriate adaptive hardware/software on them
_____ l. other (specify reason) _____

29. Please let us know if there are other computer technology issues that are important to you that we have not asked about. Also, put any comments about this questionnaire here.

MANY THANKS FOR HELPING US WITH THIS STUDY!