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COMPUTER USE BY STUDENTS WITH DISABILITIES: PERCEIVED ADVANTAGES, PROBLEMS AND SOLUTIONS

An estimated 5% to 11% of postsecondary students in North America have some type of disability, with colleges having a higher proportion of students with disabilities than universities (Fichten, Jorgensen, Havel & Barile, 2006). In addition, recent information shows a dramatic increase in the number of students with disabilities in the CEGEPs (Bonnelli, 2008). For example, at Dawson College there are approximately 300 students registered to receive disability-related services from the college.

Moreover, based on a recent study of CEGEP students who self-identified with disabilities, we estimate that there are an additional 600 students at the college who have a disability but who have not registered to receive disability-related services.

The literature is rife with studies showing that students with various disabilities benefit from the use of some form of adaptive computer technology. We recently reviewed many of these along with issues related to the availability of adaptive computer technologies on campus (Fichten, Nguyen, Barile & Asuncion, 2007). There are devices that can provide access to computer technologies that would not otherwise be accessible or that "may assist or augment task performance in a given area of disability" (Raskind & Higgins, 1998, p. 27). For example, students with visual impairments and with a learning disability such as dyslexia may employ screen-reading software to help them read text on a computer screen.

Fichten and colleagues (2001) showed that CEGEP students and graduates with disabilities both considered the availability of needed computer technologies to be an important facilitator of their academic success. Difficulties with these technologies, on the other hand, were seen as important obstacles. Both groups indicated that increased availability of and improved access to computer technologies would have made their CEGEP studies easier. Similarly, Sharpe, Johnson, Izzo & Murray (2005) found that 17% of postsecondary graduates with disabilities had not been provided with needed assistive technology such as some form of computer-related hardware or software. Moreover, almost half of these students considered the technologies they required to be of greatest use to them in an academic setting.

THE RESEARCH

What types of computer technologies do CEGEP students with disabilities use? What do these students perceive to be the advantages of using these technologies? What problems do these students encounter using these technologies and how are these problems resolved?

To answer these questions, we surveyed 44 Quebec CEGEP students (30 females and 14 males) with various disabilities who indicated that they needed specialized hardware or software to use a computer effectively. Thirty were enrolled in French-language CEGEPs and 14 in English-language CEGEPs and all were registered to receive disability-related services from their school.

Students indicated which specialized computer technologies they used and they responded to the following items:

- Indicate three advantages of using computer technologies for you;
- Indicate three problems you have encountered using computer technologies;
- How was each resolved? (If not resolved, write 'unresolved').

WHAT TYPES OF DISABILITIES DID CEGEP STUDENTS IN OUR SAMPLE HAVE?

The results show that the most frequently reported disability in our sample of college students was a learning disability followed by a psychological impairment (see Table 1). This result is consistent with data for CEGEPs in the western portion of Quebec (Bonnelli, 2008) and with research findings from American postsecondary institutions (Raskind & Higgins, 1998; Suthakaran & Sedlacek, 1999). In fact, between 2001 and 2004 the number of students with a learning disability registered to receive disability-

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related services in Quebec public colleges doubled (Fiset, 2006; Juhel, 2006). In a survey of 300 anglophone and francophone students with disabilities from 32 CEGEPs across Quebec, Fichten and colleagues (2006) found that the category of disability most commonly reported by students (47%) was learning disability/attention deficit disorder. Of the 57 campus-based disability service providers questioned, over 80% reported having provided services to at least one student with a learning disability. Similarly, Sharpe and colleagues (2005) reported that 56% of the 139 American postsecondary graduates with disabilities whom they interviewed had either a learning disability or attention deficit disorder.

[...] CEGEP students and graduates with disabilities both considered the availability of needed computer technologies to be an important facilitator of their academic success.

WHAT KINDS OF ADAPTIVE COMPUTER TECHNOLOGIES DID STUDENTS IN OUR SAMPLE USE?

The majority of students in our sample indicated that they used specialized software to improve the quality of their written work (see Table 2). Not surprisingly, this type of computer technology was used by a larger proportion of students with learning disabilities than it was by students with other impairments. Many studies have provided evidence of the benefits of computer technologies for students with disabilities. For example, teaching students with learning disabilities to use needed computer technologies has been shown to improve their academic outcomes and to produce positive attitudinal and affective changes (Raskind & Higgins, 1998).

TABLE 1: PERCENTAGE OF STUDENTS REPORTING EACH TYPE OF IMPAIRMENT

Impairment	% of Students (# of Students)		
	All[a]	Anglophone[b]	Francophone[c]
Learning Disability/Attention Deficit Disorder	68% (30)	71% (10)	67% (20)
Psychological impairment	14% (6)	14% (2)	13% (4)
Mobility impairment	11% (5)	7% (1)	13% (4)
Medically related impairment	11% (5)	7% (1)	13% (4)
Visual impairment	9% (4)	0% (0)	13% (4)
Hearing impairment	9% (4)	14% (2)	7% (2)
Limited use of hands/arms	7% (3)	7% (1)	7% (2)
Speech/communication impairment	5% (2)	0% (0)	7% (2)
Neurological impairment	5% (2)	0% (0)	7% (2)
Deaf	2% (1)	0% (0)	3% (1)
Pervasive Development Disorder (*e.g.*, Asperger's syndrome)	2% (1)	7% (1)	0% (0)
Blindness	0% (0)	0% (0)	0% (0)

Note: Percentages add up to more than 100% because some students reported having more than one disability.
[a] Total number of students with disabilities=44. [b] Total number of Anglophone students=14.
[c] Total number of Francophone students=30.

TABLE 2: PERCENTAGE OF STUDENTS USING EACH TYPE OF COMPUTER TECHNOLOGY

Computer Technology	% of Students (# of Students)				
	All[a]	Angl.[b]	Franc.[c]	LDD/ ADD/ADHD[d]	Non-LD/ ADD/ADHD[e]
Specialized software that improves writing quality	60% (26)	54% (7)	63% (19)	73% (22)	30% (4)
Other computer technology	30% (13)	38% (5)	27% (8)	27% (8)	38% (5)
Adapted mouse	12% (5)	15% (2)	10% (3)	7% (2)	23% (3)
Software that reads what's on the screen	9% (4)	8% (1)	10% (3)	3% (1)	23% (3)
Scanning and optical character recognition (OCR) software	9% (4)	15% (2)	7% (2)	7% (2)	15% (2)
Software that magnifies what is on the screen	7% (3)	8% (1)	7% (2)	3% (1)	15% (2)
Voice dictation software	7% (3)	23% (3)	0% (0)	10% (3)	0% (0)
Adapted keyboard	7% (3)	15% (2)	3% (1)	3% (1)	15% (2)
Large screen monitor	5% (2)	8% (1)	3% (1)	3% (1)	7% (1)
Refreshable Braille display	5% (2)	0% (0)	7% (2)	3% (1)	7% (1)

Note: Percentages add up to more than 100% because some students reported using more than one computer technology.
[a] Total number of students with disabilities=43. [b] Total number of Anglophone students=13.
[c] Total number of Francophone students=30. [d] Total number of students with LD/ADD/ADHD=30.
[e] Total number of students without LD/ADD/ADHD=13.



COMPUTER TECHNOLOGIES USED BY STUDENTS WITH DIFFERENT DISABILITIES

Findings from our previous investigations indicate how students with different disabilities use computers. The section that follows is based on Fichten, Asuncion, Barile, Fossey, and De Simone's (2000) paper. Most of the adaptive computer technologies mentioned are more fully described in the *Downloads* section of the Web site of Dawson College's Adaptech Research Network. [Online] http://www.adaptech.org

Students who are blind.

Most students who are blind use software that reads text on the screen (called *screen reader* or *text-to-speech*); many of these can "read" icons, tabs, and menu bars as well. By using a scanner and optical character recognition (OCR) software, printed text can be converted into electronic text that can then be read using a screen reader or a refreshable Braille display (a hardware device attached to a computer that provides Braille output). Laptops with screen readers and refreshable Braille displays can be used to take notes. Popular bilingual screen-reading software for students who are blind in Quebec is *Jaws*; and popular OCR software is *OpenBook*.

Students with low vision.

These students use software that enlarges the size of visual elements (magnification) as well as synthesized speech (*text-to-speech)* to read electronic text files. Many use both, along with large screen monitors. Students can control the visual display through readily available and built-in features of popular software (*e.g.*, zoom, font size, font and background color) to enhance contrast and visibility. These students, too, use scanners and OCR to enlarge printed materials or to convert printed material into electronic text. Popular bilingual screen-reading/magnification software for students with low vision in Quebec is *ZoomText*; and many of these students are able to use the OCR software that came with their scanner, such as *OmniPage*, for example.

Students with mobility and hand/arm impairments.

A variety of ergonomic adaptations are likely to be used by these students. Software-based keyboard adaptations include accessibility features in *Windows* operating systems such as sticky keys (built-in software to allow one keystroke use of keys that require *Shift, Control, Alt*, etc.); filter keys (to instruct the computer to ignore brief or repeated keystrokes or to slow key repeat rates); mouse keys (to allow mouse movements to be emulated by keystrokes); and a virtual keyboard (similar to those found on certain smart phones). Both software and hardware adaptations can allow for one-handed typing. Students can also use a key guard (plastic keyboard overlay to prevent hitting two keys at the same time), splints, wrist rests, as well as a variety of alternative mice including trackballs and touch pads. Many students can benefit from dictation software that allows them to dictate content as well as to control menus and dialog boxes by voice. Students can also use alternate input devices such as a mouth wand (a chopstick-like rod with a rubberized tip for typing using one's mouth), a sip and puff device (a system to give computer commands by blowing or sucking through a straw-like device) or Morse input. Some of these students, too, can benefit from electronic text (no need to handle paper) as well as electronic dictionaries and encyclopedias. Thus, scanners with OCR software can be useful for these students as well. Some students also use word prediction software to speed up their typing. Portable devices such as a laptop or a portable note-taking device can also be useful. Popular bilingual dictation software used by students is *Dragon Naturally Speaking*; and popular bilingual word-prediction software is known as *WordQ*.

Students with hearing impairments.

A variety of electronic dictionaries/encyclopedias as well as both general use (*e.g.*, spell-check and grammar-check) and specialized writing aids (*e.g.*, word-prediction software) can be helpful for these students. They can also use the *Windows* operating system's built-in accessibility features such as visual flash (instead of sounds) as well as computer-based and mobile chat programs such as *Windows Live Messenger*. When accessing video and audio clips, these students can make use of subtitles/captions when they are available.

Students with speech/communication impairments.

These students can also use a portable, lightweight laptop or note taker device (*e.g., AlphaSmart 2000*) to communicate with others in face-to-face contexts. For class presentations these students can use a word processor with a multimedia projector instead of speaking or they can have *PowerPoint* or other presentation materials projected onto a large screen.

Students with a learning disability.

Students with learning disabilities can use equipment developed for students with the disabilities mentioned above. For example, students who have dyslexia or other reading problems can use software that reads what is on the screen as well as screen magnification and highlighting. A popular free product used by many Quebec students is *ReadPlease*. These students can also use a scanner and OCR to convert printed materials to electronic text. For students who have difficulty writing cursive text, a laptop or portable note-taking device can be

useful. Students who have difficulty with grammar and spelling sometimes find dictation software helpful. Those with problems related to organization can use commonly available document manager and scheduling programs. Of course, spelling and grammar checkers are very important. These students can also benefit from word prediction and electronic dictionaries and encyclopedias. Also, specialized "mind mapping" flowcharting software may be of interest. A popular bilingual "high end" (*i.e.*, expensive) product that combines many of these elements is *Kurzweil 3000*.

The most commonly reported advantage of computer technologies [...] was associated with the use of spelling and grammar checking [...].

ADVANTAGES OF COMPUTER TECHNOLOGIES

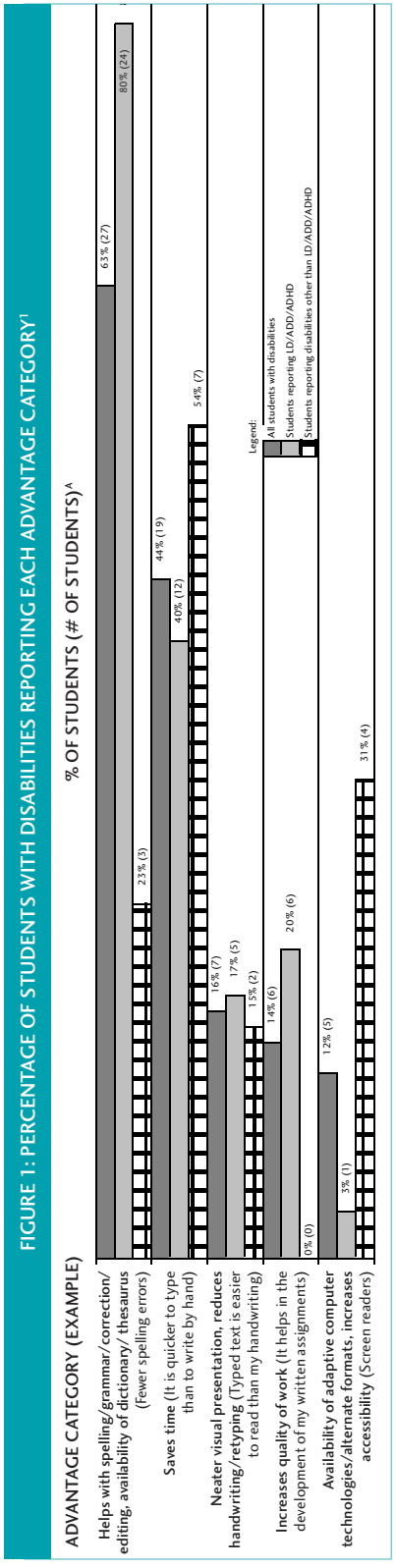
The most commonly reported advantage of computer technologies reported by students in the present investigation was associated with the use of spelling and grammar checking (*e.g.*, fewer spelling mistakes), followed by the ability of these technologies to save time (*e.g.*, to get essays done faster) and to improve the visual presentation (*e.g.*, neater work) and overall quality of written work (*e.g.*, helps in the development of written assignments; see Figure 1). At a German university, Ommerborn and Schuemer (2001) surveyed 105 distance-education students with disabilities about the advantages and disadvantages of using a personal computer. Among the advantages most frequently cited by students in their sample were: easier to write essays, easier access to information, easier communication with university staff and with fellow students. The disadvantages most frequently associated with computer use in their sample were: high cost of equipment and Internet use, fatigue of posture/wrists/eyes as a result of extended computer use, and a lack of training opportunities for learning how to use a computer effectively. Participants in their study also suggested that increased training and information on adaptive computer technologies for students with disabilities and increased accessibility of e-learning materials and course-related web sites would improve computer use by students with disabilities.

PROBLEMS AND SOLUTIONS

Students in our sample also described a number of problems they had encountered using computer technologies (see Figure 2). The most frequently mentioned issues were related to difficulties using these technologies (*e.g.*, difficulty connecting to internet), a lack of computers at home or school (*e.g.*, limited access to computer labs) and problems with spell-check/grammar-check/correction software not meeting their needs (*e.g.*, doesn't correct all mistakes). The lack of available computers reported by students in our sample echoes the findings of Sharpe and colleagues (2005) who also noted problems with inadequate access.

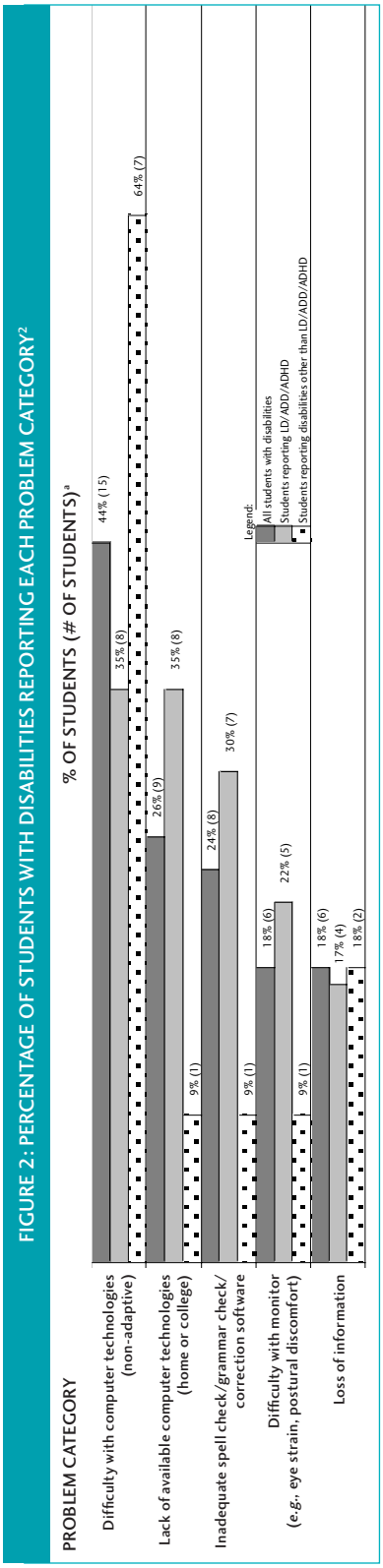
The students in our sample indicated that the vast majority of the problems they had encountered using computer technologies either remained unresolved or had required them to devote extra time and effort to resolve (*e.g.*, practice using the software during spare time, see Figure 3). It is noteworthy that in our sample, the most frequently mentioned unresolved problems were also the most frequently encountered problems, namely, the lack of computer technologies and difficulties using these.

FIGURE 1: PERCENTAGE OF STUDENTS WITH DISABILITIES REPORTING EACH ADVANTAGE CATEGORY[1]



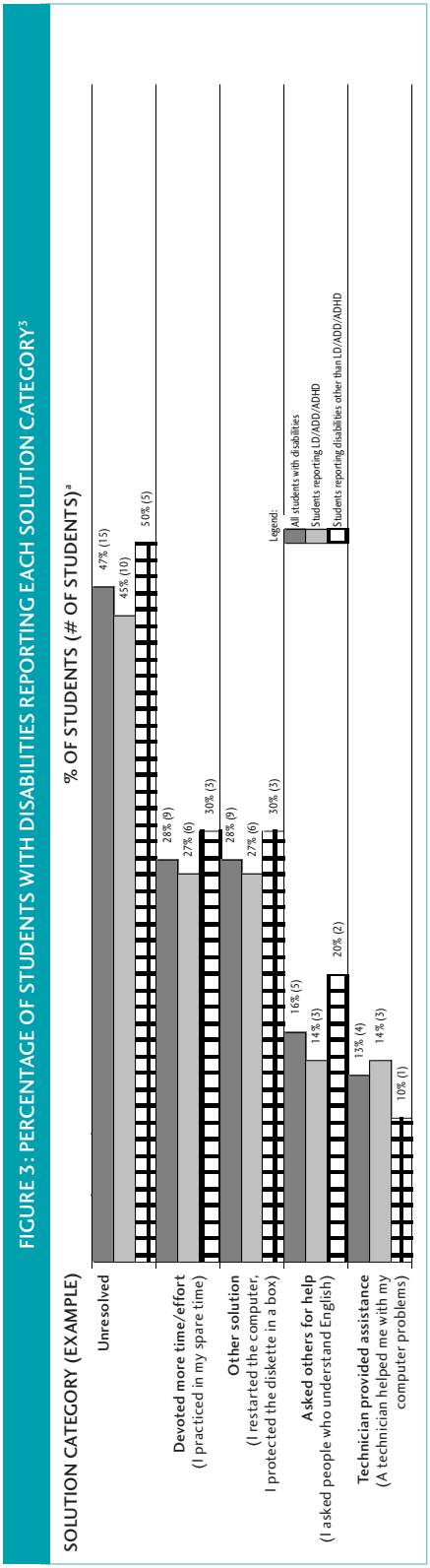
Note: Percentages add up to more than 100% because participants each provided up to three advantages.

FIGURE 2: PERCENTAGE OF STUDENTS WITH DISABILITIES REPORTING EACH PROBLEM CATEGORY[2]



Note: Percentages add up to more than 100% because participants each provided up to three problems.

FIGURE 3: PERCENTAGE OF STUDENTS WITH DISABILITIES REPORTING EACH SOLUTION CATEGORY[3]



Note: Percentages add up to more than 100% because participants each provided up to three solutions.

[1] **For Figure 1:**

[a] Total number of students with disabilities who provided at least one advantage response=43.

Total number of students reporting LD/ADD/ADHD who provided at least one advantage response=30.

Total number of students reporting disabilities other than LD/ADD/ADHD who provided at least one advantage response=13.

[2] **For Figure 2:**

[a] Total number of students with disabilities who provided at least one problem response=34.

Total number of students reporting LD/ADD/ADHD who provided at least one problem response=23.

Total number of students reporting disabilities other than LD/ADD/ADHD who provided at least one problem response=11.

[3] **For Figure 3:**

[a] Total number of students with disabilities who provided at least one solution response=32.

Total number of students reporting LD/ADD/ADHD who provided at least one solution response =22.

Total number of students reporting disabilities other than LD/ADD/ADHD who provided at least one solution response=10.

CONCLUSIONS

Students with disabilities not only perceived numerous advantages of using computer technologies, but research has also demonstrated that the advantages translate into real improvements academically and psychologically (*e.g.*, Raskind & Higgins, 1998). The findings of the present investigation confirm that there is a large body of students with learning disabilities in Quebec colleges whose computer-technologies-related needs are not being met. The first obstacle to be overcome is the lack of access to needed computer technologies reported by students with all types of disabilities. Increasing the availability of these technologies in colleges would benefit all students, not only those with disabilities. For students who cannot afford appropriate computer technologies for home use, government financial aid programs should be made much more available.

Students cannot reap the full benefits of adaptive computer technologies if they do not know how to use them properly. As Goodman and colleagues' (2002) study demonstrated, students with disabilities can benefit from training programs geared to their needs. The goal of such programs should be to introduce students to adaptive computer technologies that meet their specific needs and to show them how to use them. Without appropriate training, the difficulties experienced by students using adaptive computer technologies will persist and the resulting frustration may lead to decreased use or abandonment of needed adaptations, resulting in poorer academic performance.

Further research is needed to determine which types of technologies are best suited to the needs of college students with various disabilities and to develop effective training programs to educate students on how to use them. In particular, the software needs of students with learning disabilities need to be addressed more effectively.

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