Fichten, C. S., Ferraro, V., Asuncion, J. V., Chwojka, C., Barile, M., Nguyen, M. N., Klomp, R., & Wolforth, J. (2009). Disabilities and e-Learning Problems and Solutions: An Exploratory Study. *Educational Technology & Society*, *12* (4), 241–256.

Disabilities and e-Learning Problems and Solutions: An Exploratory Study

Catherine S. Fichten[1], Vittoria Ferraro[2], Jennison V. Asuncion[2], Caroline Chwojka[2], Maria Barile[2], Mai N. Nguyen[2], Ryan Klomp[3] and Joan Wolforth[4]

[1]Psychology Department and Adaptech Research Network, Dawson College, Montreal, Canada // catherine.fichten@mcgill.ca

[2]Adaptech Research Network, Dawson College, Montreal, Canada // vferraro@dawsoncollege.qc.ca // asuncion@alcor.concordia.ca // caroline_chwojka@hotmail.com // mbarile@dawsoncollege.qc.ca // blitzball_game@hotmail.com

[3]299 Somerset St. W. # 308 Ottawa, Canada // ryanklomp@rogers.com

[4]Office for Students with Disabilities, McGill University, Montreal, Canada // joan.wolforth@staff.mcgill.ca

ABSTRACT

This study explored e-learning problems and solutions reported by 223 students with disabilities, 58 campus disability service providers, 28 professors, and 33 e-learning professionals from Canadian colleges and universities. All four groups indicated, via online questionnaires, problems with: accessibility of websites and course/learning management systems (CMS); accessibility of digital audio and video; inflexible time limits built into online exams; PowerPoint/data projection during lectures; course materials in PDF, and lack of needed adaptive technologies. Students also mentioned technical difficulties using e-learning and connecting to websites and CMS, problems downloading and opening files, web pages that would not load, video clips taking too long to download, poor use of e-learning by professors and their own lack of knowledge working with e-learning. Disability service providers, too, mentioned the poor use of e-learning by professors as well as poor accessibility of course notes and materials in many formats. E-learning professionals noted difficulties with inaccessible course notes and materials. Professors identified mainly problems raised by the other groups. Sixty-seven percent of students, 53% of service providers, 36% of e-learning professionals and 35% of professors indicated that at least one of their three e-learning problems remained unresolved. We discuss how the different roles and perspectives of the four participant groups influence their views, and make recommendations addressing identified common e-learning problems.

Keywords

Disability, College students, Professors, E-learning, Accessibility, Problems and solutions

The increased use of information and communication technologies (ICTs) in most sectors of society and recent developments in adaptive hardware and software have allowed individuals with disabilities to do things that were difficult or impossible for them to do in the past. For example, it has allowed people who are blind to read using text-to-speech technology, people who are deaf to communicate using chat programs, and people with difficulties using their hands or arms to write and communicate using dictation software (Fichten, Asuncion, Barile, Fossey, & De Simone, 2000). In the postsecondary arena, e-learning (i.e., ICTs used in teaching) are extensively used by professors in virtually all colleges and universities, not only in the United States, but also in Canada (Abrami et al., 2006) and the United Kingdom (Weller, Pegler, & Mason, 2005). Whether it is PowerPoint presentations in class, the use of web-based discussions to further in-class conversation, or courses delivered completely over the Internet, it is clear that such technologies used by professors are here to stay.

But how well do the ICTs used by professors in teaching postsecondary courses (i.e., e-learning) meet the needs of students with different disabilities? How successfully do these ICTs interact with adaptive hardware and software that some students with disabilities require? How accessible is the growing array of available e-learning on campus (Konur, 2007; Waddell, 2007)? These are important questions because the numbers of students with disabilities in postsecondary education have been rising both in Canada (Fichten, Jorgensen, Havel, & Barile, 2006; Tremblay & Le May, 2005) and the US (National Council on Disability, 2003), where a recent large scale study showed that in 2003–2004, 11% of undergraduates had a disability (Snyder & Dillow, 2007). In addition, during the past few years, skill in using ICTs has become mandatory in postsecondary education and the workplace (e.g., Ezziane, 2007; Stodden, Conway, & Chang, 2003). For example, a recent investigation shows that computer use on the job is associated with higher salaries for employees both with and without disabilities (Canadian Council on Social Development, 2004), and that for people with disabilities this is especially important (e.g., Kruse, Krueger, & Drastal, 1996). Abrami et al. (2006), who recently showed how important e-learning initiatives are in Canadian postsecondary education, also noted that we know very little about the e-learning needs and concerns of students with disabilities.

E-learning can promote the inclusion of students with various disabilities (Di Iorio, Feliziani, Mirri, Salomoni, & Vitali, 2006). For example, online courses provide enhanced opportunities for people who, because of climate, health, transportation or physical accessibility, experience barriers to attending classroom-based courses (e.g., Debenham, 2002). Similarly, in traditional classes students who have print impairments can access course notes and handouts on the course website without assistance, so long as these are designed to be accessible.

In spite of the tremendous opportunities afforded by e-learning for learners with disabilities there are a variety of barriers that interfere with their effective use. A brief primer on how students with different disabilities use ICTs can be found in Fichten, Asuncion, Barile, Fossey, and De Simone (2000). A key concern is that faculty and individuals accountable for supporting and implementing e-learning within postsecondary institutions, in the rush to integrate technology into teaching, fail to think about the accessibility needs of students with various disabilities (Bissonnette, 2006). For example, those in charge of supporting and deploying e-learning generally do not confirm ahead of time whether newly purchased academic software is compatible with adaptive software that reads what is on the screen to individuals with print impairments. PowerPoint presentations in class, if not posted online ahead of time, can cause difficulties for students with visual and other disabilities requiring adaptive software to read and follow the presentation. Video clips posted on a course website with no captioning can pose problems for students with hearing impairments. Websites can pose problems for students with learning, visual, and neuromuscular disabilities even when they use adaptive software such as screen magnification, screen reading, and dictation software (Burgstahler, Corrigan, & McCarter, 2005; Bohman, 2007; Roberts & Stodden, 2005; Sharpe, Johnson, Izzo, & Murray, 2005).

At least four postsecondary groupings have a stake in accessibility and e-learning in colleges and universities: the students themselves, service providers who provide disability related services to the campus community, professors who use and implement e-learning in their courses, and the e-learning professionals on campus who provide leadership, choose e-learning for campus-wide use and provide help and assistance with e-learning and other ICTs. Because of their different perspectives, these four groups are likely to have different views about e-learning accessibility (Fichten, Asuncion, Barile, Fossey, & Robillard, 2001).

There have been studies related to the ICT needs and concerns of students with disabilities, including e-learning, where the participants were campus disability service providers (e.g., Stodden, Roberts, Picklesimer, Jackson, & Chang, 2006), postsecondary graduates (Sharpe et al., 2005), assistive technologists (Thompson, 2004), and professors (Vogel, Leyser, Burgstahler, Sligar, & Zecker, 2006). These studies all had different goals, used different questions, and had different sampling limitations, making their findings impossible to compare. In addition, in none of these studies did a number of different groups answer the same questions about the problems they experienced with e-learning and about how these were resolved. Perhaps more important, none of these studies included the end-users — current students with disabilities — in their samples.

In the present study, which forms part of a larger investigation of e-learning (Asuncion, Fichten, & Barile, 2007), we examine the perspectives of the four key stakeholders about the accessibility of e-learning: postsecondary students with a variety of disabilities, campus disability service providers, professors, and e-learning professionals. We examine both problems and solutions as experienced in Canadian junior/community colleges and universities and also assess the benefits of e-learning as experienced by the students themselves. Based on the findings, we make recommendations about addressing common e-learning problems encountered in postsecondary education and about how the different roles and perspectives of the four participant groups influence their views. It is important to note this is an exploratory, descriptive study that is not theoretically based. Its main objective is to compare the views of the four groups, to suggest hypotheses for future investigations, and to propose recommendations based on available information.

Method

Participants

Two hundred twenty-three Canadian university and junior/community college students with various disabilities (74 males, 149 females), 58 campus disability service providers (15 males, 43 females), 28 professors (10 males, 18 females), and 33 campus e-learning professionals (16 males, 17 females) participated. Participants studied or worked at 318 Canadian postsecondary institutions.

Students with disabilities had taken at least one course in the last three years that used some form of e-learning. Eighty-two students were enrolled in a Canadian junior/community college and 136 in a university; 5 did not specify this information. Seventy-three were pursuing a college certificate or diploma, 97 an undergraduate degree, 19 a university certificate or diploma, 26 a graduate degree and 5 students pursued other credentials. Students had a mean age of 27 (*SD* = 7.82, range = 19–59, median =25). Numbers do not always total the entire sample because some participants did not answer all questions.

Table 1 shows that the most common impairment (41%) noted by students was a learning disability, followed by mobility impairment (23%). Of the 223 students, 100 (45%) reported more than one impairment for a total of 381 impairments. Students were enrolled in a variety of disciplines such as arts, science, nursing, engineering, law, and physiotherapy.

Table 1. Percentage of Students Indicating Various Disabilities/Impairments

Disability/Impairment	Percentage of Students
Learning disability	41%
Mobility impairment / wheelchair user	23%
ADD/ADHD	21%
Psychological/psychiatric disability	17%
Health / medically related impairment	16%
Deaf / hard of hearing	13%
Difficulty using hands and/or arms	12%
Visual impairment: low vision	11%
Neurological impairment	11%
Speech or communication impairment	3%
Totally blind	2%
Other	1%

Note. The 223 students indicated 381 impairments.

Thirty-three campus disability service providers worked at a junior/community college and 23 at a university. One worked at another type of postsecondary institution. They had worked providing services an average of 7 years (range = 1–22 years, SD = 5, median = 5). They indicated that an average of 280 students (*SD* = 309, range = 4–1100) were registered to receive services from their office. However, there was a very large range and the median of 130 is probably a better measure of central tendency than the mean in this case.

All professors had taught at least one student with a disability during the last three years in a course where they used some form of e-learning. Seventeen worked at a junior/community college and 10 at a university. One failed to specify a school. They taught in a variety of disciplines from arts, science and commerce, to communications and millwright technology. They had taught an average of 25 students with disabilities (*SD* = 84, range 1–450, median = 6) during the past three years. Given the great range and the variability, the median of 6 students probably represents a better central tendency. They had been teaching in postsecondary education for a mean of 10 years (*SD* = 7, range = 1–25 years, median =11). Professors had used e-learning for a mean of 5 years (*SD* = 3.13, range = 1–12 years, median =5).

Seventeen e-learning professionals worked at a junior/community college and 16 at a university. They worked at 32 postsecondary institutions for an average of 18 years (*SD* = 9, range 2–35, median 20 years), eight of these in the e-learning field (*SD* = 4, range 1–16, median 8). Their job titles were varied and included Help Desk Intern, Distance Education Specialist, and Director of Educational Media Development.

Procedure

Participant Recruitment

Four methods were used to recruit potential participants: email discussion lists focusing on Canadian postsecondary education or e-learning, our project partners (National Educational Association of Disabled Students, Canadian

Association of Disability Service Providers in Postsecondary Education, and the Adaptech Research Network), reaching out to previous research participants who expressed willingness to participate in future studies and, in the cases of professors and e-learning professionals, where we had challenges finding participants, we asked our campus disability service provider contacts to recommend potential participants, whom we contacted by phone or email. In all cases, participants who indicated their interest were directed to a website where they read the consent form which provided information about the study, including the draw for four $100 gift certificates to a large online computer store for each group. Clicking on the "I consent" button brought participants to the online questionnaire for their specific group.

Online Questionnaire

This was administered in the first half of 2006. The online package, one each for the four participant groups, consisted of demographic questions, closed-ended e-learning related questions required for the larger investigation, open-ended questions of the present study, and a coupon to enter the draw for the gift certificate. Questions were developed in consultation with the project team and project partners. Questions were pilot tested to uncover problems. These were also tested to ensure they were technologically accessible by key informant students with different disabilities. Once complete, we conducted four-week test-retest reliability testing of the closed-ended questions. Questions with poor reliability were omitted from the final questionnaires, which are available from the first author.

Demographic questions. We asked all participants about their sex and the name of their school. We also asked: students about their field of studies, the nature of their disabilities, and the adaptive computer technologies they used; professors about their discipline, the numbers of years they taught in postsecondary education, and the number of students with disabilities they had taught during the past 3 years; disability service providers how long they had worked providing services to postsecondary students with disabilities; and e-learning professionals how long they had worked in postsecondary education and their job title. We have used most of these questions in previous studies (Fichten, Barile, & Asuncion, 1999; Fossey et al., 2005).

Definitions of e-learning and accessibility. E-learning was defined in the questionnaires as referring to the range of information and communication technologies that professors use when teaching their courses entirely in the classroom, entirely online, or a combination of both. E-learning includes (but is not limited to) the use of the Internet (e.g., course web pages, lectures delivered live online), CD-ROMs, and presentation tools (e.g., PowerPoint). Accessibility was defined as incorporating usability concepts and referring to the ability of students, regardless of their disability, to easily and independently use e-learning. We noted that for some learners this may require adaptive technology (e.g., software that reads what is on the screen).

E-learning benefits, problems and solutions. We asked students to write, in free-form text boxes, three benefits of using e-learning. We also asked all participants to respond to the following questions, "Indicate three problems you have encountered using e-learning. How was each resolved? (if not resolved write 'unresolved')" and provided them with three pairs of free-form text boxes.

Coding problems, solutions, and benefits questions. A coding manual consisting of 28 categories of Problems, 18 categories of Solutions, and 21 categories of Benefits of using e-learning was developed, based on the open-ended responses that participants provided. Three trained research assistants classified responses. Inter-rater agreements for Problems, Solutions, and Benefits based on five random spot-checks of reliability ranged from 61% to 87%. All discrepancies were resolved by consensus.

Results

Adaptive Technologies

One hundred thirty-nine students (62%) indicated that they required adaptive technology (i.e., adaptive hardware and/or software) to use e-learning effectively (e.g., software that improves writing quality, screen reader, dictation

software). There was no significant difference in the number of e-learning problems indicated by students who did and those who did not use adaptive technologies (M = 2.12 and M = 2.22, respectively, $t(167)$ =.68, p =.50).

The 139 students who required adaptive technologies to use e-learning reported 368 different technologies, indicating a mean of 2.65 different technologies per student. Table 2 shows that the most commonly used technology was software that helps with writing followed by software that reads what is on the screen. Table 2 also shows that most students felt they could use their adaptive technologies effectively, although there was substantial variability in responses.

Table 3. Percentage of Students with Disabilities Reporting Each Benefit Category

Benefit Category	Percentage of Students	Number of Students
Availability of online course notes	41%	87
Helps learning/academic success	21%	46
Helps understand course lecture/content	20%	42
Benefit other than those listed	19%	41
Ability to work at own pace	18%	38
Ability to work/learn from home	17%	37
Availability of online course materials/resources other than notes	16%	34
Helps organization/time management	15%	33
Convenience communicating with peers/professors	15%	32
Availability of information anywhere / any time	10%	22
Feel more independent / confident / less stressed	9%	19
Saves time	9%	19
Allows use of adaptive technology/software	8%	18
Ability to keep up with the rest of the class	6%	13
Makes classes more interesting and stimulating	5%	10
Availability of materials in alternate formats	4%	8
Learn more about technology	4%	8
Ability to be anonymous / reduces social anxiety	3%	7
Less materials to transport	3%	7
Saves money	2%	4

Table 2. Adaptive Computer Technologies Used by Students in Rank Order

			How Effectively Student Can Use the Technology [2]	
Adaptive Computer Technology	Percent of Students	Number of Students [1]	Mean	Std. Deviation
Software that helps with writing (e.g., Inspiration, WYNN)	60%	83	5.12	1.36
Software that reads what is on the screen (e.g., JAWS, ReadPlease)	50%	69	5.31	1.02
Scanning and optical character recognition (OCR)	35%	49	4.78	1.75
Voice dictation software	34%	47	4.56	1.56
Software that magnifies what is on the screen	24%	34	5.03	1.47
Large screen monitor	24%	33	n/a	n/a
Adapted mouse	14%	19	4.25	2.11
Adapted keyboard	13%	18	4.35	1.93
Other	7%	11	n/a	n/a
Refreshable Braille display	4%	5	4.00	2.74

[1] 139 students reported using at least one adaptive computer technolgy; several indicated using more than one.

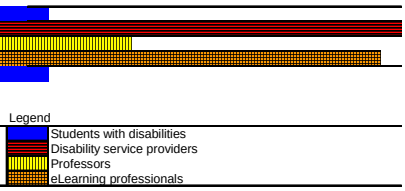
[2] Six point scale, with higher scores indicating being able to use the technology more effectively.

Benefits

The 214 students who responded to this question indicated 578 Benefits. Table 3 shows the percentage of students who indicated each Benefit in rank order. This shows that the most common benefit, noted by 41% of students, was the availability of online course notes.

Figure 1. Percentages of Participants Reporting Each Problem

Problem Category	Percent of Participants from the Four Groups	
Inaccessibility of websites / course management systems	20% 37% 24% 36%	X^2 (3,284) 7.59 p = .055
Technical difficulties	20% 4% 0% 0%	X^2 (3,284) 8.72 p = .033*
Poor use of eLearning by professors	15% 11% 5% 0%	X^2 (3,284) 5.42 p = .144
Difficulty connecting to websites/ course management systems	14% 2% 10% 0%	X^2 (3,284) 7.51 p = .057
Students' lack of knowledge of how to use eLearning	13% 5% 5% 0%	X^2 (3,284) 4.58 p = .205
Lack of technology/software required for home access	9% 7% 10% 0%	X^2 (3,284) 0.61 p = .895
Inaccessibility of course notes/materials	9% 12% 0% 36%	X^2 (3,284) 16.00 p = .001*
Professors' lack of knowledge of how to use eLearning	8% 2% 0% 5%	X^2 (3,284) 2.81 p = .422
Inaccessibility of audio/video material	8% 7% 10% 14%	X^2 (3,284) 1.11 p = .774
Professors' lack of using eLearning	7% 4% 5% 0%	X^2 (3,284) 1.14 p = .768
Lack of interaction between students and professors	7% 2% 0% 0%	X^2 (3,284) 2.40 p = .493
Time limits of online exams/assignments	6% 11% 17% 18%	X^2 (3,284) 5.39 p = .145
Difficulty with online discussions/activities	5% 4% 5% 5%	X^2 (3,284) 0.19 p = .979
Inaccessibility of PowerPoint / data projection during lectures	5% 12% 19% 9%	X^2 (3,284) 7.55 p = .056
Inaccessibility of course notes/materials in PDF	4% 11% 10% 9%	X^2 (3,284) 4.49 p = .213
Unreliable/incompatible hardware/software	4% 5% 0% 0%	X^2 (3,284) 0.25 p = .969
Inaccessibility of course notes/materials: PowerPoint	4% 5% 0% 0%	X^2 (3,284) 0.25 p = .969
Lack of needed adaptive technology	3% 11% 10% 9%	X^2 (3,284) 6.95 p = .074
Difficulty acquiring alternate formats	3% 7% 0% 0%	X^2 (3,284) 2.25 p = .523
Inaccessibility of computer / technological facilities: ergonomic	2% 2% 10% 0%	X^2 (3,284) 4.20 p = .240
Cost of software/hardware	3% 7% 0% 0%	X^2 (3,284) 2.25 p = .523
Inaccessibility of course content during in-class lectures	1% 2% 0% 0%	X^2 (3,284) 2.56 p = .464
Professors' lack of knowledge of how to make eLearning accessible	<½% 7% 10% 5%	X^2 (3,284) 10.80 p = .013*
Lack of technical support	<½% 4% 10% 0%	X^2 (3,284) 8.94 p = .030*
Inaccessibility of computer/ technological facilities: architectural	<½% 0% 10% 0%	X^2 (3,284) 9.88 p = .020*

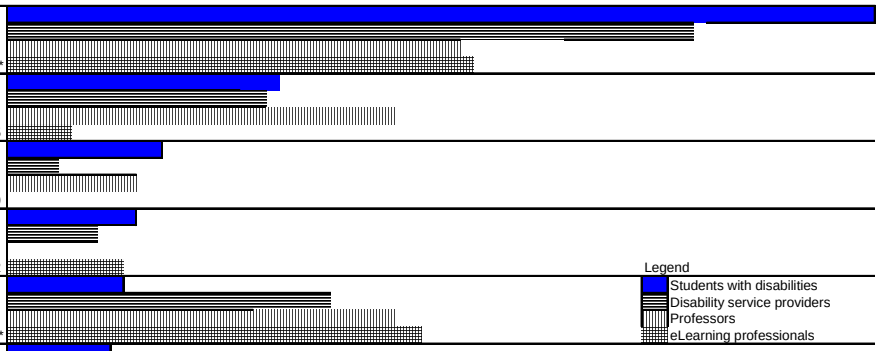


Problems and Solutions

Two hundred eighty-four participants indicated at least one problem: 184 students, 57 disability service providers, 21 professors, and 22 e-learning professionals. Their responses are shown in Figure 1, which presents the percentage of participants from the four groups who indicated each of the 28 types of problems, in rank order of student responses. It should be noted that student responses are influenced by the disproportionate number of students with learning disabilities. Problems specified by at least 10% of students were, in rank order: inaccessibility of websites/course management systems, technical difficulties, poor use of e-learning by professors, difficulty connecting to websites/course management systems, and students' lack of knowledge of how to use e-learning. Figure 1 also shows that several problem areas were identified by over 10% of the other three groups, although these were noted by less than 10% of students. For example, although 19% of professors indicated problems with PowerPoint presentations in class, less than 5% of students indicated this. Similarly, while 17% of professors indicated problems with time limits on online exams, only 6% of students singled this out as problematic.

Figure 2. Percentages of Participants Reporting Each Solution

Solution Category	Percent of Participants from the Four Groups		
Unresolved	67%	X^2	
	53%	(3,268)	
	35%	15.00	
	36%	p = .002*	
Non-eLearning solution	20%	X^2	
	20%	(3,268)	
	30%	4.58	
	5%	p = .205	
Professor provided assistance	12%	X^2	
	4%	(3,268)	
	10%	4.22	
	0%	p = .239	
Student obtained / used technology / software	10%	X^2	
	7%	(3,268)	
	0%	0.79	
	9%	p = .852	
Obtained alternate formats	9%	X^2	
	25%	(3,268)	
	30%	18.00	
	32%	p = .000*	
Devoted more time/effort	8%	X^2	
	2%	(3,268)	
	0%	2.73	
	0%	p = .435	
eLearning specialist / technician / staff provided assistance	8%	X^2	
	2%	(3,268)	
	0%	4.11	
	14%	p = .250	
Used technology/software elsewhere	7%	X^2	
	4%	(3,268)	
	5%	1.09	
	0%	p = .781	
Friends/classmates provided assistance	6%	X^2	
	2%	(3,268)	
	0%	1.61	
	5%	p = .657	
Disability service provider provided assistance	4%	X^2	
	11%	(3,268)	
	5%	4.14	
	0%	p = .247	
Obtained / used adaptive technology / software	4%	X^2	
	9%	(3,268)	
	0%	23.40	
	32%	p = .000*	
Students learned more about eLearning	3%	X^2	
	2%	(3,268)	
	0%	0.77	
	0%	p = .856	
Time extensions granted for online exams	2%	X^2	
	4%	(3,268)	
	15%	9.41	
	9%	p = .024*	
Other eLearning solution	2%	X^2	
	5%	(3,268)	
	4%	3.58	
	9%	p = .311	
Got note taker/tutor/interpreter	2%	X^2	
	7%	(3,268)	
	5%	3.32	
	0%	p = .345	
Professors learned more about eLearning	1%	X^2	
	7%	(3,268)	
	5%	6.38	
	5%	p = .095	
Student obtained government funding	1%	X^2	
	2%	(3,268)	
	0%	2.59	
	0%	p = .459	
School developed guidelines regarding eLearning	0%	X^2	
	7%	(3,268)	
	0%	8.78	
	0%	p = .032*	



Chi Square tests of independence, detailed in Figure 1, show significant findings on five comparisons: technical difficulties (frequently noted by students but not other groups), inaccessibility of course materials (e-learning professionals were most likely to think this is a problem and disability service providers least likely), professors' lack of knowledge about how to make e-learning accessible (students were least likely to think this was problematic), lack of technical support (students and e-learning professionals did not see this as problematic) and inaccessibility of computer facilities (professors were more likely to see this as problematic than the other groups).

Two hundred sixty-eight participants provided at least one Solution: 181 students, 55 disability service providers, 20 professors, and 22 e-learning professionals. Their responses are shown in Figure 2, which presents the percentage of participants from the four groups in rank order of student responses. The most common solutions, noted by at least 10% of students, are: that the problem was not resolved, that the problem was solved using a non e-learning solution, that the professor provided assistance, and that the student obtained needed computer software or hardware. It should be noted that the most common response of all groups was "unresolved," with 67% of students indicating that at least one of their three e-learning problems remained unresolved.

Chi Square tests of independence, detailed in Figure 2, show significant findings on five comparisons: problem unresolved (more frequently noted by students and professors than the other two groups), student obtaining alternate formats (least frequently noted by students), students obtaining adaptive technology (most frequently noted by e-learning professionals), time extensions for online exams (least frequently noted by students and disability service providers), and the school developing accessibility guidelines (noted exclusively by disability service providers). Figure 2 also shows that several solutions were identified by over 10% of one the other three groups, although these were noted by less than 10% of students. For example, although 11% of disability service providers indicated that a campus based disability service provider provided assistance, only 4 % of students indicated this. Similarly, although 14% of e-learning professionals indicated that an e-learning professional provided assistance, only 8% of students, 2% of disability service providers and none of the professors cited this as a solution.

Table 4. Problem-Solution Pairs for Top Five Problems of Each Group

	Problem	Number of Problem-Solution Pairs	Most Common Solution		Second Most Common Solution		Third Most Common Solution		Fourth Most Common Solution	
			Outcome	%	Outcome	%	Outcome	%	Outcome	%
Students										
1	Inaccessibility of websites / course management systems	41	Unresolved	61%	Professor provided assistance	12%	Devoted more time/effort	7%		
2	Technical difficulties	38	Unresolved	32%	eLearning specialist / technician / staff provided assistance	8%	Student obtained / used technology / software	8%	Used technology / software elsewhere	8%
3	Poor use of eLearning by professors	31	Unresolved	87%	Professor provided assistance	10%				
4	Students' lack of knowledge of how to use eLearning	27	Unresolved	33%	Devoted more time/effort	19%	Disability service provider provided assistance	11%	eLearning specialist / technician / staff provided assistance	11%
5	Difficulty connecting to websites/ course management systems	26	Unresolved	31%	eLearning specialist / technician / staff provided assistance	15%	Devoted more time/effort	15%		
Disability service providers										
1	Inaccessibility of websites / course management systems	28	Unresolved	50%	School developed guidelines regarding eLearning	14%	Disability service provider provided assistance	11%	Non-eLearning solution	11%
2	Inaccessibility of course notes/materials	9	Unresolved	33%	Obtained alternate formats	22%				
3	Inaccessibility of PowerPoint / data projection during lectures	9	Unresolved	22%	Obtained alternate formats	22%				
4	Poor use of eLearning by professors	6	Unresolved	67%						
5	Inaccessibility of course notes/materials in PDF	6	Obtained alternate formats	67%	Unresolved	33%				
Professors										
1	Inaccessibility of websites / course management systems	5	Obtained alternate formats	60%						
2	Inaccessibility of PowerPoint / data projection during lectures	3	Obtained alternate formats	67%						
3	Time limits of online exams/assignments	3	Time extensions granted for online exams	67%						
eLearning Professionals										
1	Inaccessibility of websites / course management systems	10	Unresolved	30%	eLearning specialist / technician / staff provided assistance	30%				
2	Inaccessibility of course notes/materials	10	Obtained / used adaptive technology / software	30%	Unresolved	20%	Obtained alternate formats	20%		
3	Time limits of online exams/assignments	4	Obtained alternate formats	50%	Time extensions granted for online exams	50%				
4	Inaccessibility of audio/video material	3	Unresolved	67%						

One question of interest concerned the solution for specific problems. Table 4 presents results which show that most of the common problems noted by participants, with the exception of professors, remained unresolved. This was true

for ALL of the students' top five problems, for 4 of disability service providers' and ½ of e-learning professionals' top five items.

When it comes to e-learning problems and solutions the nature of students' disabilities and impairments can have an important impact. Therefore, in Table 5 we present the most common problems and solutions for students with different disabilities. This shows that the most popular solution for students with all types of disabilities is unresolved. For most groups of students, solving e-learning problems by using non e-learning solutions was also popular. In addition to the common problems of inaccessibility of websites and course management systems and technical difficulties, which seem to pose problems for students regardless of the nature of their disability, students with learning disabilities and students with mobility impairments and arm/hand issues also had problems due to their lack of knowledge about how to use e-learning effectively. Students with psychiatric and with health issues noted problems due to poor use of e-learning by professors. Students with hearing impairments, not surprisingly, had problems related to the accessibility of audio and video materials. Students with visual impairments had problems related to the accessibility of course notes and materials, especially those in PDF. When their problem had a solution it was through non e-learning solutions, such as having someone read the materials aloud to them or through alternative formats or using adaptive technologies.

Table 5. Common Problems and Solutions for Students with Different Disabilities

Student's Disability / Impairment	Problems in Rank Order	Solutions in Rank Order
Learning disability	Technical difficulties Students' lack of knowledge of how to use eLearning	Unresolved Non-eLearning solution Professor provided assistance
Mobility impairment / Difficulty using hands and/or arms	Inaccessibility of websites / course management systems Technical difficulties Students' lack of knowledge of how to use eLearning	Unresolved Non-eLearning solution Student obtained / used technology / software
ADD/ADHD	Technical difficulties	Unresolved
Psychological / psychiatric disability	Poor use of eLearning by professors Difficulty connecting to websites/ course management systems	Unresolved Obtained alternate formats
Health / medically related impairment	Technical difficulties Poor use of eLearning by professors Inaccessibility of websites / course management systems	Unresolved Non-eLearning solution
Deaf / hard of hearing	Inaccessibility of audio/video material	Unresolved Professor provided assistance
Visual impairment: low vision	Inaccessibility of course notes/materials Inaccessibility of websites / course management systems Inaccessibility of course notes/materials in PDF	Unresolved Non-eLearning solution Obtained alternate formats Obtained / used adaptive technology / software
Totally blind	Inaccessibility of websites / course management systems Inaccessibility of course notes/materials in PDF	Unresolved

Discussion

Limitations of the Present Investigation

There were several limitations. While the number of participants is large and diverse, the samples are neither random nor, we believe, fully representative of the populations studied. Given self-selection biases, and the fact that recruitment was carried out primarily online, we expect that the proportion of students who read online discussion lists and have experience using e-learning are over represented. Similarly, disability service providers passionate about and/or more heavily engaged in e-learning and accessibility are likely to be over sampled. And we deliberately sought out specific professors and e-learning professionals who had had experience with e-learning and students with disabilities. Even more troubling, we are unable to calculate a final "return rate" because of the manner in which we recruited participants. The use of email discussion lists as the main form of recruitment poses challenges in this regard.

Yet, available indices suggest that our samples have characteristics which resemble the realities of Canadian postsecondary education. The age range of students is normative for studies of students with disabilities (e.g., Henderson, 1999; Horn & Berktold, 1999; Killean & Hubka, 1999; Middleton, 2003). The sample contains more female than male students and disability service providers; this too, is characteristic of these populations in postsecondary institutions (e.g., Fossey et al., 2005; Sharpe et al., 2005; Michaels, Prezant, Morabito, Jackson, 2002; Statistics Canada, 2007).

Findings Unique to Students

Types of Disabilities/Impairments

The results indicate that, consistent with the findings of others (e.g., Stodden, 2006), the most common disability indicated by students was a learning disability, often coupled with attention deficit disorder/attention deficit hyperactivity disorder. Our sample also reflects the trend toward the "new clientele" of students with disabilities in postsecondary education (Fichten et al., 2006; Fiset, 2006), with many students reporting psychological/psychiatric disabilities and health/medically related impairments. Almost half of the students reported more than one disability, a finding consistent with the substantial number of students who have multiple impairments reported in the literature (e.g., Fichten et al., 2006).

Adaptive Technology Use

Over half of the sample indicated that they needed some form of adaptive technology, such as software that improves writing quality, screen reader, or dictation software to access e-learning effectively. Two-thirds of the students who used adaptive technology indicated using more than one type, suggesting the need to ensure that these can work with each other. Given the nature of students' impairments it is not surprising that the most common software that students indicated is software which helps with writing quality (e.g., WYNN, TextHelp) followed by software that reads what is on the screen (e.g., ReadPlease, Jaws), scanning and optical character recognition software (OCR - both specialized products for students with visual impairments, such as Open Book, and general use products such as OmniPage), and voice dictation software (e.g., Dragon Naturally Speaking).

Benefits of e-Learning

Consistent with the results of others (e.g., Goodman, Tiene, & Luft, 2002), students were enthusiastic about the benefits of e-learning. The most popular response, noted by over 40% of students, was the availability of online course notes. Students also noted the benefits of information anywhere and any time and the availability of online course materials other than course notes. Students also noted that e-learning allows them to work at their own pace, to study from home, and to easily communicate with peers and professors.

Problems and Solutions

Commonalities Among Problems

All groups complained of the inaccessibility of websites and course/learning management systems (CMS). This was the most common problem reported by all four groups of participants. Problems reported with these is hardly surprising given that these are the most popular means of delivering e-learning in postsecondary education (Malik, Asuncion, & Fichten, 2005). Of course, this type of problem can reflect both accessibility and usability issues with CMS systems, such as WebCT, as well as problems with course websites developed by individual professors, departments and schools. In addition, problems experienced can be due both to software issues as well as to content put into a CMS and websites. Content is often designed by professors, departments, and schools, as well as by e-vendors such as the producers of course textbooks. So difficulties in this realm could be due, for example, to accessibility issues directly related to the CMS (e.g., a chat interface which cannot be accessed using dictation software); to usability issues such as the 10 frames inserted by a course text book publisher into a WebCT shell; and

to inaccessible content, such as image based PDFs which cannot be read by screen reading software and video clips without captioning (subtitles). Other issues noted by participants included difficulties using some websites by screen reading technologies, confusing structures for web pages for students with learning disabilities, problems with fixed font size of materials on websites, and problems for students with visual impairments to access online maps and images.

Another problem area identified by all groups relates to accessibility of audio and video materials. Online and textbook-related video clips as well as "taped" lectures are becoming commonplace. Although most free computer based video players (e.g., Windows Media Player) are capable of displaying closed captions (similar to subtitles in movies), most digital videos needed by students are not captioned, making them inaccessible to students with hearing impairments. The absence of a description about what is going on in the video causes accessibility problems for many students with visual impairments. The same is true for online lectures and other multimedia materials which are generally not captioned, described, or accompanied by written materials such as a text file. This type of problem also arises in video and audio chats.

All groups also found inflexible time limits to complete activities built into online exam and assignment CMS products problematic. In many schools, students with a variety of disabilities are entitled to additional time to complete the tests and assignments (e.g., Harding, Blaine, Whelley, & Chang, 2006; Sharpe, et al., 2005). But faculty can usually specify only one time duration for all students in most online evaluation systems, making the allocation of additional time impossible.

PowerPoint and data projection during lectures can also pose accessibility problems for students, mainly for those with visual and hearing impairments. Students with visual impairments, of course, experience difficulty seeing the presentation while those with hearing impairments have difficulty following the onscreen presentation and taking notes at the same time. These students also have problems viewing both the presentation as well as the professor's lips (or the sign language interpreter) at the same time, especially with the lights off.

Another area identified by all groups concerns problems with course notes and materials in PDF. The problem with PDF is that its accessibility is dependent on how the PDF was made. Faculty often scan old, heavily annotated documents and articles and distribute these to students in PDF format. Scanning produces a PDF document consisting of "images" of the scanned pages — these cannot be edited and sections cannot be copied and pasted. Students who use screen reading technologies cannot access these documents since there are no words to read. Such PDFs need to be rendered into electronic text by optical character recognition (OCR) software. But this works very poorly if the original paper version had been heavily annotated or underlined or if it had already been photocopied several times. Similarly, unless specifically marked-up to be accessible, documents with multiple columns and those with tables and figures, even when made into PDF from clean originals, can create difficulties because of the way in which screen readers handle this kind of text.

All groups also identified lack of needed adaptive technologies as problematic. This can be missing in the school's specialized as well as general use computer labs and can leave students with disabilities merely sitting in class while their peers are engaged with the e-learning materials provided by the professor. Participants noted problems such as inadequate numbers of adapted keyboards, insufficient site licenses for adaptive computer technologies, and difficulties caused by the inability to install adaptive software on locked work stations.

Problems Unique to Each Group

In many cases, some but not all groups identified a specific item as problematic. Best seen in Figure 1, these generally reflect the respondent's perspective (e.g., end-user vs. campus professional). Disability service providers, whose role sees them responsible for accommodating students with disabilities and acting as an advocate for them on campus, are most likely to deal with problems that students, sometimes in collaboration with their professors, cannot resolve. Problems they face are likely to be different from those confronting students or the other groups. For example, they may find problems experienced by students who are blind as especially problematic, even though there are few students with this disability on campus. Professors generally experience problems in the context of their own courses and students. So the types of problems and solutions they indicated reflect the types of e-learning they use and the disabilities of students in their classes. Similarly, e-learning professionals are more likely to

experience systemic problems and technical issues that the other groups are not familiar with. They also have limited direct contact with students in general, and with students with disabilities in particular.

Students described technical difficulties using e-learning and problems connecting to websites and course management systems They also had problems downloading and opening files, they had difficulties with web pages that would not load, and video clips that took long times to download. They also noted poor use of e-learning by professors. Commonly reported issues were: the professor does not get the material onto the website on time; course notes online are incomplete; in class PowerPoint presentations are delivered too quickly. Students also indicated that they themselves also lack knowledge about how to use e-learning (e.g., not knowing how to log in or use the CMS, finding web searches for learning materials complicated, needing to learn to use online learning technologies). Many of these problems are probably shared by nondisabled students and research comparing e-learning problems and solutions of students with and without disabilities is needed for comparison.

Disability service providers, who are generally responsible for arranging accommodations for students with disabilities, also wrote about poor use of e-learning by professors. They also identified problems with poor accessibility of course notes and materials in formats other than PDF. For example, interactive mathematics graphs, inaccessible maps and images, and problematic supplementary materials provided by e-vendors such as CD based crossword puzzles and online flash cards and practice tests.

Professors noted problems that are likely to be brought to their attention by their students. These were all raised by members of the other groups.

E-learning professionals, perhaps because they are the ones to whom all others turn when other avenues have been exhausted, failed to mention many of the problems raised by students and disability service providers. They did, however, note difficulties with inaccessible course notes and materials (36% noted this as a problem).

Solutions

The results show that the most common response, for all four groups, was "unresolved" with 67% of students, 53% of disability service providers, 36% of e-learning professionals and 35% of professors indicating that at least one of their three e-learning problems remained unresolved. Solving an e-learning problem with a non e-learning solution (e.g., taking course materials home to have the student's husband read the materials aloud, writing an exam at a different time from the rest of the class) ranked next in popularity for all groups except e-learning professionals. The student obtaining alternate formats was a popular response for most groups, except for students, who were least likely to note this as a solution to their problem.

Again, certain solutions were noted by some but not all groups of respondents. For example, the professor providing assistance was mentioned relatively frequently by both students and professors. E-learning professionals indicated that an e-learning staff member provided assistance (e.g., fixing logins, altering time frameworks for exams). Disability service providers indicated that a campus disability service provider provided assistance. Because of their vantage point, professors, disability service providers, and e-learning professionals are more likely to be aware of their own contribution to solving problems than the contributions of others (Fichten, 1984).

Obtaining or using adaptive technology was seen as solving the problem by a large proportion of e-learning professionals, but by virtually none of the other groups. Examples include: use of video equipment that enlarges the instructor's face to help a student lip read, converting an online exam to an alternate format that was accessible to the student, and scanning PDFs and distributing the CDs to students. The problem being resolved by providing time extensions for online exams was a popular option mainly for professors.

Problem-Solution Pairs

We wanted to find out whether certain problems were more easily resolved than others. To do this we inspected solutions to problems noted frequently by each participant group. As expected, most problems remained unresolved. For problems identified by students where a solution was found the results indicate that inaccessibility of websites and professors' poor use of e-learning were resolved by professors and that technical difficulties and problems connecting to websites and course/learning management systems were resolved by e-learning specialists. Disability

service providers', professors', and e-learning professionals' problems related to inaccessibility of course notes and PowerPoint and data projection were resolved by obtaining alternate formats.

Problems and Solutions of Students with Different Disabilities/Impairments

Because the nature of students' impairments was also likely to influence problems and solutions we also investigated how problems noted by students with different impairments were resolved. The results show that students with learning disabilities indicated experiencing technical difficulties and problems caused by their own lack of knowledge about how to use e-learning. This was also true for students with mobility impairments and difficulty using their hands and/or arms, but these students also noted problems related to inaccessible course/learning management systems. Students with attention deficit and/or attention deficit hyperactivity disorder experienced technical difficulties most often as did students with health and medically related impairments. But this latter group of students also noted problems with poor use of e-learning by professors and inaccessibility of websites and CMS. Students with psychological/psychiatric disabilities also noted poor use of e-learning by professors as well as difficulty connecting to websites and CMS. It was not surprising to find that students with hearing impairments experienced problems with inaccessibility of digital audio and video materials and that students with visual impairments noted problems with inaccessibility of course notes/materials, especially those in PDF as well as problems related to the accessibility of websites and CMS.

Recommendations

Training

One means of addressing problems involving inaccessibility of websites and course management systems, of e-learning broadly, and of specific materials, such as course notes and audio and video clips is through training of professors. Many colleges and universities already offer training on how to integrate e-learning in teaching and on how to use specific e-learning tools. Developing a module, as a start, on how to make e-learning accessible, and integrating this into existing training, would, at a minimum, begin sensitizing faculty and staff on the issues. Other, more targeted sessions can be considered on specific topics, such as how to make a website or PDF file accessible, based on needs. There are numerous online resources to act as a starting-point (e.g., EASI < http://easi.cc/>, DO-IT <www.washington.edu/doit/>, and WebAIM <www.webaim.org/>).

Similarly, to address students' concerns about their lack of knowledge on how to use e-learning, any existing training opportunities available to students at large on e-learning use should be promoted to students with disabilities as well. It goes without saying that such training would need to be accessible to these students.

Adopt e-Learning Accessibility Guidelines

Colleges and universities should consider developing and adopting e-learning accessibility guidelines that address both in-house development of e-learning as well as purchases of e-learning products and technology. Wording of these should be in language that is readily understood by faculty (Gabrielli, Mirabella, Kimani, & Catarci, 2006). Like training, having such guidelines in place would help resolve problems with inaccessible websites and other e-learning tools and materials, and would inform those making purchasing decisions about the need to select the most accessible product. Of course, it goes without saying that the strength of such guidelines would be based on the commitment demonstrated by those who lead and/or champion e-learning on campus.

Proactively Engage On-campus Accessibility Experts

Whether it is testing a new e-learning tool with end-users or running a committee whose focus is e-learning, ensure that accessibility is represented. In the case of end-user testing, actively seek out and invite students with different disabilities to participate in such activities. Who better to identify possible accessibility issues then the users themselves? Such users can provide first-hand insight into potential accessibility problems, particularly if they require the use of adaptive hardware or software to interact with the e-learning. In the case of committees, engage,

where possible, someone who is accountable for supporting students with disabilities so that accessibility interests are on the table. At a minimum, make sure that accessibility is a standing agenda item, so that any issues can be raised on a regular basis. Both of these activities not only increase the visibility and awareness of accessibility in the e-learning context, but they also help bring to light problems such as those raised by study participants.

The fact that "unresolved" was the most frequently noted solution to addressing e-learning accessibility problems by all four groups of participants cannot go unmentioned. While not within the scope of this study, it is critical to understand the implications of this finding given the prevalence of e-learning use in colleges and universities today. How is this impacting on the ability of students with disabilities to succeed academically and to compete and participate on a level playing-field with their non-disabled peers? Why do problems remain unresolved? Is it the reluctance of institution's to take steps to make accessibility a requirement for professors? Is it poor accessibility of the products produced by e-vendors, such as software developers and book publishers? Or is there a knowledge gap that needs to be closed? These are fundamental questions that postsecondary institutions have a shared responsibility to answer.

Conclusions

During the last decade there has been tremendous development and interest in e-learning on campus. While our research shows the many benefits of e-learning, such as the availability of online course notes, there are also problems. Chief among these are problems related to inaccessibility of websites and course management systems. Our study also illustrates that problem experiences differ among the four groups of stakeholders in our study. This is most likely attributable to the differing roles and levels of interaction with accessibility of e-learning that each group has. That being said, the most commonly cited response to solving e-learning problems by all four groups was "unresolved." This is a cause for concern given the prevalence of e-learning use on campus. It is the charge to all postsecondary stakeholders to ensure that e-learning technologies continue to benefit rather than hamper students with all types of disabilities and that accessibility gains are maintained and built upon.

Acknowledgements

Funding for this research was provided by the Social Sciences and Humanities Research Council of Canada (SSHRC), the Dis-IT Research Alliance, and the Canadian Council on Learning. The research was carried out with the collaboration of our partners: the Adaptech Research Network, NEADS, AQEIPS, CADSPPE, and AQICEBS.

References

Abrami, P. C., Bernard, R. M., Wade, C. A., Schmid, R. F., Borokhovski, E., Tamim, R., Surkes, M., Lowerison, G., Zhang, D., Nicolaidou, I., Newman, S., Wozney, L., & Peretiatkowicz, A. (2006). A review of eLearning in Canada: A rough sketch of the evidence, gaps and promising directions. *Canadian Journal of Learning and Technology, 32* (3). Retrieved April 11, 2009, from http://www.cjlt.ca/index.php/cjlt/article/view/27/25.

Asuncion, J. V., Fichten, C. S., & Barile, M. (2007). Which forms of eLearning are accessible to Canadian postsecondary students with disabilities? *Communiqué, 7* (3), 36.

Bissonnette, L. A. (2006). *Teaching and learning at Concordia University: Meeting the evolving education needs of faculty in providing access for university students with disabilities*, Doctoral dissertation, Concordia University, Canada.

Bohman, P. (2007). Cultivating and maintaining web accessibility expertise and institutional support in higher education. *ATHEN e-Journal, 2*, retrieved February 27, 2009, from http://athenpro.org/book/print/55.

Burgstahler, S., Corrigan, B., & McCarter, J. (2005). Steps toward making distance learning accessible to students and instructors with disabilities. *Information Technology and Disabilities, 11* (1), retrieved May 9, 2009, from http://people.rit.edu/easi/itd/itdv11.htm.

Canadian Council on Social Development (2004). *Disability information sheet No. 16: Workers with disabilities and the impact of workplace structures*, retrieved March 14, 2009, from http://www.ccsd.ca/drip/research/drip16/drip16.pdf.

Debenham, M. (2002). *Computer-Mediated Communication (CMC) and disability support: Addressing barriers to study*, retrieved September 12, 2009, from http://www.techdis.ac.uk/index.php?p=3_10_17.

Di Iorio, A., Feliziani, A. A., Mirri, S., Salomoni, P., & Vitali, F. (2006). Automatically producing accessible learning objects. *Educational Technology & Society, 9* (4), 3-16.

Ezziane, Z. (2007). Information technology literacy: Implications on teaching and learning. *Educational Technology & Society, 10* (3), 175-191.

Fichten, C. S. (1984). See it from my point of view: Videotape and attributions in happy and distressed couples. *Journal of Social and Clinical Psychology, 2*, 125-142.

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

Fichten, C. S., Asuncion, J., Barile, M., Fossey, M., & De Simone, C. (2000). Access to educational and instructional computer technologies for postsecondary students with disabilities: Lessons from three empirical studies. *Journal of Educational Media, 25* (3), 179-201.

Fichten, C. S., Barile, M., & Asuncion, J. V. (1999). *Learning technologies: Students with disabilities in postsecondary education*, Final report to the Office of Learning Technologies. Ottawa: Human Resources Development Canada, retrieved September 7, 2009, from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/15/da/77.pdf.

Fichten, C. S., Jorgensen, S., Havel, A., & Barile, M. (2006). *College students with disabilities: Their future and success* - Final report presented to FQRSC. Montréal: Adaptech Research Network, Dawson College.

Fiset, D. (2006). *Global de la clientèle desservie pour la région Ouest à la session Automne 2004*, Montréal: Cégep du Vieux Montréal.

Fossey, M. E., Asuncion, J. V., Fichten, C. S., Robillard, C., Barile, M., Amsel, R., Prezant, F., & Morabito, S. (2005). Development and validation of the Accessibility Of Campus Computing For Students With Disabilities Scale (ACCSDS). *Journal of Postsecondary Education and Disability, 18* (1), 23-33.

Gabrielli, S., Mirabella, V., Kimani, S., & Catarci, T. (2006). A boosting approach to econtent development for learners with special needs. *Educational Technology & Society, 9* (4), 17-26.

Goodman, G., Tiene, D., & Luft, P. (2002). Adoption of assistive technology for computer access among college students with disabilities. *Disability and Rehabilitation, 24* (1,2,3), 80-94.

Harding, T., Blaine, D., Whelley, T. A., & Chang, C. (2006). A comparison of the provision of educational supports to students with disabilities in AHEAD versus non-AHEAD affiliated institutions. *Journal of Postsecondary Education and Disability, 18* (2), 125-134.

Henderson, C. (1999). *College freshmen with disabilities: A biennial statistical profile (Statistical Year 1998)*, Washington DC: HEATH Resource Center.

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

Killean, E., & Hubka, D. (1999, July). *Working towards a coordinated national approach to services, accommodations and policies for post-secondary students with disabilities: Ensuring access to higher education and career training*, Ottawa: NEADS.

Konur, O. (2007) Computer assisted teaching and assessment of disabled students. *Journal of Computer Assisted Learning, 23*, 207-219.

Kruse, D., Krueger, A., & Drastal, S. (1996). Computer use, computer training, and employment: Outcomes among people with spinal cord injuries. *Spine, 21* (7), 891-896.

Malik, R., Asuncion, J. V., & Fichten, C. S. (2005). Accessibility of eLearning in Canadian postsecondary education. *Paper presented at the American Psychological Society Annual Conference*, May, Los Angeles, USA.

Middleton, E. (2003). Survey of university and college students with disabilities: Report on personal profile, academic profile and financing education. Unpublished manuscript.

Michaels, C., Prezant, F., Morabito, S., & Jackson, K. (2002). Assistive and instructional technology for college students with disabilities: A national snapshot of postsecondary service providers. *Journal of Special Education Technology, 17* (1), 5–14.

National Council on Disability. (2003). *People with disabilities and postsecondary education*, Position paper. Washington, DC: National Council on Disability. Retrieved May 4, 2009, from http://www.ncd.gov/newsroom/publications/2003/education.htm.

Roberts, K. D., & Stodden, R. A. (2005). The use of voice recognition software as a compensatory strategy for postsecondary education students receiving services under the category of learning disabled. *Journal of Vocational Rehabilitation, 22*, 49-64.

Sharpe, M. N., Johnson, D. R., Izzo, M., & Murray, A. (2005). An analysis of instructional accommodations and assistive technologies used by postsecondary graduates with disabilities. *Journal of Vocational Rehabilitation, 22* (1), 3-11.

Snyder, T. D., & Dillow, S. A. (2007). *Digest of educational statistics 2006. NCES 2007-017*, Washington, DC: National Center for Education Statistics, U.S. Department of Education, retrieved May 4, 2009, from http://nces.ed.gov/pubs2007/2007017.pdf.

Statistics Canada (2007). Youth in Transition Survey: Participation in postsecondary education - December 2005. *The Daily*, November 20.

Stodden, R. A., Conway, M. A., & Chang, K. B. T. (2003). Findings from the study of transition, technology and postsecondary supports for youth with disabilities: Implications for secondary school educators. *Journal of Special Education Technology, 18* (4), 29-44.

Stodden, R. A. (2006). From the guest editor. *Journal of Postsecondary Education and Disability, 18* (2), 99-100.

Stodden, R. A., Roberts, D. K., Picklesimer, T., Jackson, D., & Chang, C. (2006). An analysis of assistive technology supports and services offered in postsecondary educational institutions. *Journal of Vocational Rehabilitation, 24* (2), 111-120.

Thompson, T. (2004). *Results: 2004 survey on access technology in higher education*, Seattle, WA: University of Washington, Access Technologists Higher Education Network.

Tremblay, D., & Le May, S. (2005). *Statistiques concernant les étudiants ayant des besoins spéciaux dans les universités québécoises: 2004–2005 (sommaire)*, Québec: AQICEBS, Université Laval.

Vogel, S. A., Leyser, Y., Burgstahler, S., Sligar, S. R., & Zecker, S. G. (2006). Faculty knowledge and practices regarding students with disabilities in three contrasting institutions of higher education. *Journal of Postsecondary Education and Disability, 18*, 109–123.

Waddell, C. D. (2007). Accessible electronic & information technology: Legal obligations of higher education and Section 508. *ATHEN e-Journal, 2*, retrieved May 3, 2009, from http://athenpro.org/node/54.

Weller, M., Pegler C., & Mason R. (2005) Students' experience of component versus integrated virtual learning environments. *Journal of Computer-Assisted Learning, 21*, 253–259.