The POSITIVES Scale: Development and Validation of a Measure of How Well the Information and Communication Technology Needs of Students with Disabilities are Being Met

Catherine S. Fichten
Jennison V. Asuncion
Mai N. Nguyen
Jillian Budd
Adaptech Research Network

Rhonda Amsel
McGill University

Abstract

Data on perceptions of 1354 Canadian college and university students with disabilities about how well their information and communication technology (ICT) needs are being met on and off campus were collected. These formed the basis for the POSITIVES Scale (Postsecondary Information Technology Initiative Scale). The measure contains 26 items which use a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree) to indicate level of agreement with each of the positively worded items. The Scale has three factor analysis derived subscales (ICTs at School Meet Student's Needs, ICTs at Home Meet Student's Needs, e-Learning ICTs Meet Student's Needs) and a total score. Reliability and validity are excellent for both English and French versions. Versions that could be completed online, on paper (printable PDF), and within a Microsoft Word document were found to be equivalent. Both the measure and the norms are provided.

Skill using information and communication technologies (ICTs) has become mandatory in postsecondary education and the workplace (Stodden, Conway, & Chang, 2003). For example, literature shows that computer use on the job is linked to higher salaries for employees both with and without disabilities (Canadian Council on Social Development, 2004; Kruse, Krueger, & Drastal, 1996). This makes it important that empirical data about the degree to which ICT related needs of learners with disabilities are being met is made available to decision makers involved in ICTs in postsecondary education. Having a means of gathering of such data will help to achieve this.

The use of ICTs, including e-learning, both on campus and in distance education, is ubiquitous (Campus Computing Project, 2008). By now, it is self-evident that for students to succeed in postsecondary education they need to have good access to computer technologies both on and off campus (Green, 2005). As the numbers of students with disabilities in postsecondary education continue to rise 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), so does the need to assure that the growing array of available ICTs on campus is accessible (Konur, 2007; Waddell, 2007).

General Use ICTs, E-learning, and Adaptive Computer Technologies

Students need to use a variety of general use software such as Microsoft Word for writing papers and e-mail programs as well as software related to their specialties (e.g., for statistical analyses, for virtual science experiments, for language tutorials). To succeed in college or universities, learners must also adapt to the extensive use of e-learning used by faculty (Abrami et al., 2006; Weller, Pegler, & Mason, 2005). This includes PowerPoint presentations in class, web-based discus-

sions to further in-class dialogue, and the full range of ICTs that professors use when teaching their courses entirely in the classroom, entirely online, or a combination of both. Students are expected to download materials from course web sites, to access course management systems (CMS) such as WebCT and Blackboard, and to give presentations using PowerPoint. In addition to general use and e-learning ICTs, many students with disabilities also need to acquire and learn to use adaptive software as well as software which allows them to use ICTs effectively.

ICTs have many benefits for students with disabilities. These include: the availability of online course notes and course materials; the ability to work at one's own pace and to work and learn from home; the ease of communicating with peers and professors; the availability of information anywhere and at any time; autonomy and feeling more independent, confident and less stressed; the ability to keep up with the rest of the class; and to use materials in alternate formats (Fichten et al., 2009). Nevertheless, a variety of barriers can interfere with the effective use of ICTs. These include: poor accessibility of needed hardware and software necessary in labs and student work areas; inadequate administrative support and funding for the purchase of adaptive technologies and for disability services staffing and training; lack of awareness and knowledge about adaptive technologies among students with disabilities; unreliable and incompatible hardware and software; the cost of adaptive technologies and their upgrades; difficulties acquiring alternate format course materials; technical problems connecting to websites and course management systems; difficulties encountered using online discussions and activities; poor faculty awareness and support for students who use adaptive tehcnologies; inaccessibility of adapted audio and video clips; ergonomic issues; poor accessibility of course content, PowerPoint and data projection during in-class lectures; inaccessibility of course notes and materials; inadequate technical support for adaptive technologies; lack of technology/software required for home access needs; poor use of e-learning by professors and their lack of knowledge of how to make e-learning accessible; and time limits on online exams/assignments (Michaels, Prezant, Morabito, & Jackson, 2002; Fichten, Jorgensen, Havel, & Barile, 2005; Fichten et al., 2009).

Evaluation of How Well Students' ICT Related Needs are Being Met

An important aspect of increased use of ICTs on campus includes ongoing evaluation of how well these technologies meet the needs of students, faculty and other members of the institution's constituencies (Educause, n.d.). Evaluation should be carried out for a variety of reasons. These include ensuring a return on investment, measuring penetration and acceptance, and pinpointing areas for improvement (Bullock & Ory, 2000). A neglected topic in such evaluations has been consideration of how well students with different disabilities perceived their ICT related needs being met. It was recently noted by Burton and Nieuwenhuijsen (2008) that, "The instruments currently used to measure issues and concerns about computer-related technologies among the disabled community clearly are inadequate" (p. 105). They recommended that survey items specifically applicable to computer related ICTs for individuals with disabilities be developed. This is especially true for postsecondary students with disabilities, where ICT use is ubiquitous.

Recent investigations surveyed junior/community college and university adaptive computer technologists in seven countries, including the USA and Canada (Asuncion, Draffan, Guinan, & Thompson, 2009; Thompson, Draffan, & Patel, 2009). These investigations inquired about adaptive ICT use at postsecondary institutions. While these reports are based on extensive investigations of policies and practices, they did not evaluate the views and experiences of the students themselves. To obtain the student view, the present investigation explored the types of ICTs students indicated using on and off campus.

Recently, we developed a scale concerning adaptive ICTs for campus disability service providers (Fossey et al., 2005) as well as a companion measure to evaluate the availability of adaptive ICTs from the students' vantage point (Fichten, Nguyen, Barile, & Asuncion, 2007). Because of the variety of ICTs used by students with different disabilities, it is important to evaluate not only adaptive technologies, but all types of ICTs, including e-learning, general use products, and those needed for the student's program of study. Therefore, in the present investigation we developed the POSITIVES Scale, a brief measure to evaluate how well the ICT related needs of postsecondary students with various disabilities are being met in a variety of contexts both on and off campus.

Method

Participants

A convenience sample of 1354 students with various disabilities (456 males, 894 females, 4 did not indicate; mean age = 28.10, median = 24, standard deviation = 9.42, range = 18–64), from 111 different Canadian universities and junior/community colleges who completed the items that make up the POSITIVES Scale and the other measures were participants. Of these, 972 students (73%) attended a university and 368 (27%) a junior/community college. Participants attended school in all 10 of Canada's provinces. All were either current students or had attended a postsecondary institution within the past year. One hundred twenty-nine attended French speaking institutions (38 university, 91 junior/community college), 1397 attended English speaking institutions (866 university, 329 junior/community college) and 16 attended bilingual institutions (15 university, 1 junior/community college). One hundred forty-one participants (97 females and 44 males) chose to complete measures in French and 1213 in English (797 females, 412 males, 4 did not specify). Students' disabilities are presented in Table 1.

Measures

*Demographic question*s. These include objective questions related to: sex, age, postsecondary institution name and language, and the nature of students' disabilities/impairments. We have used most of these questions in previous studies (Fichten, Barile, & Asuncion, 1999; Fichten et al., 2005; Fichten, Asuncion, Barile, Ferraro, & Wolforth, 2009).

Disabilities. We provided a list of 13 disabilities / impairments and asked students to self-identify as many as applied to them. These are presented in Table 1.

Overall Criterion Items. Using a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree), participants rated two Overall Criterion Items that inquired about how well their computer and/or adaptive computer needs are being met at school and at home: "In general, my computer and/or adaptive computer technology needs at my school are adequately met" and "In general, my computer and/or adaptive computer technology needs at home are adequately met."

POSITIVES Scale (Postsecondary Information Technology Initiative Scale). We developed this 26-item objective measure concerning how well students' ICT related needs are being met for the present investigation. We adapted the items from a questionnaire we developed earlier to evaluate the accessibility of adaptive computer technologies used by junior/community college students (Fichten et al., 2007) and for disability service providers (Fossey et al., 2005), with modifications suggested by our partner groups of students with disabilities and campus disability service providers. Questions were pilot tested by key informant students with different disabilities to uncover problems related to possible ambiguities, concerns about appropriate language, and the accessibility of the interface.

The POSITIVES Scale examines the extent to which students' computer related needs are being met. To complete the measure, students use a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree) to indicate their level of agreement with each of the positively worded items. The measure has three subscales derived using factor analysis (ICTs at School Meet Student's Needs, ICTs at Home Meet Student's Needs, e-Learning ICTs Meet Student's Needs), and a Total Score. The measure can be administered online, on paper (printable PDF), and within a Microsoft Word document that can be submitted on a diskette or emailed as an attachment. The measure is available in both French and English.

Procedure

In 2007, an online questionnaire was developed and completed by 1354 Canadian university and junior/community college students with various disabilities. Participants were recruited through email discussion lists dealing with Canadian postsecondary education and disability. Project partners publicized the study to their memberships and students who had participated in previous investigations carried out by the authors were contacted. The research protocol was approved by Dawson College's Human Research Ethics Committee.

Potential participants were asked to email the researchers for more information. Those indicating interest were directed to the study's web site where they chose the language (English or French) in which they preferred to read the consent form, which provided information about the study, including the honorarium of $10, and to complete the questionnaire. Clicking the "I consent" button brought participants to the online questionnaire, which took approximately 10 minutes to complete.

Once participants clicked on the "Submit" button, they were brought to a screen which asked for contact information to enable us to send the honorarium of $10. Students were also asked if we may contact them again for future projects.

Table 1

Age and Disabilities of Participants: Single Versus Multiple Disabilities

Type of Disability/Impairment	Number of Students	Percent	Mean Age
Single disabilities/ impairments	894		
Totally blind	17	1%	30.71
Low vision	62	5%	27.26
Deaf	14	1%	27.36
Hard of hearing	43	3%	26.58
Speech/communication impairment	2	<1%	21.00
Learning disability/ADD/ADHD	386	29%	24.44
Mobility impairment	51	4%	31.02
Limitation in the use of hands/arms	47	3%	29.49
Medically related/health problem	67	5%	30.82
Psychological/psychiatric disability	172	13%	27.52
Neurological impairment	27	2%	29.63
PDD	6	<1%	25.00
Other	0	0%	n/a
Multiple disabilities/impairments	460	34%	30.70
Total number of students	1354		

Type of Disability/Impairment	Number Reporting Each Disability	Percent
All participants reporting each disability [1]		
Totally blind	24	2%
Low vision	116	9%
Deaf	19	1%
Hard of hearing	92	7%
Speech/communication impairment	45	3%
Learning disability/ADD/ADHD	603	45%
Limitation in the use of hands/arms	176	13%
Medically related/health problem	172	13%
Psychological/psychiatric disability	258	19%
Neurological impairment	429	32%
PDD	107	8%
Other	17	1%
	4	<1%
Total disabilities reported by the 1354 students	2062	

[1] 1354 participants reported reported 2062 disabilities. Subjects reporting a disability may have more than one impairment.

Retest. Four weeks after receipt of students' completed questionnaires, we e-mailed those who indicated that we may do so to request that they complete the measure a second time. Of the original sample, 638 participants (47%) completed the measure a second time (432 females, 205 males, 1 did not indicate; mean age = 28.70, median = 25, standard deviation = 9.45, range = 18-59). Of these students, 496 (78%) attended a university and 141 (22%) a junior/community college. Participants attended school in 9 of Canada's 10 provinces. Sixty-eight students completed measures in French (51 university, 17 junior/community college) and 569 in English (445 university, 124 junior/community college).

Alternate formats. To determine the equivalence of POSITIVES Scale versions that could be completed online, on paper (printable PDF), and within a Microsoft Word document, we randomly assigned a subset of English speaking participants with learning disabilities to complete the retest in one of these three modalities (stratified random sampling by sex). This was done to ascertain whether the POSITIVES Scale could be administered in different formats and still yield similar results. Fifty-nine students participated in this trial (31 females and 28 males). Twenty-one students completed the online version, 14 the paper (printable PDF) version, and 24 the Microsoft Word version.

Results

Sample Characteristics

Students' disabilities. Table 1 shows that the 1354 students reported a total of 2062 disabilities (mean = 1.53 disabilities/student). Four-hundred and sixty students (34%) reported more than one disability: 22% of students indicated two, 8% indicated three, and 4% of students indicated four or more disabilities. It can be seen in Table 1 that the most common disability reported by participants was a learning disability (with or without attention deficit or attention deficit hyperactivity disorder), followed by a psychological/psychiatric disability, and by a medically related/health problem.

POSITIVES Scale Properties

Two types of reliability estimates were obtained for the POSITIVES Scale: temporal stability (test-retest) and internal consistency (Cronbach's alpha, split half, item:total). All items with acceptable test-retest reliability were included in a principal components analysis with varimax rotation which yielded 3 factors (Subscales). Construct, concurrent, and criterion validity were evaluated (a) by correlating POSITIVES Scale Subscale and Total scores with each other, (b) by correlating Subscale scores with scores on the two Overall Criterion Items, (c) by correlating Subscale scores with aspects that were not expected to be related to how well ICT related needs are being met, and (d) by comparing the scores of groups of students with different impairments whose ICT related needs were expected to be met especially well and those whose needs were expected to be met especially poorly.

Reliability. Six hundred thirty-eight participants completed the POSITIVES Scale twice an average of 4.59 weeks apart (range = 1 week to 17.6 weeks, median = 4.24). Pearson product-moment correlation coefficients for all scores are significant at the .001 level or better. The coefficients for POSITIVES Scale single items range from .47 to .73, and the coefficients for the Subscales range from .73 to .79. The coefficient for the Total score is .81. We also carried out paired t-test comparisons on test and retest scores. The results show no significant differences for POSITIVES Scale Subscale and Total scores. Five of the 26 item-by-item t-tests were significant at the .05 level. Because of the number of comparisons, a Bonferroni correction to the alpha level was made. Following this correction, none of the comparisons remain significant.

We also conducted a series of internal consistency analyses. These can be seen in Table 2. Results show that Cronbach's alpha for the three Subscales ranges from .786 to .910 and that it is .936 for the Total score. The results also show that the removal of any item would not greatly affect alpha. Guttman split-half coefficients for the factors range from .715 to .852. Item-Total Pearson correlation coefficients range from .466 to .714 and the correlations between Subscale and Total scores range from .762 to .920.

Derivation of Subscales: Factor Analysis

We established Subscales using factor analysis (see Table 3). A principal components analysis with varimax rotation was carried out both with and without mean substitution. This was done because of the large amount of missing data. Three factors were extracted. Table 3 presents the rotated factor loadings for each item for the entire sample, with and without mean substitution. Table 6 presents the results of the factor analysis. Items were generally assigned to the factor (Subscale) corresponding to the highest factor loading for factor

Table 2

POSITIVES Scale Internal Consistency: Item Analysis - All Participants

Items	# of items	Mean	Cronbach's alpha [1]	Cronbach's alpha if item removed	Guttman Split-Half Coefficient	Range of Pearson Correlations: Item-Score
Positives Scale subscales and total score						
Subscale 1 - ICTs at school meet student's needs	12	4.52	0.910	.900 to .908	0.852	.606-.733
Subscale 2 - ICTs at home meet student's needs	5	4.12	0.786	.715 to .772	0.715	.654-.802
Subscale 3 - e-Learning ICTs meet student's needs	9	4.89	0.814	.774 to .800	0.774	.589-.689
Item - Total [2]	26		0.936	.931 to .936		.466-.714
Subscale - Total [3]	3		0.791	.649 to .710		.762-.920

[1] Cronbach's alpha based on standardized items.
[2] Cronbach's alpha for Total (based on the 26 items).
[3] Cronbach's alpha for Total (based on the 3 subscales).

loadings greater than .4. The findings show remarkable consistency, regardless of the way in which the factor analysis was carried out (i.e., with or without mean substitution). Subscales are described below. Table 4 includes all items comprising each Subscale.

Subscale 1 - ICTs at School Meet Student's Needs. This twelve-item subscale evaluates the extent to which students' ICT related needs are being met while they are at school (e.g., My school has enough computers with internet access to meet my needs. The hours of access to computer technologies at my school meet my needs).

Subscale 2 - ICTs at Home Meet Student's Needs. This five-item subscale evaluates the extent to which ICT related needs are being met while students are off campus (e.g., Funding for computer technologies for personal use is adequate to meet my needs. My personal computer technologies are sufficiently up-to-date to meet my needs).

Subscale 3 - E-learning ICTs Meet Student's Needs. This nine-item subscale evaluates the extent to which the school's e-learning meets the student's needs (e.g., My school's web pages are accessible to me. I have no problems when professors use e-learning for tests and exams).

Scoring, Standardization and Norms

Table 4 shows mean scores for all POSITIVES Scale single item, Subscale, and Total scores for all participants. These indicate that although all items have scores that are more favorable than unfavorable (i.e., scores > 3.5 on the 6-point scale of agreement - items all positively worded), the most problematic items are those that deal with the availability of adapted computers at school in specialized computer laboratories as well as those available through the school's loan program. In addition, funding for computer technologies for personal use as well as problems with training, both on and off campus, had low scores, as did the item dealing with poor technical support when the student is not at school.

On the other hand, the results also show that students felt the school's web pages are accessible, that they can effectively use the computer technologies they need, that expertise in adaptive ICTs was readily available on campus, that needed electronic format course materials are available, and that the school's interactive online services (e.g., registering, financial aid applications on the web) as well as the library's computer systems were generally quite accessible.

Students with different disabilities. The findings above represent the sample as a whole. To facilitate interpretation and to provide POSITIVES Scale norms for the different groups of participants, in Table 5 we provide preliminary norms (i.e., mean scores) for the three POSITIVES Scale Subscales and for the Total score for the different disability groups. Although overall the findings suggest that the ICT related needs of students in all groups are relatively well met, needs of students who are totally blind, those with multiple disabilities, and those

Table 3

POSITIVES Scale Factor Loadings: Analyses with and Without Mean Substitution

Item	No Mean Substitution [1]			With Mean Substitution [2]		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
	Subscale 1 ICTs at School Meet Student's Needs	Subscale 3 - E-learning ICTs Meet Student's Needs	Subscale 2 - ICTs at Home Meet Student's Needs	Subscale 1 ICTs at School Meet Student's Needs	Subscale 3 - E-learning ICTs Meet Student's Needs	Subscale 2 - ICTs at Home Meet Student's Needs
4 There are enough computer technologies in my school's specialized labs/centres for students with disabilities to meet my needs	0.701	0.283	0.252	0.694	0.086	0.250
1 My school has enough computers with internet access to meet my needs	0.685	0.265	0.040	0.666	0.247	0.020
5 The availability of computer technologies in my school's general use computer labs meet my needs	0.676	0.345	0.200	0.694	0.224	0.100
3 At my school, computer technologies are sufficiently up to date to meet my needs	0.666	0.298	0.086	0.693	0.213	0.059
11 The availability of technical support when I am not at school meets my needs	0.665	0.117	0.387	0.404	0.153	0.484
14 Informal help is available at my school to show me how to use technologies if I need this	0.659	0.085	0.385	0.493	0.147	0.420
8 The technical support provided at my school for computer technologies meets my needs	0.657	0.195	0.417	0.575	0.111	0.379
24 The physical access to computer technologies at my school meets my needs	0.638	0.162	0.026	0.445	0.166	0.231
9 When I approach staff at my institution with problems related to the accessibility of computer technologies on campus they act quickly to resolve any issues	0.621	0.245	0.387	0.461	0.246	0.306
13 Training provided by my school on how to use the computer technologies meets my needs	0.618	0.129	0.485	0.455	0.139	0.550
2 The hours of access to computer technologies at my school meet my needs	0.605	0.385	0.123	0.632	0.203	0.050
10 There is at least one person on staff at my school who has expertise in adaptive hardware and software	0.484	0.071	0.344	0.471	0.100	0.269
7 Funding for computer technologies for personal use is adequate to meet my needs	0.012	0.252	0.718	0.028	0.113	0.662
12 I know how to effectively use the computer technologies that I need	0.258	0.021	0.705	0.157	0.206	0.607
23 My personal computer technologies are sufficiently up-to-date to meet my needs	0.196	0.288	0.672	0.085	0.311	0.564
6 My school's loan program for computer technologies meets my needs	0.217	0.339	0.661	0.158	0.123	0.605
15 Training available off campus on how to use computer technologies meets my needs	0.394	0.070	0.477	0.231	0.091	0.524
21 My school's interactive online services are accessible to me	0.193	0.705	0.115	0.215	0.691	0.050
18 Distance education courses offered by my institution are accessible to me	-0.040	0.694	0.186	0.051	0.483	0.105
25 My school's web pages are accessible to me	0.328	0.601	-0.008	0.214	0.667	0.026
22 The accessibility of the library's computer systems meets my needs	0.423	0.539	0.043	0.350	0.528	0.116
26 The availability of electronic format course materials meets my needs	0.308	0.530	0.282	0.248	0.551	0.262
17 I have no problem when professors use eLearning for tests and exams	0.121	0.503	0.352	0.088	0.534	0.194
19 If I bring computer technology into the classroom I am able to use it	0.239	0.469	0.160	0.140	0.405	0.196
20 I feel comfortable using needed computer technologies in the classroom	0.272	0.461	0.281	0.101	0.402	0.369
16 When professors use eLearning, it is accessible to me	0.306	0.445	0.455	0.180	0.636	0.176

Note. Rotated component matrix. Factor loadings belonging to each Subscale are boxed Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser Normalization.

1 Test sample, n = 207. Percent of variance for rotated factors is as follows: Factor 1 = 22.728%, Factor 2 = 14.606%, Factor 3 = 14.360%.

2 Test sample, n = 1354 (mean substitution). Percent of variance for rotated factors is as follows: Factor 1 = 16.592%, Factor 2 = 12.724%, Factor 3 = 12.537%.

Table 4

POSITIVES Scale Items, Factors, and Scoring

Subscale / Factor	Item number, item wording and scoring	Mean	SD	n
Subscale 1 -ICTs at school meet student's needs (Scoring: average all Factor 1 single item scores other than "not applicable")		4.65	1.03	592
1	1. My school has enough computers with internet access to meet my needs	4.83	1.46	1315
1	2. The hours of access to computer technologies at my school meet my needs	4.91	1.45	1290
1	3. At my school, computer technologies are sufficiently up to date to meet my needs (e.g., grammar checking, adaptive mouse, software that reads what is on the screen)	4.90	1.43	1221
1	4. There are enough computer technologies in my school's specialized labs/centres for students with disabilities to meet my needs	4.19	1.69	1069
1	5. The availability of computer technologies in my school's general use computer labs meet my needs	4.47	1.62	1273
1	8. The technical support provided at my school for computer technologies meets my needs	4.59	1.46	1172
1	9. When I approach staff at my institution with problems related to the accessibility of computer technologies on campus they act quickly to resolve any issues (e.g., cannot see the PowerPoint presentation, cannot hear a video clip, need a grammar checker to write an essay)	4.72	1.43	978
1	10. There is at least one person on staff at my school who has expertise in adaptive hardware and software (e.g., knowledgeable about software that reads what is on the screen, keeps up to date with the latest in adapted keyboards)	5.00	1.37	1046
1	11. The availability of technical support when I am not at school meets my needs (e.g., school IT help desk, vendor support)	4.22	1.55	1054
1	13. Training provided by my school on how to use the computer technologies meets my needs	4.29	1.60	996
1	14. Informal help is available at my school to show me how to use computer technologies if I need this	4.54	1.46	1167
1	24. The physical access to computer technologies at my school meets my needs (e.g., adjustable table, wide enough doorway)	4.90	1.49	976
Subscale 2 - ICTs at home meet student's needs (Scoring: average all Factor 2 single item scores other than "not applicable")		4.38	1.20	486
2	6. My school's loan program for computer technologies meets my needs	3.88	1.86	703
2	7. Funding for computer technologies for personal use is adequate to meet my needs (e.g., government, foundation, rehab center, loan program)	4.07	1.85	955
2	12. I know how to effectively use the computer technologies that I need	5.08	1.25	1331
2	15. Training available off campus on how to use computer technologies meets my needs	3.64	1.65	803
2	23. My personal computer technologies are sufficiently up-to-date to meet my needs	4.76	1.52	1318
Subscale 3 - e-Learning ICTs meet student's needs (Scoring: average all Factor 3 single item scores other than "not applicable")		4.98	0.88	589
3	16. When professors use eLearning, it is accessible to me (e.g., PowerPoint in the classroom, course notes on the web, CD-ROMs, WebCT)	4.99	1.32	1186
3	17. I have no problems when professors use eLearning for tests and exams (e.g., quizzes in WebCT)	4.71	1.57	941
3	18. Distance education courses offered by my institution are accessible to me	4.70	1.56	726
3	19. If I bring computer technology into the classroom I am able to use it (e.g., can plug it in)	4.59	1.50	1150
3	20. I feel comfortable using needed computer technologies in the classroom	4.63	1.54	1137
3	21. My school's interactive online services are accessible to me (e.g., registering, financial aid applications on the web)	5.36	1.06	1297
3	22. The accessibility of the library's computer systems meets my needs (e.g., catalogues, databases, CD-ROMs)	5.02	1.28	1290
3	25. My school's web pages are accessible to me	5.52	0.94	1341
3	26. The availability of electronic format course materials meets my needs (e.g., Word, PDF, MP3)	5.04	1.35	1293
Total (average) score (Scoring: average all single item scores other than "not applicable")		4.75	0.86	1354

Scoring. For all statements, rate your level of agreement using the following scale: 1 = Strongly Disagree, 2 = Moderately Disagree, 3 = Slightly Disagree, 4 = Slightly Agree, 5 = Moderately Agree, 6 = Strongly Agree, 7 = Not Applicable

Note: n= 1354.

Table 5

POSITIVES Scale Preliminary Norms for Students with Different Disabilities

Group	Mean	SD
Subscale 1 - ICTs at School Meet Student's Needs		
Totally blind	4.21	1.12
Low vision	4.47	1.13
Deaf	4.60	0.81
Hard of hearing	4.95	0.76
Learning disability / ADD / ADHD (e.g., dyslexia)	4.76	0.98
Mobility impairment (e.g., use of a wheelchair / cane / crutches)	4.81	0.97
Limitation in the use of hands / arms	4.56	0.86
Medically related / health problem (e.g., diabetes, Crohn's)	4.94	0.86
Psychological / psychiatric disability (e.g., anxiety, depression)	4.81	0.89
Neurological impairment (e.g., epilepsy, traumatic brain injury)	4.52	1.08
Multiple disabilities	4.45	1.11
Whole sample [1]	4.65	1.02
Subscale 2 - ICTs at Home Meet Student's Needs		
Totally blind	4.80	0.96
Low vision	4.69	1.11
Deaf	4.86	0.67
Hard of hearing	4.73	0.92
Learning disability / ADD / ADHD (e.g., dyslexia)	4.39	1.20
Mobility impairment (e.g., use of a wheelchair / cane / crutches)	4.70	1.21
Limitation in the use of hands / arms	4.48	1.02
Medically related / health problem (e.g., diabetes, Crohn's)	4.47	1.15
Psychological / psychiatric disability (e.g., anxiety, depression)	4.37	1.21
Neurological impairment (e.g., epilepsy, traumatic brain injury)	4.58	0.93
Multiple disabilities	4.19	1.26
Whole sample [1]	4.38	1.20
Subscale 3 - E-learning ICTs Meet Student's Needs		
Totally blind	4.63	0.69
Low vision	4.90	0.93
Deaf	5.15	0.80
Hard of hearing	5.30	0.54
Learning disability / ADD / ADHD (e.g., dyslexia)	5.01	0.80
Mobility impairment (e.g., use of a wheelchair / cane / crutches)	5.37	0.76
Limitation in the use of hands / arms	5.02	0.69
Medically related / health problem (e.g., diabetes, Crohn's)	5.28	0.86
Psychological / psychiatric disability (e.g., anxiety, depression)	5.13	0.76
Neurological impairment (e.g., epilepsy, traumatic brain injury)	4.91	0.86
Multiple disabilities	4.85	0.92
Whole sample [1]	5.00	0.85
Total (average) score		
Totally blind	4.48	0.73
Low vision	4.67	0.90
Deaf	4.86	0.64
Hard of hearing	5.05	0.63
Learning disability / ADD / ADHD (e.g., dyslexia)	4.81	0.84
Mobility impairment (e.g., use of a wheelchair / cane / crutches)	5.03	0.82
Limitation in the use of hands / arms	4.72	0.73
Medically related / health problem (e.g., diabetes, Crohn's)	5.03	0.78
Psychological / psychiatric disability (e.g., anxiety, depression)	4.87	0.79
Neurological impairment (e.g., epilepsy, traumatic brain injury)	4.69	0.90
Multiple disabilities	4.57	0.92
Whole sample [1]	4.75	0.86

Table 6

Correlations Among POSITIVES Scale Subscales, Total, and Overall Item Scores

Variables	Subscale 1 - ICTs at School Meet Student's Needs			Subscale 2 - ICTs at Home Meet Student's Needs			Subscale 3 - E-learning ICTs Meet Student's Needs			Total (average) score		
	n	r	Sig =	n	r	Sig =	n	r	Sig =	n	r	Sig =
Overall Criterion Items												
In general, my computer technology needs at my school are adequately met	1261	0.627	0.000	1083	0.446	0.000	1257	0.450	0.000	1297	0.616	0.000
In general, my computer technology needs at home are adequately met	1243	0.328	0.000	1068	0.590	0.000	1245	0.295	0.000	1284	0.438	0.000
Positive Scale Subscales												
Subscale 1 - ICTs at School Meet Student's Needs	-	-	-	1081	0.567	0.000	1258	0.622	0.000	1301	0.920	0.000
Subscale 2 - ICTs at Home Meet Student's Needs	1081	0.567	0.000	-	-	-	1078	0.521	0.000	1115	0.762	0.000
Subscale 3 - E-learning ICTs Meet Student's Needs	1258	0.622	0.000	1078	0.521	0.000	-	-	-	1311	0.833	0.000
Total (average) score	1301	0.920	0.000	1115	0.762	0.000	1311	0.833	0.000	-	-	-

with low vision were met least well. Needs of students who are hard of hearing, have a medically related/health problem, have a mobility impairment, and those with psychological/psychiatric disabilities were met best. However, Subscale results suggest that while this pattern is true for Subscale 1 (ICTs at School Meet Needs) and Subscale 3 (e-learning ICTs meet students' needs), the pattern of results is very different for off campus use, where the ICT related needs of the following groups are being met least well: multiple disabilities, psychological/psychiatric disability, learning disability/ADD/ADHD. In contrast, the needs of students with mobility impairment, those who are hard of hearing, and those who are totally blind are best met in this context.

Validity

Two types of construct validation were undertaken: convergent and discriminant validity. In addition, concurrent and criterion validity were examined.

Convergent validity. Examination of the properties of the POSITIVES measure, provided in Table 6, shows moderate correlations among the three Subscales (range r = .521 to r = .622). Internal validity correlation coefficients in this table also show strong relationships between Subscale scores and the Total score (range from r = .762 to r = .920). Overall, the coefficients indicate that Subscales measure different concepts, all of which are important components of the accessibility of ICTs as measured by the Total score.

Discriminant validity. There was no reason to expect that females' and males' POSITIVES Scale Subscale or Total scores would differ. Therefore, to test discriminant validity we compared female and male participants' POSITIVES Scale Subscales and Total scores. The means, and the multivariate analysis of variance (MANOVA), ANOVA and t-test findings show that none of the Subscales differentiated between these two groups; nor did the Total score.

Concurrent validity. Although the two Overall Criterion Items are significantly correlated with all Subscale and Total scores, coefficients in Table 8 show that, as expected, the Overall Item "In general, my computer and/or adaptive computer technology needs at my school are adequately met" was most closely correlated to Subscale 1 - ICTs at School Meet Student's Needs and that the Overall item, "In general, my computer and/or adaptive computer technology needs at home are adequately met" was most closely related to Subscale 2 - ICTs at Home Meet Student's Needs.

In addition, we examined the relationship between POSITIVES Subscale as well as Total scores and selected questions from data collected in the context of two studies conducted in 2005 (Fichten, Jorgensen, Havel, & Barile, 2006) and 2006 (Fichten et al., 2006). These are presented in Table 7 and show that the two POSITIVES Subscales that deal with ICTs in schools (Subscales 1 and 3) are especially highly correlated with items which deal with ICTs and e-learning in school, along with the extent to which the college environments meets students' needs, and that students' personal situation is most closely related to POSITIVES Subscale 2 (how well ICTs at home meet students' needs). In addition, The POSITIVES Total score is significantly related to scores on all items.

Criterion validity. Based on a priori assumptions, students with psychological/psychiatric disabilities would be expected to have their ICT related needs better met than students with multiple disabilities. We selected these groups because we thought that students with psychological/psychiatric disabilities were less likely to need specialized adaptive technologies than students with other disabilities, especially students with multiple disabilities. In addition, we thought that students with multiple disabilities would be especially likely to experience ICT related problems because of compatibility issues between different types of needed ICTs.

To test criterion validity we wanted to examine the extent to which the POSITIVES Scale Subscale and Total scores were able to differentiate between these two groups of participants. The means and MANOVA, ANOVA and t-test findings presented in Table 8 show that all three Subscales differentiated between these two groups, as did the Total score.

Equivalence of Formats

To evaluate whether the POSITIVES Scale can be administered in alternate formats we used a 1-way ANOVA to compare scores of English speaking participants with learning disabilities who had been randomly assigned to one of three experimental conditions: completing the retest Online, within Microsoft Word, and on Paper (printable PDF) formats. Mean scores and 1-way ANOVA test results indicate that there were no significant differences on the 26 POSITIVES Scale single items or on the 3 Subscales or the Total score.

Table 7

Correlations Among POSITIVES Scale Subscales, Total, and Overall Items with the e-learning Scores

Variables	POSITIVES Subscale 1 - ICTs at School Meet Student's Needs			POSITIVES Subscale 2 - ICTs at Home Meet Student's Needs			POSITIVES Subscale 3 - E-learning ICTs Meet Student's Needs			POSITIVES Total (average) score		
	n	r	Sig =	n	r	Sig =	n	r	Sig =	n	r	Sig =
Cross-Canada study of college and University students [1]												
There are individuals at the student's school who are knowledgeable about how to make ICTs and e-learning accessible to students with disabilities.	73	0.479	0.000	63	0.367	0.003	71	0.321	0.006	73	0.477	0.000
ICTs and e-learning used by professors in their courses is accessible to the student (e.g., PowerPoint in the classroom, downloadable PDF files, CD-ROMs, WebCT)	74	0.570	0.000	64	0.431	0.000	72	0.587	0.000	74	0.636	0.000
ICTs and e-learning used by professors over the Internet are accessible to the student (e.g., downloadable PDF files, course web pages, discussion boards)	74	0.422	0.000	64	0.226	0.073	72	0.583	0.000	74	0.515	0.000
Inaccessibility of ICTs and e-learning in a course has posed difficulties for the student	75	-0.446	0.000	65	-0.274	0.027	73	-0.395	0.001	75	-0.471	0.000
Average accessibility of 18 different types of ICTs and e-learning used by professors to the student	74	0.456	0.000	64	0.309	0.013	72	0.506	0.000	74	0.529	0.000
Junior/community college students in Quebec [2]												
Student's personal situation has made college studies harder-easier	42	0.327	0.035	32	0.431	0.014	43	0.267	0.083	45	0.368	0.013
The college environment has made college studies easier-harder	42	0.333	0.031	32	0.236	0.193	43	0.250	0.106	45	0.344	0.021

[1]-Unpublished data: Fichten et al.
[2] Higher scores indicate "easier" -Fichten et al., 2006.

Table 8

Criterion Validity: Comparison of POSITIVES Scores of Participants with Psychological / Psychiatric Disabilities and with Multiple Disabilities

Positive Scale Variables	Psychological / psychiatric disability			Multiple disabilities			Significance test
	n	Mean	SD	n	Mean	SD	
Whole sample							
Subscales							MANOVA F(3,483) = 4.16, p=.0045
Subscale 1 - ICTs at School Meet Student's Needs	115	4.78	0.84	372	4.38	1.12	ANOVA F(1,485) = 12.09, p = .0006
Subscale 2 - ICTs at Home Meet Student's Needs	115	4.43	1.17	372	4.17	1.26	ANOVA F(1,485) = 3.91, p = .0485
Subscale 3 - E-learning ICTs Meet Student's Needs	115	5.08	0.77	372	4.79	0.93	ANOVA F(1,485) = 9.05, p = .0028
Total (average) score	172	4.87	0.79	460	4.57	0.92	t-test t(630) = 4.11 p = .000
English speaking participants							
Subscales							MANOVA F(3,431) = 4.93, p=.0022
Subscale 1 - ICTs at School Meet Student's Needs	112	4.78	0.85	323	4.36	1.13	ANOVA F(1,433) = 12.96, p = .000
Subscale 2 - ICTs at Home Meet Student's Needs	112	4.43	1.19	323	4.12	1.25	ANOVA F(1,433) = 5.179, p = .023
Subscale 3 - E-learning ICTs Meet Student's Needs	112	5.09	0.77	323	4.77	0.92	ANOVA F(1,433) = 11.420, p = .001
Total (average) score	169	4.88	0.79	399	4.54	0.93	t-test t(566) = 4.38 p = .000

Note. There were insufficient numbers of French speaking participants with psychological/psychiatric impairments to carry out meaningful comparisons.

Discussion

POSITIVES Scale Properties

The goal of the research was to develop the 26-item POSITIVES Scale (Postsecondary Information Technology Initiative Scale), a valid and reliable measure of how well postsecondary students with various disabilities perceive that their ICT related needs are being met. The measure has a total score as well as three factor analysis derived subscales which evaluate how well ICTs available at school, at home, and in e-learning contexts meet the needs of students with different disabilities in postsecondary education. In addition, alternate formats of the measure (i.e., versions that can be completed online, on paper (printable PDF), and within Microsoft Word) yielded equivalent results. The Scale, in both French and English, is available from the authors. Norms for Canadian postsecondary students are provided and preliminary norms for students with different disabilities are also provided. These are preliminary because of sample size limitations.

POSITIVES Scale Subscales

In addition to a Total score, the POSITIVES Scale has the following Subscales:

Subscale 1 - ICTs at School Meet Student's Needs. This twelve-item subscale evaluates the extent to which students' ICT related needs are being met while they are at school (e.g., My school has enough computers with internet access to meet my needs. The hours of access to computer technologies at my school meet my needs).

Subscale 2 - ICTs at Home Meet Student's Needs. This five-item subscale evaluates the extent to which ICT related needs are being met while they are off campus (e.g., Funding for computer technologies for personal use is adequate to meet my needs. My personal computer technologies are sufficiently up-to-date to meet my needs).

Subscale 3 - E-learning ICTs Meet Student's Needs. This nine-item subscale evaluates the extent to which the school's e-learning meets the student's needs (e.g., My school's web pages are accessible to me. I have no problems when professors use e-learning for tests and exams).

Reliability

Reliability and validity estimates indicate excellent psychometric properties for the scale. Four-week test-retest reliabilities for the three Subscales range from .73 to .79 and the reliability of the Total score is .81. Paired t-tests on test and retest scores show no significant differences. Cronbach's alpha, a measure of internal consistency, ranges from .79 to .91 for the three Subscales and is .94 for the Total score. Split-half reliabilities and Subscale:Total correlations all exceed .70.

Validity

Convergent validity. Data show moderate correlations among the three subscales and strong relationships between subscale and total scores, suggesting that the subscales measure different concepts, all of which are important components of the accessibility of ICTs as measured by the Total score.

Discriminant validity. We compared female and male participants' POSITIVES Scale subscale and total scores because we had no reason to assume that their scores would differ. Consistent with this prediction, we found no significant differences between the groups.

Concurrent validity. As a measure of criterion validity we predicted - and found - that scores on Subscales 1 and 2 would be most closely related to scores on the criterion items, "In general, my computer and/or adaptive computer technology needs at my school are adequately met" and, "In general, my computer and/or adaptive computer technology needs at home are adequately met," respectively. In addition, we found that subscale scores were logically related to selected items answered by a small subset of students from two previous studies conducted up to two years earlier

Criterion validity. Based on a priori assumptions, students with psychological/psychiatric disabilities were expected to have their ICT related needs better met than students with multiple disabilities. To test criterion validity we examined the extent to which the POSITIVES Scale subscale and total scores were able to differentiate between these two groups. The findings show significant differences between the two groups on all subscales as well as on the total score.

Limitations of the Present Study

Although the POSITIVES Scale has demonstrated acceptable reliability and validity, the present investigation has some limitations that need to be taken into account when interpreting the findings. The samples of French and English speaking students are neither random nor fully representative of the populations studied. First, students self-identified as having a disability. Second, given the nature of participant recruitment and

self-selection biases, students who read online discussion lists, had experience using e-learning, or were power-users of ICTs are over-represented. Especially troubling is that calculating a "return rate" was impossible because of the manner in which participants were recruited.

Yet, most available indices suggest that the studies' samples have characteristics which resemble the realities of Canadian postsecondary education. For example, the samples contained more females than males, students were older than typical postsecondary samples, and the proportions of students with different disabilities reflect the realities of many postsecondary institutions.

It should also be noted that the norms have not been cross-validated on another, independently recruited sample and that the sample sizes for the alternate formats comparison were especially small. All students are from Canada, necessitating additional validation of the POSITIVES Scale involving samples of postsecondary students from other English and French speaking countries. Thus, we present the POSITIVES Scale as a promising research tool that needs additional validation.

Key Findings

Sample characteristics. Consistent with others' findings, students with disabilities were relatively older (mean age was 28) and approximately half of the sample reported a learning disability (e.g., Stodden, 2005). Approximately 1/3 of the sample reported a psychological / psychiatric disability. This is not surprising given Blanco et al.'s (2008) findings showing that close to 50% of a large representative sample of American university students had a diagnosable psychiatric condition during the past twelve months.

It is noteworthy that over a third of our sample reported more than one disability, a finding similar to those of earlier investigations (e.g., Asuncion, Fichten, Fossey, & Barile, 2002; Sharpe, Johnson, Izzo, & Murray, 2005). This implies that ICTs need to be operable together and that conflicts between different adaptive technologies meant to support people with different disabilities need to be avoided.

Findings Using the POSITIVES Scale: How Well are Students' ICT Related Needs Met?

Consistent with data from other researchers (Sharpe et al., 2005) our results show more favorable than unfavorable scores and no significant differences between college and university students' ratings. Nevertheless, there are some concerns around the availability of adapted computers in the school's specialized computer laboratories as well as with institutional computer technology loan programs. The accessibility of computers in campus computer labs has been noted as an issue of concern by students elsewhere as well (e.g., Armstrong, Lewis, Turingan, & Neault, 1997). In addition, funding for computer technologies for personal use and poor technical support when the student is not at school had low scores. As highlighted by others (e.g., Berkowitz, 2006), training, both on and off campus, was also seen as relatively problematic.

On the plus side, the findings show that students feel the school's web pages are accessible, that they can effectively use the computer technologies they need, that expertise in adaptive ICTs was readily available on campus, that needed electronic format course materials are readily available, and that the school's interactive online services (e.g., registration, financial aid applications on the web) as well as the library's computer systems were generally quite accessible.

Students with different disabilities. Although overall the findings suggest that the ICT related needs of students in all groups are relatively well met, those of students who are totally blind, those with multiple disabilities, and those with low vision were met least well, while the needs of students who are heard of hearing, have a medically related/health problem, have a mobility impairment or have a psychological/psychiatric disability were met most effectively. However, the findings on POSITIVES Scale subscales suggest that while this pattern is true for Subscale 1 (ICTs at School Meet Needs) and Subscale 3 (e-learning ICTs meet students' needs), the pattern of results is very different for home use, where the ICT related needs of the following groups were met least well: multiple disabilities, psychological/ psychiatric disability, learning disability/ADD/ADHD. The home based ICT related needs of students with a mobility impairment, those who are hard of hearing and those who are totally blind were being met best.

Implications for Future Research and Practice

As a key step in addressing the evaluation of how well the ICT needs of students with disabilities in postsecondary education are being met, the POSITIVES Scale fills a gap. The reliability and validity testing conducted to date allows students with disabilities to assess the availability and accessibility of campus computing as well as of ICTs available for off campus

use. The measure has a variety of features that make it easy-to-use. Only 26 items long, it is easy for learners with all types of disabilities to complete. The simple scoring requires only a straightforward calculation of means. The measure, which can be completed online, within a Microsoft Word file, and in print formats, has the advantage of flexibility due to its "face validity."

Potential uses. The POSITIVES Scale (a) permits item-by-item analysis to identify individual areas of perceived strength and weakness, (b) can assess modifiable aspects of the accessibility, usability, and availability of ICTs both on and off campus, as well as (c) permit monitoring and evaluation of the effects of efforts to improve meeting students' needs. For example, the measure could be administered at different times as major modifications occur in campus computing infrastructure or in ICT related policies as these relate to students with disabilities. Other uses of the scale include: (d) evaluation of one's own institution; (e) a means for continuously measuring progress through internal and external benchmark setting; (f) identifying gaps and targeting specific areas for improvement; and (g) a means of informing policy documents, ICT strategy, and ICT budget allocations.

The POSITIVES Scale can be used in a number of ways by disability service providers in concert with their colleagues in IT and other domains. For example, internally, through an item-by-item analysis, individual areas of strength and weakness, as indicated by the student end-users, can be identified, with areas requiring further investigation given focus, possibly leading to building a case for increased funding or other organizational improvements. For the off-campus items, institutions can use data from the POSITIVES Scale to help advocate for change with external stakeholders in the broader community. Strategically, postsecondary educational institutions could use data based on the Scale to drive key performance indicators. In addition. the data can be useful for year-over-year internal and/or external benchmarking. Finally, the POSITIVES Scale, in whole or in part, could be folded into larger satisfaction surveys of the entire student population to inquire about their ICT use and experiences.

Possible research directions include: (a) continued validation by comparing scores of students with disabilities with their grades as well as with their views about other aspects of their postsecondary experience; (b) additions to the normative data by testing larger, more diverse samples, by providing separate norms by student disability, by school type, location, and nature (e.g., junior/community college versus university, urban versus rural, private versus public); and (c) collecting data from new samples, including nondisabled students, as well as from samples outside Canada such as the U.S., Great Britain, Australia, France and Belgium.

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, 2007, from http://www.cjlt.ca/content/vol32.3/abrami.html

Armstrong, W. B., Lewis, M., Turingan, M., & Neault, L. C. (1997). *Americans with Disabilities Act (ADA): City College self-evaluation study*. San Diego, CA: San Diego Community College District. (ERIC Document Reproduction Service No. ED413972).

Asuncion, J., Draffan, E. A., Guinan, E. P. & Thompson, T. (2009). International comparison on accessible technology in higher education. *ATHEN E-Journal*, Issue #44. Retrieved February 26, 2009, from http://athenpro.org/node/120

Asuncion, J. V., Fichten, C. S., Fossey, M., & Barile, M. (2002). Dialoguing with developers and suppliers of adaptive computer technologies: Data and recommendations. *Universal Access in the Information Society, 1*(3), 177-196.

Berkowitz, D. J. (2006). Literature review. Unpublished manuscript available from the author at dann@digilifemedia.biz

Blanco, C., Okuda, M., Wright, C., Hasin, D., Grant, B.F., Liu, S.M., & Olfson, M. (2008). Mental health of college students and their non–college-attending peers results from the national epidemiologic study on alcohol and related conditions. *Archives of General Psychiatry, 65*(12), 1429-1437.

Bullock, C., & Ory, J. (2000). Evaluating instructional technology implementation in a higher education environment. *American Journal of Evaluation, 21*(3), 315-28.

Burton, M., & Nieuwenhuijsen, R. (2008). Computer-related assistive technology: Satisfaction and experiences among users with disabilities. *Assistive Technology, 20*, 99-106.

Campus Computing Project (2008). The 2008 National Survey of Information Technology in U.S. Higher Education: Campuses Invest in emergency notification. Retrieved December 23, 2009, from http://www.campuscomputing.net/sites/www.campuscomputing.net/files/CC2008-Executive%20Summary_3.pdf

Canadian Council on Social Development. (2004). *Disability information sheet No. 16: Workers with disabilities and the impact of workplace structures.* Retrieved March 14, 2006, from http://www.ccsd.ca/drip/research/drip16/drip16.pdf

Educause (n.d.). An Educause guide to evaluating information technology on campus. Boulder, CO: Educause. Retrieved March 30, 2005, from http://www.educause.edu/consumerguide

Fichten, C.S., Asuncion, J.V., Barile, M., Ferraro, & Wolforth, J. (2009). Accessibility of eLearning, computer and information technologies to students with visual impairments in postsecondary education. *Journal of Visual Impairment and Blindness, 109*(9), 543-557.

Fichten, C.S., Asuncion, J.V., Ferraro, V., Chwojka, C., Nguyen, M.N., Barile, M. (2006, November). *eLearning problems and solutions: An empirical study of Canadian postsecondary students with disabilities, campus disability service providers, faculty, and elearning specialists*. Presentation at the annual Accessing Higher Ground conference. November, Boulder, Colorado.

Fichten, C. S., Barile, M., & Asuncion, J. V. (1999). *Learning technologies: Students with disabilities in postsecondary education / Projet Adaptech: l'Utilisation des technologies d'apprentissage par les étudiant(e)s handicapé(e)s au niveau postsecondaire.* Final report to the Office of Learning Technologies. Ottawa, ON, Canada: Human Resources Development Canada. Retrieved July 11, 2003, from http://adaptech.dawsoncollege.qc.ca/pubs/79160final_e.pdf

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 and Society. 12* (4), 241–256.

Fichten, C. S., Jorgensen, S., Havel, A., & Barile, M. (2005). *Étudiant(e)s de niveau collégial ayant des incapacités / College students with disabilities.* Final report presented to PAREA (Programme d'aide à la recherche sur l'enseignement et l'apprentissage). Québec, QC, Canada: Ministère de l'Éducation, du Loisir et du Sport du Québec. (ERIC Document Reproduction Service No. ED490017).

Fichten, C. S., Nguyen, M. N., Barile, M., & Asuncion, J. (2007). Scale of Adaptive Information Technology Accessibility for Postsecondary Students with Disabilities Scale (SAITAPSD): A preliminary investigation. *Journal of Postsecondary Education and Disability, 20*(1), 54-75.

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.

Green, K. C. (2005). *Summary of the Campus Computing Survey*. Retrieved January 21, 2006, from http://www.campuscomputing.net/pdf/2005-CCP.pdf

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. Retrieved August 11, 2006, from http://gateway.ut.ovid.com/gw1/ovidweb.cgi

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. Retrieved March 30, 2003, from http://jset.unlv.edu/17.1/michaels/first.html

National Council on Disability. (2003). *People with disabilities and postsecondary education — Position paper.* Washington, DC: National Council on Disability. Retrieved December 4, 2007, from http://www.ncd.gov/newsroom/publications/2003/education.htm

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 Sept. 4, 2007, from http://nces.ed.gov/pubs2007/2007017.pdf

Stodden, R. A. (2005). Supporting persons with disabilities in postsecondary education and life long learning. *Journal of Vocational Rehabilitation, 22*, 1-2.

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.

Thompson, T., Draffan, E.A., & Patel, P. (2009). 2008 ATHEN Survey on accessible technology in higher education. *ATHEN E-Journal, 4*. Retrieved December 30, 2008 from http://athenpro.org/node/119

Tremblay, D., & LeMay, S. (2005). *Statistiques concernant les étudiants ayant des besoins spéciaux dans les universités québécoises : 2004–2005 (sommaire)*. Québec: AQICEBS, Université Laval. Retrieved June 21, 2005, from http://www.aqicebs.qc.ca/documents/SOMMAIRE_0405.pdf

Waddell, C. D. (2007). Accessible electronic & information technology: Legal obligations of higher education and Section 508. *ATHEN e-Journal*, 2. Retrieved December 3, 2007, 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.

About the Authors

Catherine S. Fichten received a B.Sc. degree in Psychology from McGill University, a Master's Degree in Experimental Psychology from Concordia University, and Ph.D. in Clinical Psychology from McGill University. She is currently a Professor in the Department of Psychology at Dawson College and an Associate Professor in the Department of Psychiatry at McGill University. She is also a clinical psychologist at the Behavioural Psychotherapy and Research Unit of the Jewish General Hospital. Her research interests include factors which affect success in postsecondary education for students with disabilities, with a special focus on computer and information technologies. She can be reached by email at: catherine.fichten@mcgill.ca.

Rhonda Amsel received her B.Sc. degree in mathematics and M.Sc. in computer science from McGill University. She serves as consulting statistician in the Department of Psychology at McGill University, where she teaches statistics. She was Associate Dean of Students from 1996-2001 and is associate member of the Department of Neuropsychology at the Montreal Neurological Institute, the McGill School of Nursing, and McGill Teaching and Learning Services. Her research on experimental methodology is done in the context of collaborative work in the areas of health science, neuropsychology, and education. She can be reached at rhonda.amsel@mcgill.ca.

Mai Nhu Nguyen received her B.Sc. degree in psychology from Université de Montréal. She is currently working as a research associate for the Research Adaptech Network. Her research interests relate to the benefits of internet for students with disabilities, particularly those with hearing impairments. She can be reached by email at: vizaura@gmail.com.

Jennison V. Asuncion holds both a B.A. (with distinction) in Political Science and an M.A. in Educational Technology from Concordia University. He co-directs the Adaptech Research Network and has been conducting research on the use and accessibility of information and communication technology (ICT) and postsecondary students with disabilities for 13 years. Jennison has a particular interest in the accessibility of various forms of social media used by these students. He is also Senior Advisor to the National Educational Association of Disabled Students (NEADS www.neads.ca). He can be

reached by email at: asuncion@alcor.concordia.ca

Jillian Budd is currently an undergraduate in Honours Psychology at Concordia University. She is a long-time research assistant with the Adaptech Research Network. She can be reached by email at: jbudd@dawsoncollege.qc.ca.