Scale of Adaptive Information Technology Accessibility for Postsecondary Students with Disabilities (SAITAPSD): A Preliminary Investigation

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Abstract

The responses of 81 Canadian junior and community college students with disabilities were used to develop and evaluate the Scale of Adaptive Information Technology Accessibility for Postsecondary Students with Disabilities (SAITAPSD). This is an 18-item self-administered tool that evaluates computing accessibility for and by students with various disabilities. The scale, a companion to the service provider version of the measure (Fossey et al., 2005), contains a total score and three empirically derived subscales: Adaptive Computer Availability and Support, Perceived Computer Competency, and New Computer Technologies. Results indicated that the three subscales account for 50% of the variability in total scores. Psychometric data showed good temporal stability and internal consistency for both the subscales and the total score. Validity data showed strong relationships between scores and key criterion variables as well as other measures of obstacles and facilitators to academic success. The scale may be used to evaluate an institution's information technology (IT) accessibility, provide empirical data to influence IT policy, and pinpoint areas of strength as well as areas for improvement, all from the perspective of students with disabilities.

Recently, we reported on the development of a scale to evaluate the accessibility of campus computing intended for disability service providers to complete (Fossey et al., 2005). Here we present a companion measure, designed for completion by students with various disabilities. The student measure had to meet a variety of criteria: including easy for students with all types of disabilities to complete; reflective of the changing landscape in the use of information and computer technologies on campus (e.g., eLearning); meaningful to rehabilitation centers to assist them in making needed adaptive hardware (e.g., foot mouse) and software (e.g., software that reads material on the screen) available for their clientele; and helpful as a tool for advocating with campus administration and staff regarding the importance of acquiring and implementing computer technologies accessible to all learners.

The measure focuses on the availability and accessibility of adaptive computer technologies in a variety of locations on as well as off campus. Accessibility in this context refers to a range of situations such as whether computers with adaptive technologies are available in general use computer labs; whether eLearning (e.g., course web pages, CD-ROMs) used by faculty is accessible to all learners; and whether learners receive adequate training in how to use needed adaptive software/hardware (Goodman, Tiene, & Luft, 2002).

Data from students with disabilities and campus disability service providers will provide institutional administrators a better picture of the issues surrounding the availability and accessibility of computers. In this way they can make empirically based decisions to meet the information technology needs of all students. For many, this includes adaptive computer technologies such as screen readers and voice dictation software (Burgstahler, 2002, 2003). Using the scale developed here, along with the version for campus disability service providers, can assist in this effort.

Information and Communication Technologies (ICTs) in Postsecondary Education

The number of postsecondary students with disabilities has increased in the past decade in both Canada and the United States (Fournier & Tremblay, 2003; Harris Interactive, 2004; Henderson, 2001; Tremblay, Gagné, & Le May, 2004; Wagner, Newman, Cameto, & Levine, 2005a, b). Recent estimates put the proportion of the postsecondary student population with disabilities between 10% and 17% (Fichten, Jorgensen, Havel, & Barile, 2006; Stodden, Whelley, Chang, & Harding, 2001; Wagner et al., 2005a, b.) In general, proportionately more students with disabilities enroll in junior/community colleges than in universities (Fichten Asuncion, Barile, Robillard, Fossey, & Lamb, 2003; Horn, Berktold, & Bobbitt, 1999; Richardson, 2001; Richardson & Roy, 2002; Stodden, Conway, & Chang, 2003).

Many students with disabilities require some form of adaptive software or hardware to use a computer effectively. As the number of these learners continues to grow, so does the need to ensure the accessibility of a growing array of computer and information technologies (ICTs) on campus (Asuncion, Fichten, Barile, Fossey, & Robillard, 2004). Abrami et al. (2006), who recently demonstrated the importance of eLearning initiatives in Canadian postsecondary education, also noted that we know very little about the eLearning needs and concerns of students with disabilities. Clearly, more research is necessary given the ubiquity of ICTs across North American campuses.

During the past few years, skill using ICTs has become mandatory in postsecondary institutions and the workplace (Stodden et al., 2003). For example, a recent investigation 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 to provide evidence-based data showing how investment in learning technologies accessible to all learners results in improvements in success rates to information technology (IT) decision makers. Better system wide collection of data on the availability of accessible computer technologies will help to achieve this.

In spite of tremendous opportunities afforded by computers for learners with disabilities (Burgstahler & Doe, 2006), a variety of barriers can interfere with effective use of these technologies (Bouchard & Veillette, 2005; Fichten, Jorgensen, Havel, & Barile, 2005; Michaels, Prezant, Morabito, & Jackson, 2002;) Postsecondary institutions and their faculty, in the rush to integrate technology into teaching, may fail to think about access needs of learners with various disabilities (Bissonnette & Schmid, 2003). Examples include eLearning, such as course web pages with small print and colors that cannot be changed, downloadable files incompatible with adaptive software, and video clips without captioning abound.

Those in charge of supporting and deploying eLearning generally do not confirm ahead of time the compatibility of newly purchased academic software with popular screen reading programs or ensure the availability of at least one large-screen monitor in general use computer labs (Armstrong, Lewis, Turingan, & Neault, 1997). Such problems generally do not surface until a student with a disability experiences difficulties, a situation that frequently results in a call to the campus disability service provider. The question then becomes, “How well are the colleges and those who provide disability related services on campus prepared to provide accommodations based on the new realities?”

Our findings on a large number of Canadian disability service providers (Fichten, Asuncion, Barile, Fossey, Robillard et al., 2004) show the following. (a) In general, disability service providers do not know much about computer technologies for students with disabilities, a finding echoed by Berkowitz’s (2006) recent review of the role of computers in the education of individuals with disabilities. (b) Virtually all four-year universities had specific dedicated computer equipment for students with disabilities, while two-year junior/community colleges were less likely to have this, a finding not consistent with U.S. results reported by Christ and Stodden (2005), who showed that two-year colleges were more likely to provide assistive technology supports than four-year universities. (c) The presence of adaptive technologies in general-use computer labs was seen as an urgent priority. (d) A strong need was expressed for better technical support for adaptive computer technologies on campus. (e) Computer-based teaching materials used by faculty were frequently seen as inaccessible. (f) Faculty were seen as poorly informed about the computer-related needs of students with disabilities. (g) Accessibility of Internet-based distance education and web-based "hybrid" courses were seen as problematic in some institutions.

Integration of educational technologies with campus computing infrastructure proceeds on an active basis on virtually all North American campuses (Educause, 2005; Green, 2005; Kiernan, 2002). An important aspect of this implementation includes ongoing evaluation of how well these technologies meet the needs of students, faculty and other members of the institution's constituencies (Educause, 2004). Evaluation should be carried out for a variety of reasons, these including 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 the institution's computer technologies for students with disabilities. The scale we recently developed for campus disability service providers (Fossey et al., 2005) and the scale developed for students with disabilities in the present investigation are designed to fill this gap.

By now, it is axiomatic that to succeed in postsecondary education students need to have good access to computer technologies both on and off campus (Green, 2005). In the present study we developed a measure that focuses on the views of students with disabilities about the availability of accessible computer technologies they need both on and off campus. Here we report on the measure for junior/community college students; we are currently working on validating the measure on university students.

Method

Participants

Participants were 81 Canadian junior/community college students with various disabilities, 28 males and 53 females, who indicated they require some specific type of hardware or software to use a computer effectively participated. Fifty-six students studied in French-speaking colleges and 25 in English-speaking colleges. Students had enrolled in 22 of Quebec province's 48 public junior/community colleges.

Students' mean age was 22 (range = 17-50, median = 20). All had registered with their college to receive disability-related services and all had enrolled in the regular day division or in continuing education either in a two-year pre-university or in a three-year career/technical program in the January 2005 semester. All participated in a larger investigation of facilitators and obstacles to academic success (Fichten, Jorgensen et al., 2006). Those 81 of the 159 participants in the larger investigation who answered "Yes" to the following question participated in the present study: "Do you require any specific hardware or software to use a computer effectively (e.g., grammar checking, adaptive mouse, software that reads material on the screen)?"

Table 1 shows that the most common impairment (65%) noted by students was a learning disability and/or attention deficit/attention-deficit hyperactivity disorder (LD/ADD/ADHD), followed by mobility, visual, and psychological impairment. Table 1 also shows similar proportions of students' impairments in test and retest samples. Twenty-one students (26%) reported more than one impairment for a total of 109 impairments (mean = 1.35 impairments/student). Fifteen indicated having two, five indicated three, and one student indicated four impairments.

Software/Hardware Used

Figure 1 shows the types of adaptive hardware and/or software students needed to use a computer effectively. As illustrated, specialized software that improves writing quality, such as grammar and spell checkers, and software that reads material on the screen were the two most popular types of software noted by students with LD/ADD/ADHD as well as by students with all other impairments. Students with LD/ADD/ADHD also frequently mentioned voice dictation software. For students with at least one disability other than LD/ADD/ADHD, the following were also important: software that magnifies material on the screen, adapted input devices such as an adapted keyboard and mouse, a large-screen monitor, and a scanner with optical character recognition software. Students noted a variety of other technologies as well, such as a laptop/note-taker, ergonomic adaptations, and digital recorders for lectures.

Measures

Demographic questions. These include objective questions related to sex, age, college name and program, 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).

Overall criterion items. Participants make ratings on a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree) on two Overall Criterion Items that inquire about how well the student's computer and/or

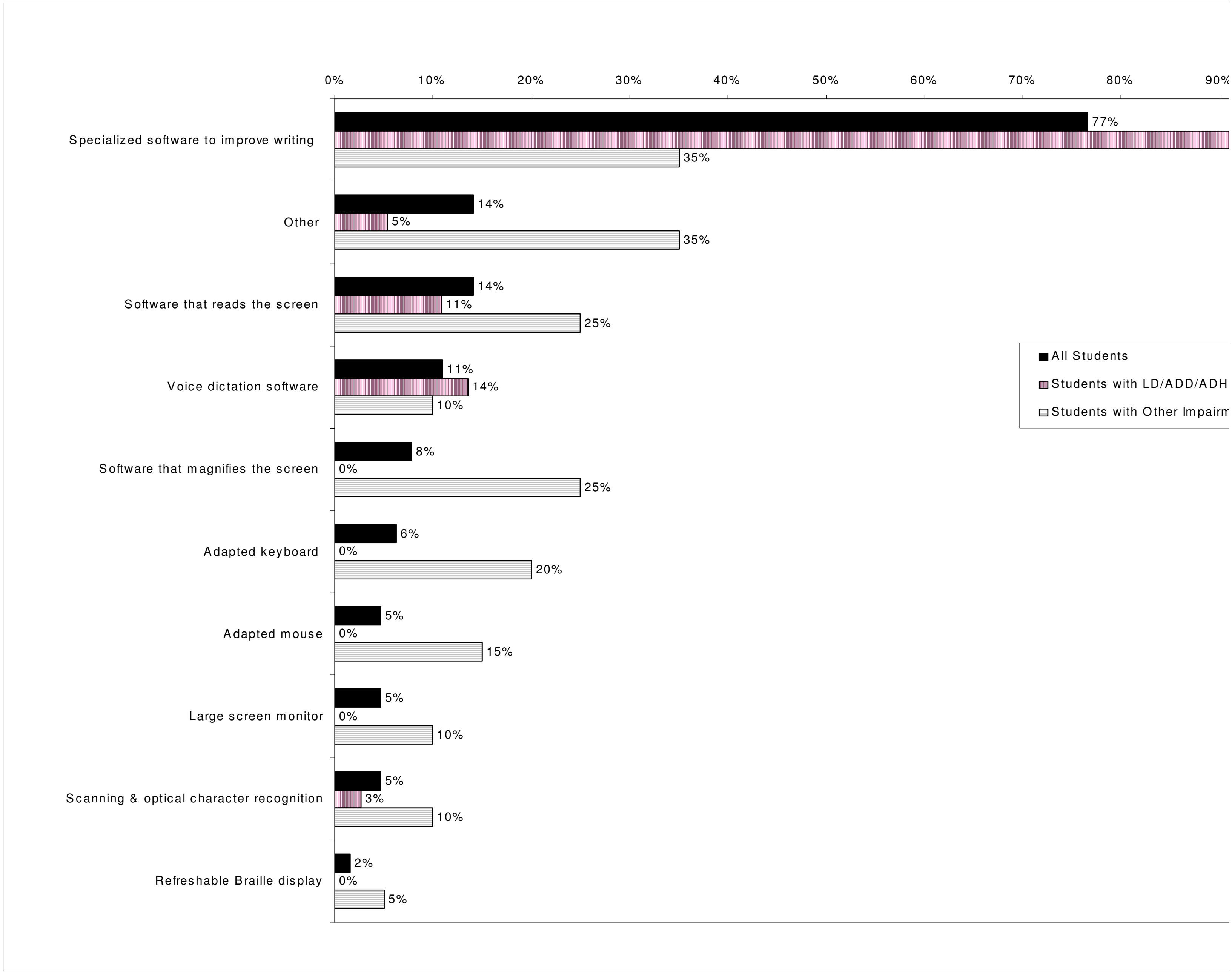
Table 1

Students' Impairments

Type of Impairment	Test: Number of Students Reporting Impairment (N=81)	Test: %	Retest: Number of Students Reporting Impairment (N=44)	Retest: %
Learning disability / ADD / ADHD	53	65%	30	68%
Mobility impairment	10	12%	5	11%
Visual impairment	8	10%	4	9%
Psychological disability	8	10%	6	14%
Medically related condition	7	9%	5	11%
Hearing impairment	6	7%	4	9%
Limitation in the use of hands / arms	6	7%	3	7%
Deafness	5	6%	1	2%
Neurological impairment	3	4%	2	5%
Speech / language impairment	2	2%	2	5%
PDD (pervasive developmental disorder - e.g., autism, Asperger's)	1	1%	1	2%
Blindness	0	0%	0	0%
Total number of impairments reported reported by students	109		63	

Note. The order in which items were presented was such that the more "severe" form of visual and hearing impairments came before the "less severe" form (i.e., blindness was followed by visual impairment, deafness was followed by hearing impairment). Students were allowed to check as many as applied. If a student checked both the more and the less "severe" forms of an impairment we deleted the less severe version and kept only the more severe one.

Figure 1


0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
Specialized software to improve writing
77%
35%
Other
14%
5%
35%
Software that reads the screen
14%
11%
25%
Voice dictation software
11%
14%
10%
Software that magnifies the screen
8%
0%
25%
Adapted keyboard
6%
0%
20%
Adapted mouse
5%
0%
15%
Large screen monitor
5%
0%
10%
Scanning & optical character recognition
5%
3%
10%
Refreshable Braille display
2%
0%
5%
All Students
Students with LD/ADD/ADH
Students with Other Impairm

adaptive computer needs are 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.”

Scale of Adaptive Information Technology Accessibility for Postsecondary Students with Disabilities (SAITAPSD). This one-page, 20-item objective measure was developed for the present investigation. We adapted the items from a questionnaire developed earlier for disability service providers (Fossey et al., 2005) using modifications suggested by our partner groups of students with disabilities and campus disability service providers and by student research team members with disabilities. The SAITAPSD examines the extent to which students' computer related needs are met.

To complete the measure students use a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree, as well as not applicable) to indicate their level of agreement with each of the positively worded items. The measure yields three subscales derived using factor analysis (Adaptive Computer Availability and Support, Perceived Computer Competency, New Computer Technologies), a total score, and two extra items related to the accessibility of distance education and to computer technologies provided by off campus organizations. We did not include the extra items in the subscales because relatively few students answered them.

College experience questionnaire (CEQ). This 32-item questionnaire was part of the larger investigation (Fichten, Jorgensen et al., 2006). It deals with obstacles and facilitators of academic success. Students use a 6-point Likert-type scale (1 = much harder, 6 = much easier) to indicate the extent to which each item made their college studies easier or harder. The measure has an overall total score (Index of Difficulty) and three subscales: Students' Personal Situation, College Environment, and Government and Community Supports and Services. Higher scores indicate that the attribute made academic success easier.

Procedure

Ethics. Attached was an Information and Consent Form to the questionnaire packages to let potential subjects know they could choose to participate or not and that we would maintain confidentiality. This assured students that neither their campus disability service provider nor any of the disability service provider team members would be able to associate their responses with their names. We also informed potential participants about the purpose of the project, risks and benefits envisaged, task requirements, their right to withdraw at any time without penalty, and measures taken to ensure confidentiality. We also noted that participants would receive $10 upon receipt of their completed questionnaire and that they may discuss any questions or concerns about the study with the principal investigator. Dawson College's Human Research Ethics Committee approved the protocol and the Information and Consent Form.

Participant Recruitment

As mentioned, students with disabilities were recruited from a larger investigation of factors related to academic success (Fichten, Jorgensen et al., 2006) that involved completing a questionnaire that dealt with academic obstacles and facilitators: the College Experience Questionnaire (CEQ). Participating students attended a Quebec public junior/community college in the January 2005 semester. All had registered to receive disability-related services from their college. We recruited students with the assistance of campus disability service providers who indicated how many packages in each format (i.e., regular print, large print, Word diskette, Braille) they wished to have for distribution.

The questionnaire package consisted of an Information and Consent Form, demographic questions, the College Experience Questionnaire (CEQ), and a stamped, self-addressed envelope as well as a tear-off coupon form. This coupon asked students for contact information and whether we may communicate with them again for future studies. The cover letter noted that students could complete the questionnaire on paper, by email, or online in French or English, and that they could request a different format.

We suggested that disability service providers mail questionnaire packages to students or make them available in their offices for students to pick up. We sent 928 questionnaire packages to 43 campus disability service providers and received 300 completed questionnaires. Of these, we asked the 255 participants who indicated that we may contact them again, “Do you require any specific hardware or software to use a computer effectively (e.g., grammar checking, adaptive mouse, software that reads material on the screen)?” Of the 159 individuals who answered, 81 (i.e., 51%) said, “Yes.” These students completed the demographic questions and the two Overall Criterion Items. They then listed the specialized software or hardware they used and completed the SAITAPSD. Seventy-seven participants completed the regular print paper copy of the scale, one completed the Word version, and three completed the web version. To determine test-retest reliability, 44 of the 81 students also completed the questionnaire approximately eight weeks later (mean = 8 weeks, median = 7 weeks, range = 4-13 weeks).

Results

Sample Characteristics

Seventy-five students (93%) followed a diploma program (associate's degree), with slightly less than half ($n = 34$) enrolled in a two-year pre-university program, and slightly over half ($n = 41$) in a three year career or technical program. The remaining students were enrolled in another course of studies. Because there were very few differences on SAITAPSD items between males and females or between students form English-and French-speaking colleges (Nguyen, Fichten, & Barile, 2007), we combined the data for these participants.

Reliability and Validity

Two types of reliability estimates were obtained for the SAITAPSD: temporal stability (test-retest) and internal consistency (Cronbach's alpha). Validity was evaluated by correlating SAITAPSD Subscale and Total Scores with each other and with scores on the two Overall Criterion Items and on the College Experience Questionnaire (CEQ).

Test-retest reliability. Forty-four participants completed the SAITAPSD twice approximately eight weeks apart. Of the original 22 items two were discarded because of poor test-retest reliability. Table 2 depicts positive test-retest Pearson product-moment reliability coefficients for the 20 remaining items. Sixteen were significant at the .05 level or better (range of significant r values = .326 to .804). The r values for the four non significant items ranged from .170 to .254.

Based on a principal-components analysis, 18 of the 20 items were grouped into three Subscales and a Total Score. Pearson Product-moment correlation coefficients in Table 2 show that the test-retest reliability of subscales ranged from .447 to .532 and that all are significant at the .01 level or better. The Total Score test-retest correlation also produced significant findings, $r(38) = .515$, $p < .001$. These correlation coefficients are acceptable for research purposes.

Internal consistency. We computed Cronbach's alpha for subscales and for the Total Score. The alpha coefficient for Total Score equaled .89 (18 items), and the coefficient for the subscales ranged from .67 (New Computer Technologies, 4 items) to .84 (Adaptive Computer Availability and Support, 9 items, and Perceived Computer Competency, 5 items). The results also showed that the removal of any item would not greatly affect alpha.

Factor Analysis

We established subscales using factor analysis. Of the 20 items originally included in the development of the scale, only 18 were retained. Two items were dropped because the number of participants who answered them was too low for inclusion in the factor analysis. A principal components analysis with varimax rotation was carried out using mean substitution. A three-factor (subscale) solution showed that principal-components analysis, with varimax rotation, explained a cumulative 50.37% of the variability in scores. The Adaptive Computer Availability and Support Subscale explained 22.14% of the variability. The Perceived Computer Competency Subscale explained an additional 15.76%, and the New Computer Technologies Subscale explained a further 12.47%. Table 3 presents the rotated factors with the factor loading for each item. Items were assigned to the factor (subscale) corresponding to the highest factor loading. Table 2 presents means and standard deviations for subscales. Subscales measure three constructs, as follows.

Adaptive Computer Availability and Support Subscale. This nine-item subscale evaluates the extent to which up-to-date Internet-enabled computers with adaptive hardware/software are available on campus as well as aspects of technical support and assistance at school.

Perceived Computer Competency Subscale. This five-item subscale evaluates the extent to which students feel able to use computer and adaptive computer technologies in a variety of contexts.

New Computer Technologies Subscale. This four-item subscale evaluates the extent to which eLearning (e.g., PowerPoint, testing using WebCT) used by professors and the institution's IT infrastructure are accessible.

Scoring, Standardization, Norms, Validation, and Extra Items

Table 2 shows mean scores for all SAITAPSD items. As illustrated, although all items have scores that are more favorable than unfavorable (i.e., scores > 3.50 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 both specialized and general-use computer laboratories as well as those available through the school's loan program. On the other hand, the results also show that students felt they can effectively use

Table 2

SAITAPSD Item Characteristics and Temporal Stability

		Test Item Scores				Test-Retest (
Item Number	Item Concept	Mean	Std. Deviation	Std. Error of the Mean	*N*	Correlation Coefficient
SAITAPSD Items In Ascending Order of Agreement[1]						
4	Enough adaptive computer technologies in school's specialized labs/centers	3.93	1.68	0.20	69	0.457
14	School’s loan program for adaptive computer technologies	3.94	1.70	0.24	50	0.804
16	No problems when professors use eLearning for tests	4.05	1.82	0.26	50	0.653
7	Availability of adaptive computer technologies in general use computer labs at school	4.07	1.67	0.19	76	0.533
9	Informal help is available at school	4.09	1.65	0.20	68	0.254
13	Training provided at school meets my needs	4.11	1.66	0.22	59	0.576
11	I feel comfortable using adaptive computer technology in class	4.30	1.72	0.21	64	0.498
3	At school adaptive computer technologies are sufficiently up-to-date	4.36	1.51	0.17	78	0.326
10	I am able to use adaptive computer technology in class	4.36	1.66	0.22	55	0.170
2	Tech support provided at school for adaptive computer technologies	4.42	1.50	0.18	71	0.182
1	School has enough computers with adaptive technology that have access to the Internet	4.53	1.59	0.18	77	0.472
15	When professors use eLearning it is accessible	4.61	1.58	0.19	70	0.345
8	Staff at school act quickly to resolve problems	4.66	1.51	0.18	70	0.501

5	Hours of access to adaptive computer technologies at school	4.69	1.54	0.18	77	0.429
18	Library's computer systems accessible	4.73	1.56	0.18	75	0.499
6	Staff at school have expertise in adaptive computer technologies	4.74	1.38	0.16	73	0.544
12	I know how to effectively use adaptive computer technologies	4.97	1.32	0.15	77	0.668
17	School's online services are accessible	5.40	1.17	0.13	78	0.573
Extra Items						
19	Computers/adaptive computer technologies provided by off-campus organizations	3.88	1.71	0.27	41	0.598
20	Distance education at school is accessible	4.05	1.93	0.31	40	0.209
SAITAPSD Subscales						
	Adaptive Computer Availability and Support	4.37	1.06	0.12	78	0.447
	Perceived Computer Competency	4.39	1.19	0.15	64	0.532
	New Computer Technologies	4.82	1.12	0.13	81	0.510
SAITAPSD Total Score		4.46	0.87	0.10	77	0.515
Overall Criterion Items						
	Needs Met at School	4.50	1.49	0.17	78	0.462
	Needs Met at Home	4.64	1.59	0.18	80	0.555

[1] Higher scores indicate greater agreement with the statement (i.e., higher is better).

* $p < .05$
** $p < .01$
*** $p < .001$

the computer technologies they need, that needed help with computers was readily available on campus, and that the school's online and library services were generally quite accessible.

Table 4 contains SAITAPSD means for participants with various impairments. These are provided for illustrative purposes only because sample sizes are very low in most groups. Nevertheless, the findings suggest that the computer-related needs of students with visual impairments were met least well.

As noted earlier, we retained only 18 items as part of the SAITAPSD. Too few participants answered the two Extra Items (equipment provided by off campus agencies (Item 19) and Internet-based distance education (Item 20)). However, Table 5 shows that correlations between scores on these items and on the two Overall Criterion Items as well as on the Total Score are moderate and, for the most part, significant. Therefore, we include them at the end of the measure as Extra Items that will allow for more comprehensive evaluation of elements important in ensuring good access to computers for students with disabilities

Table 5 shows moderate correlations among the three subscales (range r = .25 to r = .56). Internal validity correlation coefficients also show strong relationships between Subscale scores and the Total Score (range from r = .53 to r = .90). 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.

Means on the two Overall 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" did not differ significantly, $t(76) = .68, p >. 05$ ($M = 4.49, SD =$ 1.50 and $M = 4.64, SD = 1.57$), respectively. Similarly, Cohen's d (.10) indicates a trivial effect. Table 5 shows that the two scores are slightly, although significantly, $r(75) = .28, p < .05$, related to each other.

Correlations between SAITAPSD Subscale and Total Scores and scores on the two Overall Criterion Items in Table 5 show that, as expected, Adaptive Computer Availability and Support Subscale scores were highly and significantly correlated with the "At School" item, but not with the "At Home" item. The Perceived Computer Competency Subscale was moderately but significantly correlated with both "At School" and "At Home" items, while the New Computer Technologies Subscale was not significantly related to either. The scale's Total Score was correlated highly and significantly with the "At School" item and more modestly, although significantly, with the "At Home" item.

As an additional index of validity, we correlated scores on the two Overall Criterion Items, the three Subscales and the Total Score, as well as the two Extra Items, with College Experience Questionnaire (CEQ) Subscale and total Index of Difficulty scores, which were completed an average of 6-1/2 weeks earlier. Table 6 shows logical relationships between scores on the two measures. For example, the Adaptive Computer Availability and Support Subscale was most closely and significantly related to the CEQ subscale, which deals with the college environment, whereas the Perceived Computer Competency Subscale and the SAITAPSD Total Score were moderately and significantly related to both the CEQ College Environment Subscale as well as the CEQ Government and Community Supports and Services Subscale. All SAITAPSD Subscale and Total Scores were significantly related to the CEQ total Index of Difficulty, showing that SAITAPSD scores reflect students' perceived overall academic success experiences.

Comparison with Service Provider Data

In an attempt to compare the scores of students with disabilities to those of disability service providers from our recent investigation (Fossey et al., 2005), we compiled a subscale comprised of the six items that are identical to those that make up the most important subscale of the Accessibility of Campus Computing for Students with Disabilities Scale (i.e., the service provider version of the SAITAPSD): "Access to Adaptive Computers." This subscale is comprised of six items, each of which has an exact match on the student version of the SAITAPSD (see Table 7 for item equivalences between the student and service provider scales).

In the Fossey et al. (2005) investigation participants were 156 postsecondary personnel responsible for providing services to students with disabilities: 96 worked in a college, 58 in a university, and two in postsecondary distance education. Participants had worked for an average of nine years providing services to students with disabilities; they represented 91 of the 115 junior/community colleges and 55 of the 68 universities officially recognized in Canada.

The mean score for disability service providers for this subscale was 3.77 (SD = 1.22). We compared scores on this subscale with scores from the present investigation ($M = 4.32, SD = 1.16$). An independent t-test shows a significant difference between scores, $t(232) = 3.36, p < .001$, Cohen's $d = .46$, with a moder-

Table 3

SAITAPSD: Factor Loadings of Each Item Following Varimax Rotation

		Factors/Subscales		
Item #	Item Concept	Adaptive Computer Availability and Support	Perceived Computer Competency	New Computer Technologies
1	School has enough computers with adaptive technology that have access to the Internet	*0.749*	-0.043	0.288
2	Tech support provided at school for adaptive computer technologies	*0.709*	0.045	0.008
3	At school adaptive computer technologies are sufficiently up-to-date	*0.683*	0.309	-0.112
4	Enough adaptive computer technologies in school's specialized labs/centers	*0.659*	0.363	-0.133
5	Hours of access to adaptive computer technologies at school	*0.656*	-0.188	0.350
6	Staff at school have expertise in adaptive computer technologies	*0.569*	0.254	-0.010
7	Availability of adaptive computer technologies in general use computer labs at school	*0.560*	0.138	0.245
8	Staff at school act quickly to resolve problems	*0.518*	0.417	0.124
9	Informal help is available at school	*0.461*	0.286	-0.072
10	I am able to use adaptive computer technology in class	0.103	*0.830*	-0.025
11	I feel comfortable using adaptive computer technology in class	-0.025	*0.681*	0.195
12	I know how to effectively use adaptive computer technologies	0.143	*0.613*	0.261
13	Training provided at school meets my needs	0.429	*0.590*	0.018
14	School's loan program for adaptive computer technologies	0.363	*0.558*	0.086
15	When professors use eLearning it is accessible	0.063	0.038	*0.804*
16	No problems when professors use eLearning for tests	0.027	0.092	*0.732*
17	School's online services are accessible	-0.075	0.170	*0.596*
18	Library's computer systems accessible	0.339	0.071	*0.526*

Note. Items in italics belong to the subscale in question.

Table 4

s' Impairments and Mean SAITAPSD Subscale and Total Scores

	Visual Impairment	Deafness	Learning Disability / ADD / ADHD	Psychological Disability	Hearing Impairment	Limitation In The Use Of Hands / Arms	Neurological Impairment
ales							
ptive Computer Availability and Support	3.64	4.22	4.29	5.33	4.55	5.00	5.33
ceived Computer Competency	3.53	4.20	4.32	n/a	4.40	5.00	5.80
/ Computer Technologies	3.50	4.88	5.01	3.83	4.75	5.25	4.75
core							
TAPSD Total Score	3.57	4.39	4.44	4.55	4.63	5.06	5.33
e size	4	2 to 3	33 to 43	0-2	3 to 5	1	1

Samples include only participants who indicated that they had only 1 disability / impairment.

5

SD Correlations of Subscale Scores to Each other, to the Total Score, and to Selected Criterion Variables

	Subscales			SAITAPSD Total Score	Overall Criterion Items		Additional Items	
	Adaptive Computer Availability and Support	Perceived Computer Competency	"New" Computer Technologies		Needs Met at School	Needs Met at Home	#19 Computer technologies provided by off-campus organizations	#20 Distance education courses are accessible
ve Computer Availability and Support								
ved Computer Competency	.560***							
Computer Technologies	.252*	.252*						
e								
PSD Total Score	.900***	.801***	.534***				.523**	.372*
PSD Total Score With Subscale Deleted	.534***	.513***	.326**				n/a	n/a
verall Items								
Met at School	.818***	.398***	.184	.715***			.404*	.273+
Met at Home	.212+	.338**	.171	.302**	.278*		.429**	.312*

rson product-moment correlation dfs range from 60 to 76 except for Additional Items, where *df*s range from 37 to 39. The Total Score reflects the 18 items that form the and is computed only for the subjects who completed at least 50% of question. Scale 1 has 9 items, Scale 2 has 5 items, Scale 3 has 4 items. Subscale scores were computed se subject who answered a minimum of 50% of questions on the subscale concerned.

)

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$^{**}p < .01$

$^{***}p < .001$

Table 6

Correlations between College Experience Questionnaire (CEQ) Subscale and Total Index of Difficulty Scores and SAITAPSD Overall Criterion, Subscale, Total, and Additional Item Sc

College Experience Questionnaire (CEQ)	Criterion Variables		SAITAPSD Subscales			SAITAPSD Total Score	#19.Co technol provide off-cam organiz
	Needs Met at School	Needs Met at Home	Adaptive Computer Availability and Support	Perceived Computer Competency	New Computer Technologies		
Subscales							
Students' Personal Situation (e.g., health, level of motivation)	.273*	.193+	.269*	.237+	0.173	.313**	0.174
College Environment (e.g., course schedule, accessibility of building facilities)	.462***	.214+	.560***	.455***	.262*	.597***	.359+
Government and Community Supports and Services (e.g., availability of adaptations at home, disability-related support services off-campus)	.337*	.286*	.415**	.452**	.342*	.493***	.552**
Total Index of Difficulty	.429***	.287**	.513***	.474***	.318**	.589***	.419**

*Note. df*s range from 43 to 78 for Criterion Variables and for SAITAPSD Subscales and Total scores. *df*s range from 24 to 39 for the two Additional Items.

+$p < .10$

* $p < .05$

** $p < .01$

*** $p < .001$

Table 7

Scale of Adaptive Information Technology Accessibility for Postsecondary Students with Disabilities

For all statements, rate your level of agreement using the following scale:

1	*2*	*3*	*4*	*5*	*6*	*[N/A]*
Strongly Disagree	*Moderately Disagree*	*Slightly Disagree*	*Slightly Agree*	*Moderately Agree*	*Strongly Agree*	*Not Applicable*

Do not spend too much time on any one statement. Simply give the answer which best describes the general situation. Put a number beside all items. If an item is not applicable to you, respond with N/A (not applicable). Scale of Adaptive Information Technology Accessibility for Postsecondary Students with Disabilities

1___ My school has enough computers with adaptive technology that have access to the Internet to meet my needs.
2___ The technical support provided at my school for adaptive computer technologies meets my needs.
3___ At my school, adaptive 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___ There are enough adaptive computer technologies in my school's ***specialized labs/centres*** for students with disabilities to meet my needs.
5___ The hours of access to adaptive computer technologies at my school meet my needs.
6___ There is at least one person on staff at my school who has expertise in adaptive computer technologies (i.e., knowledgeable, keeps up to date, fixes problems).
7___ The availability of adaptive computer technologies in ***general use computer labs*** at my school meet my needs.
8___ 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).
9___ Informal help is available at my school to show me how to use adaptive computer technologies if I need this.

10___ If I bring adaptive computer technology into the classroom I am able to use it (e.g., can plug it in).
11___ I feel comfortable using adaptive computer technology in the classroom.
12___ I know how to effectively use the adaptive computer technologies that I need.
13___ Training provided by my school on how to use the adaptive computer technologies meets my needs.
14___ My school's loan program for adaptive computer technologies meets my needs.

15___ When professors use eLearning, it is accessible to me (e.g., PowerPoint in the classroom, course notes on the web, CD-ROMs, WebCT).
16___ I have no problems when professors use eLearning for tests and exams (e.g., quizzes in WebCT).
17___ My school's online services are accessible to me (e.g., registering and class cancellations on the web).
18___ The accessibility of the library's computer systems meets my needs (e.g., catalogues, databases, CD-ROMs).

Extra Items
19___ The computers and/or adaptive computer technologies provided by off campus organizations meet my needs (e.g., rehab centres, provincial loan programs).
20___ Distance education courses offered by my institution are accessible to me.

[1] Scoring Instructions

SAITAPSD

SAITAPSD Total Score: Average all scores for items 1 through 18
SAITAPSD Subscales

- Adaptive Computer Availability and Support Scoring: Average scores from items 1, 2, 3, 4, 5, 6, 7, 8, and, 9
- Perceived Computer Competency Scoring: Average scores from items 10, 11, 12, 13, and 14
- New Computer Technologies Scoring: Average scores from items 15, 16, 17, and, 18

Service provider subscale equivalences (Accessibility Of Campus Computing For Students With Disabilities Scale, Fossey et al., 2005)

- Service provider subscale "Access To Adaptive Computers:" Average SAITAPSD scores from items 1, 2, 3, 4, 5, and 13
- Item-by-item SAITAPSD and service provider scale equivalences: SAITAPSD #1 = Service provider #3, SAITAPSD #2 = Service provider #4, SAITAPSD #3 = Service provider #1, SAITAPSD #4 = Service provider #5, SAITAPSD #5 = Service provider #2, SAITAPSD #6 = Service provider #18, SAITAPSD #7 = Service provider #14, SAITAPSD #13 = Service provider #6, SAITAPSD #14 = Service provider #20, SAITAPSD #15 = Service provider #15, SAITAPSD #18 = Service provider #16, SAITAPSD #19 = Service provider #22, SAITAPSD #20 = Service provider #21

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ate effect size (students' scores more favorable than service providers' scores). In addition, a recent large-scale study administered the Accessibility of Campus Computing for Students with Disabilities Scale (i.e., the service provider version of the SAITAPSD) in 2005 (Dunmire, Broski, Goodman, & Yurick, 2006) to 339 American college and university disability service providers. The subscale in this study had a mean of 4.03 (*SD* = 1.29). The Cohen's *d* of .24 (small effect) and an independent *t*-test, which takes means, variances, and sample sizes in both the American campus disability service provider sample and the present student sample into account, of $t(415) = 1.95$, $p < .06$ suggests that students' scores are somewhat higher (i.e., more accessible ICTs) than American campus disability service provider scores.

Discussion

Overview of Key Findings

The Scale of Adaptive Information Technology Accessibility for Postsecondary Students with Disabilities (SAITAPSD) evaluates the accessibility of information and computer technologies needed to succeed in postsecondary education. Its psychometric properties suggest it holds promise for evaluating the accessibility of adaptive information and computer technologies needed by postsecondary students with various disabilities. Here we provide preliminary norms for (a) the total score, (b) the three subscales, and (c) all 20 items for junior/community college students. We also make the scale and scoring instructions available in Table 7.

The results indicate that (a) overall, SAITAPSD scores were more favorable than unfavorable, although availability of adapted computers at school in both specialized and general-use computer laboratories was seen as somewhat problematic, as was availability of adaptive ICTs through the school's computer loan program; (b) the computer-related needs of students with visual impairments seemed to be met least well; (c) the scores of male and female students and students from English-and French-speaking schools were very similar, (d) students were more optimistic about the accessibility of ICTs than were campus service providers; (e) the most common impairment of our sample of junior/community college students was a learning disability, with or without attention deficit/attention-deficit hyperactivity disorder (LD/ADD/ADHD), followed by mobility, visual, and psychological impairment; (f) approximately ¼ of our sample had more than one disability; (g) specialized software that improves writing quality, such as grammar and spell checkers, and software that reads material on the screen were the two most popular types of software noted by students; (h) students with LD/ADD/ADHD also frequently mentioned voice dictation software while students with other disabilities noted the importance of software that magnifies material on the screen, adapted input devices such as an adapted keyboard and mouse, a large screen monitor, and a scanner with optical character recognition software.

Scoring, Norms, and Psychometric Properties of the SAITAPSD

The SAITAPSD and scoring instructions are available in Table 7. The scale yields a total score obtained by averaging all 18 items. Factor analysis, a technique which groups related items together, resulted in three subscales: (a) Adaptive Computer Availability and Support Subscale - this evaluates the extent to which up-to-date internet enabled computers with adaptive hardware or software are available and supported on campus; (b) Perceived Computer Competence Subscale - this evaluates the extent to which students feel capable of using computer and adaptive computer technologies in a variety of contexts; and (c) New Computer Technologies Subscale - this evaluates the extent to which eLearning used by professors (e.g., PowerPoint) and the institution's IT infrastructure (e.g., library databases) are accessible. Scoring on an item-by-item basis is also possible: single item subscale and total score means and standard deviations are provided in Table 2. Subscale scores are modestly correlated with one another and logically related to the two criterion items that ask about how well, overall, students' computer related needs are met at school and at home. The same is true for scores on a measure of obstacles and facilitators of academic success. These results provide an indication of validity. Good test-retest correlations and internal consistency for subscales and the total score provide evidence for good reliability. Overall, the reliability and validity evaluations suggest that the SAITAPSD has acceptable psychometric properties for research use.

Limitations of the Present Study

Although the SAITAPSD has demonstrated acceptable validity and test-retest as well as internal consistency reliability, the "norms" reflect a relatively small sample of junior/community college students from only one Canadian province. The validity of this measure for other postsecondary student populations in other parts of North America has not been assessed. Nor have the results been cross-validated on a second sample. Additional validation of the scale involving much larger and diverse samples of postsecondary students from both the United States and Canada is necessary. This should include evaluating the equivalence of different formats of the scale (e.g., regular print paper, Word file, web version). Additional validation would also permit the development of norms for students with different impairment/disabilities. We present the SAITAPSD not as a final product but as a research tool in need of further testing and development.

Findings Using the SAITAPSD

Consistent with data from other researchers (Sharpe, Johnson, Izzo, & Murray, 2005), our findings show more favorable than unfavorable scores. Nevertheless, there are some concerns around the availability of adapted computers in both specialized and general-use 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 et al., 1997). On the plus side, the findings show that students feel they can effectively use the computer technologies they need, that they can readily obtain help with computers on campus, and that they can access online and library services.

Because of small sample sizes, the scores of students with different impairments could not be meaningfully compared. The available data do suggest, however, that the computer related needs of students with visual impairments are met least successfully.

Comparison of student and campus service provider views. Comparison of students' and service providers' scores on identical items suggests more optimism by students than by service providers. However, the student data were obtained in 2005 for junior/community colleges from one Canadian province, whereas, the service provider data came from a nationwide study conducted five years earlier on disability service providers from both Canadian junior/community colleges and universities. Because of the sampling and testing time confounds, we also compared the present results on students with data from a large American study of junior/community college and university disability service providers conducted in 2005 (Dunmire et al., 2006). Again, the results suggest that students' scores are more optimistic than those of service providers, a finding consistent with our current findings on the accessibility of eLearning (Fichten, Asuncion et al., 2006). Whether the discrepancies are due to the nature of the samples or to the unique experiences of disability service providers, who generally do not get involved in accessibility issues unless there are problems, cannot be determined by our data. To answer this question in future investigations the views of disability service providers about how well the computer needs of students with different impairments are met should be compared to the views of students with the impairments in question.

Because it may be of interest to compare the views of students and disability service providers, we detail two ways of doing this. First, all items that comprise the Access to Adaptive Computer subscale of the service provider version of the SAITAPSD measure (Fossey et al., 2005) also appear on the student version. Therefore, in Table 7 we provide scoring instructions for this subscale for the student version as well. In addition, 13 of the items on the student version also appear on the service provider version, allowing single-item scores to be directly compared. Table 7 also provides item "equivalences."

Sample characteristics. Consistent with other findings (Stodden, 2005), over half of the sample reported a learning disability and about one quarter reported having more than one impairment (Asuncion, Fichten, Fossey, & Barile, 2002; Sharpe, Johnson, Izzo, and Murray, 2005). Half of the students with disabilities we contacted indicated they needed specialized software and/or hardware to use a computer effectively. This suggests that a large proportion of students with disabilities on campus may need some type of specialized computer equipment.

Adapted, General Use, and "Adaptable" Computer Technologies as Assistive Aids

Students with all types of impairments indicated using software to improve writing quality. Students with learning disabilities were most likely to do so. Thus, 95% used such software, mostly spelling and grammar checkers. Students with learning disabilities also indicated using voice dictation and screen reading software, technologies traditionally considered to be useful primarily to students with visual and neuromuscular impairments (Ofiesh, Rice, Long, Merchant, & Gajar, 2002). Students who did not have a learning disability also indicated needing software that magnifies material on the screen, adapted input devices, a large-screen monitor, and a scanner with optical character recognition software. In addition, students noted a variety of other technologies such as laptops and note-taking devices, ergonomic adaptations, and digital recorders for lectures.

These are similar to items noted by a much larger sample of junior college and university students in a previous investigation (Fichten, Asuncion, Barile, Fossey, & De Simone, 2000), where we also noted a blurring between adaptive and general use technologies. Consistent with the present findings, general-use technologies are used as adaptive aids by students with certain disabilities. For example, most people use spell checkers. Students with some learning disabilities use this tool as an assistive aid to help compensate for the disability. Students with a variety of hand or arm impairments and some types of learning disabilities use voice dictation software, originally intended for professionals and executives, as an adaptive technology. Screen reading technologies, originally used by individuals with visual impairments, have crossed over into the mainstream. These now form part of mobile computer and "smart phone" technologies for nondisabled users to access email on the road. The same is true for scanners and optical character recognition software, currently used as adaptive technologies by students with visual and other print impairments.

But some computer technologies have remained disability specific, such as refreshable Braille, head and foot mice, high-end writing aids (e.g., Wynn, Kurzweil 3000, TextHelp), and sophisticated screen-reading and magnification programs. Not all technologies can be considered accessible for all even though there has been a blurring between adaptive and general-use computers in some areas, as long as software and hardware are designed and built without consideration for their accessibility, and as long as universal design is not adopted when developing and purchasing college information and computer technologies, problems will continue to be problems related to the accessibility of ICTs on campus.

Universal design for instruction. Concerns the access needs of learners with various disabilities can be partly addressed by implementing universal design for instruction (UDI), an approach to teaching that consists of designing and using instructional strategies that benefit a broad range of students, including those with disabilities (McGuire, Scott, & Shaw, 2003; Scott, McGuire, & Foley, 2003). Universal design, first introduced in architectural and graphic design in the late 1980s, has the following central tenet, "The design of products and environments are to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design [or at extra cost]" (Story, Mueller, & Mace, 1998, p. 3). These principles have quickly spread to other areas of scholarship and practice, such as teaching and learning. For example, in a series of pamphlets Burgstahler (2005, 2006) provided suggestions for implementing UDI in the postsecondary environment. Proponents of this concept hold that if something works well for people with disabilities, it works better for everyone. Shaw (2002) expounds on the benefits of UDI. Among other things, he states that UDI is:

> … designed to anticipate the needs of diverse learners and incorporate effective strategies to make learning more accessible to a wide variety of students. Much like universal design in architecture, UDI has a set of basic principles that can help in the implementation of strategies to more effectively include and provide students with as well as those without disabilities the skills, knowledge and self assurance of learning in an environments free of academic limitations, (Shaw, 2002, p. 11)

Implications for Future Research and Practice: Potential Uses of the SAITAPSD

As the first step in evaluating ICT accessibility to students with disabilities in postsecondary education, the SAITAPSD fills an important void. The reliability and validity testing conducted to date allows students with disabilities to have a say about the availability and accessibility of campus computing as well as of computers available for off campus use. The measure has a variety of attractive features. Only one page long, it is easy for learners with all types of disabilities to complete, and the simple scoring requires only a straightforward calculation of means. The measure also has the advantage of flexibility due to its "face validity." Thus, the scale (a) permits item-by-item analysis to identify individual areas of perceived strength and weakness, (b) can assess modifiable aspects of the accessibility of ICTs on campus as well as (c) monitor and evaluate the effects of efforts to improve accessibility. For example, the measure may be administered at different times as major modifications occur in campus, computing infrastructure. 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) item-by-item evaluation; (g) identifying gaps and targeting specific areas for improvement; (h) comparison with service providers' views; and (i) a means of informing policy documents, institutional changes, and IT budget allocations.

Possible research directions include (a) continued validation by comparing scores of personnel responsible for providing services to students with disabilities with student views; (b) additions to the normative data by providing separate norms by student disability and by school type, size, location, and nature (e.g., junior/community college versus university, urban versus rural., private versus public); and (c) collecting new samples and samples outside Canada such as the United States, Great Britain, Australia, France and Belgium (a French version of the measure is available in Nguyen et al., 2007).

Conclusions

While many potential uses for the SAITAPSD exist, it needs further validation. In particular, we need additional research on university populations and on larger samples of students with different disabilities. Nevertheless, the findings underscore the idea that good access to ICTs involves widespread availability of Internet-capable computers with accessibility features in both specialized and general-use labs, good support for these technologies, the availability of training on adaptive computer technologies, as well as accessible campus computing infrastructure and eLearning used by faculty.

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