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Accessibility of e-Learning and Computer and Information Technologies for Students with Visual Impairments in Postsecondary Education

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Abstract

Two studies were conducted in Canada to examine the accessibility of online learning resources and other forms of information and communication technology for 143 students with poor vision and 29 students who were blind. The findings of these research are presented in this article. The report suggests ways to remove barriers, open up new avenues for education, and improve accessibility.Whether in a traditional classroom setting or via online learning, information and communication technologies, such as the Internet, are pervasive. College life is full of e-learning, or technology that instructors use to help students learn. This includes things like online discussion boards to expand on classroom discussions, PowerPoint presentations, and all sorts of information and communication technologies that teachers use whether they teach their classes in a traditional classroom setting, completely online, or a hybrid of the two. These days, it's common practice for students to download course materials.Canadian Council on Learning, SSHRC, and Dis-IT all contributed to the funding of this study. Adaptech Research Network, NEADS, AQEIPS, CADSPPE, SAIDE, and AQICEBS are all partners in this project, and we are thankful to them for all of their help and participation.access course-management systems like WebCT and Blackboard; create presentations using PowerPoint; and work from specialized course websites.Online education has great promise for leveling the playing field for students with visual impairments in university courses. If a teacher has made sure that their course websites are accessible and that their students have the necessary information and communication technologies, such as screen reading and magnification software, then students with disabilities should be able to access the course materials online without assistance, even in more conventional classroom settings.

INTRODUCTION

One cause that has transformed the way students with visual impairments interact with e-learning materials and information and computer communication technologies is the widespread adoption of these tools in education.access course-management systems like WebCT and Blackboard; create presentations using PowerPoint; and work from specialized course websites.Online education has great promise for leveling the playing field for students with visual impairments in university courses. If a teacher has made sure that their course websites are accessible and that their students have the necessary information and communication technologies, such as screen reading and magnification software, then students with disabilities should be able to access the course materials online without assistance, even in more conventional classroom settings.One cause that has transformed the way students with visual impairments interact with e-learning materials and information and computer communication technologies is the widespread adoption of these tools in education. ways that visually impaired students have reported employing both on and off campusAs an example, students with visual impairments in Canada may only use text-to-speech screen readers via certain government programs

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that provide adaptive computer technologies for off-campus usage. Few studies have examined how often or how extensively visually impaired college students utilize adaptive computer technology (ACTE), as pointed out by Argyropoulos, Sideridis, and Katsoulis (2008). Students who reported being blind or having impaired vision were thus the subjects of our examination of adaptive computer technology. In order to assess the challenges associated with online education access in higher education, we conducted two studies with students who reported being visually impaired or blind. The first study looked at students' usage of adaptive computing technologies and how well such technologies served their information and communication requirements both on and off campus. In the second study, we polled students on their perceptions of the availability of eighteen different kinds of online course resources. We also inquired as to whether and how they dealt with issues that arose while using these items.

Method

Participants

A convenience sample of 139 studentsfrom 52 Canadian universities and junior or community colleges participated in the first study. Of the 139 participants, 24(11 men and 13 women, mean age = 31, range = 20 –56, median = 28) identified themselves as being "totally blind" and 115 (46 men, 68 women, and 1 with an unspecified gender; mean age = 32, range = 19 –59, median = 27) indicated they had a "visual impairment that is not adequately corrected by wearing glasses or contact lenses." The participants had attended within the past year or were cur- rently attending a postsecondary institu- tion. All were participating in a largerinvestigation to develop the POSITIVES Scale, a psychometrically sound instru- ment to evaluate how well the informa- tion and communication technology– related needs of students with various impairments is being met at home andat school (Fichten, Asuncion, Nguyen, Budd, & Amsel, 2009).

Procedure

In 2007, an online questionnaire was de- veloped and administered to more than 1,000 Canadian college and university students with various disabilities. The participants were recruited through e-mail discussion lists dealing with Canadian postsecondary education. The project's partners publicized the study to their members, and students who had partici- pated in our previous investigations were contacted. The research protocol was ap- proved by Dawson College's Human Re- search Ethics Committee.

Potential participants were asked to e-mail us for more information. Thosewho indicated an interest were directedto the study's web site, where they read the consent form that provided informa- tion about the study, including the hon- orarium of $10. Clicking the "I consent" button brought participants to the online questionnaire.

The questions, which were adapted from the POSITIVES Scale, asked thestudents to provide demographic informa-tion, identify their disabilities or impair- ments, and indicate the types of computertechnologies they used (Fichten, Nguyen, Barile, & Asuncion, 2007). Students also rated, on a 6-point Likert scale (from 1 = strongly disagree to 6 = strongly agree), how well their computer-related needs were met on and off campus in a variety of contexts. Item-by-item test-retest cor- relations showed acceptable reliability forall items (all correlation coefficients werehigher than .50, $p < .001$), and validation showed significant and meaningful results(Fichten et al., 2009).

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Results

Computer technologies usedTable 1 shows the most popular types of computer technologies used by the partic- ipants. Software that is designed to read what is on the screen (text to speech) or convert hardcopy print to electronic text with optical character recognition (OCR) scanning technology were noted by the participants in both groups. Close to 100% of those who were blind and 50% of those with low vision reported using screen-reading technologies. Scanning with optical character recognition (OCR) was used by close to 90% of students whowere blind and a third of those with low vision. Refreshable braille displays were used by slightly more than two-thirds of the students who were blind and 4% of those with low vision. The most popular form of adaptive software mentioned by the participants with low vision was screen magnification, used by more than

Adaptive computer technologies used by students, in rank order.

Software used	%	Number
Students who are totally blind[a]		
Software that reads what is on the screen	96	23
Scanning and optical character recognition	88	21
Refreshable braille display	71	17
Software that improves the quality of writing (such as grammar and spell check, colors, and highlighting)	42	10
Alternative mouse (such as track ball and mouse keys)	8	2
Students with low vision[b]		
Software that enlarges what is on the screen (such as magnification and zoom)	70	81
Software that improves the quality of writing (such as grammar and spell check, colors, and highlighting)	55	63
Software that reads what is on the screen	50	58
Large-screen monitor	46	53
Scanning and optical character recognition	34	39
Alternative mouse (such as track ball and mouse keys)	10	12
Dictation software	8	9
Adapted keyboard (such as large keys and an on-screen keyboard)	6	7
Refreshable braille display	4	5

[a] 16 of the 17 students who used a refreshable braille display also used text-to-speech technology.
[b] All 5 students who used a refreshable braille display also used text to speech and 2 used screen magnification as well. Among the 58 students who used text-to-speech technology, 45 also used screen magnification.

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two-thirds of this group. Almost half the students with low vision also indicated that they used a large-screen monitor.

The participants in both groups felt comfortable using needed information and communication technologies in the classroom; those who were blind felt significantly more comfortable (*M* = 5.50 ona 6-point scale, *SD* = 0.93) than those with low vision [*M* = 4.58, *SD* = 1.71, $t(119) = 2.54$, $p < .001$] in using this technology.

How adequately students' technology needs are met

Table 2 presents comparative information about the views of the participants in the two groups on how well their informationand communication technology needs locations (home, school)] on four de- pendent variables (technology needs are met, technology is sufficiently up to date, technical-support needs are met, and technology-training are needs met) indicated that, overall, the participants' needs were significantly better met at home than at school. The results also showed that the information and commu- nication technologies the participants used at home were significantly more up to date than those at school, especially for the participants who were blind. Therewere no significant findings on training ortechnical support, although the means in-dicate that these aspects posed difficulties for both groups.

How well students' needs were met at home and at school: students with low vision versus studentswho are blind.

	Mean	*SD*	*n*	ANOVA	*F*	*df*	*p*
In general, my computer technology needs at my school are adequately met							
Students with low vision	4.39	1.64	107	Group	1.07	1,128	.304
Students who are blind	4.57	1.67	23	Location	6.88	1,128	.010
				Interaction	0.32	1,128	.572
In general, my computer technology needsat home are adequately met							
Students with low vision	4.84	1.52	107				
Students who are blind	5.26	1.32	23				
At my school, computer technologies are sufficiently up to date to meet my needs							
Students with low vision	4.41	1.76	102	Group	0.04	1,123	.834
Students who are blind	3.87	1.79	23	Location	7.28	1,123	.008
				Interaction	3.58	1,123	.061
My personal computer technologies are sufficiently up-to-date to meet my needs							
Students with low vision	4.62	1.52	102				
Students who are blind	5.04	1.36	23				
The technical support provided at my school for computer technologies meets my needs							
Students with low vision	3.91	1.75	86	Group	1.42	1,106	.236
Students who are blind	3.64	1.97	22	Location	0.03	1,106	.859
				Interaction	0.71	1,106	.402
The availability of technical support when I am notat school meets my needs							
Students with low vision	4.12	1.70	86				
Students who are blind	3.50	1.99	22				
Training provided by my school on how to usecomputer technologies meets my needs							
Students with low vision	3.90	1.79	63	Group	0.29	1,79	.594
Students who are blind	3.33	2.09	18	Location	0.22	1,79	.643
				Interaction	1.51	1,79	.222
Training available off campus on how to use computer technologies meets my needs							
Students with low vision	3.41	1.81	63				

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Students who are blind	3.56	1.95	18

Note: The numbers in boxes are significant. Scores range from 1 (strongly disagree) to 6 (stronglydisagree).

The scores of the two groups were compared on 17 items related to how adequately their technology needs were metin a variety of contexts. Table 3 presents means and *t*-test results. Because of the number of comparisons, a Bonferroni cor-rection to the alpha level was applied. Theresults show that the technology needs of

Item	Group of students	*N*	Mean	*SD*	*t*-test	*df*	*p*
The availability of computer technologies in my school's general-use computer labs meets my needs	Low vision	109	3.50	1.97	3.10	128	.002**
	Blind	21	2.10	1.51			
I have no problems when professors use e-learning for tests and exams (such as quizzes in WebCT)	Low vision	77	3.96	1.93	2.01	92	.047*
	Blind	17	2.94	1.71			
My school's loan program for computer technologies meets my needs	Low vision	52	3.48	1.98	0.73	63	.466
	Blind	13	3.92	1.80			
There are enough computer technologies in my school's specialized labs or centers for students with disabilities to meet my needs	Low vision	99	3.85	1.95	0.50	118	.619
	Blind	21	3.62	1.75			
Distance education courses offered by my institution are accessible to me	Low vision	60	4.37	1.68	2.47	74	.016*
	Blind	16	3.19	1.76			
Informal help is available at my school to show me how to use computer technologies if I need it	Low vision	100	4.07	1.71	0.39	121	.695
	Blind	23	3.91	1.78			
The accessibility of the library's computer systemsmeets my needs (such as catalogs, databases, CD-ROMs)	Low vision	108	4.68	1.47	3.65	126	.006**
	Blind	20	3.30	1.95			
When professors use e-learning (such as PowerPoint in the classroom, course notes on the web, CD-ROMs, WebCT), it is accessible to me	Low vision	101	4.61	1.49	2.41	121	.017*
	Blind	22	3.77	1.45			
Funding for computer technologies for personal use isadequate to meet my needs (such as from the government, foundations, rehabilitation centers, or loan programs)	Low vision	95	4.27	1.82	0.06	117	.954
	Blind	24	4.25	1.59			
My school has enough computers with Internet access to meet my needs	Low vision	108	4.56	1.65	1.24	129	.218
	Blind	23	4.09	1.65			
When I approach staff at my institution with problems related to the accessibility of computer technologieson campus (such as I cannot see a PowerPoint presentation), they act quickly to resolve any issues	Low vision	98	4.46	1.57	0.45	117	.654
	Blind	21	4.29	1.76			
The hours of access to computer technologies at my school meet my needs	Low vision	107	4.42	1.77	0.03	127	.978
	Blind	22	4.41	1.65			
The availability of electronic-format course materials (such as Word, PDF, and MP3) meets my needs	Low vision	108	4.58	1.73	0.11	130	.913
	Blind	24	4.54	1.50			
There is at least one person on staff at my school who has expertise in adaptive hardware and software (for example, is knowledgeable about software that reads what is on the screen)	Low vision	106	4.86	1.58	1.42	128	.158
	Blind	24	4.33	1.86			
My school's interactive online services are accessible to me (such as registering)	Low vision	111	5.19	1.16	3.70	132	.011*
	Blind	23	4.09	1.86			

(cont.)

Item	Group of students	*N*	Mean	*SD*	*t*-test	*df*	*p*
My school's web pages are accessible to me	Low vision	114	5.11	1.29	2.43	135	.017*

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Blind		23	4.35	1.70			
If I bring computer technology into the classroom, I am able to use it (for example, I can plug it in)	Low vision	98	4.67	1.43	1.81	118	.073
Blind		22	5.27	1.24			

Note: Numbers in boxes are significant after a Bonferroni correction to the alpha level. Scores rangefrom 1 (strongly disagree) to 6 (strongly disagree).
* $p < .05$; ** $p < .01$.

Compared to individuals with poor vision, those who were blind or had low vision had their technological demands constantly unmet (15 out of 17 comparisons, 7 of which were significant before and 2 after the Bonferroni adjustment). The blind participants felt their technology needs were particularly unmet in the following situations: when taking distance education courses, when trying to access the library's computer systems, when their instructors used e-learning materials, and when seeking informal help related to information and communication technologies at school. This was in addition to the problem areas mentioned by the low vision participants. Access to necessary adaptive technology in the classroom, school websites, and on-campus technical support were all items that both groups deemed reasonably accessible.

Find out 2) Approach

Folks involved

A total of thirty-three undergraduates and graduate students from twenty-six different institutions in Canada took part in the study. Of the 33 people that took part, 28 (11 males, 16 females, and 1

unknown; median age = 26; mean age = 30

(ranging from 18 to 61 years old) self-reported as

They claimed to be "completely blind" (median = 23, range = 20–59). All of the students had participated in an online class at some point over the previous three years. The purpose of their participation was to assess how students with various disabilities see the accessibility of online learning.

Procedure

The research started with 22 in-depth interviews with faculty, students with a range of disabilities, people who made accommodations for students with disabilities on campus, experts who helped establish or expand online education, and companies that sell online course materials to universities and colleges. These interviews served as the foundation for the development, testing, and administration of web-based surveys throughout the first half of 2006. The participants were enlisted in the same way as in Study 1, only this time a $100 gift voucher to a major online computer retailer was drawn instead of an honorarium. Dawson College's Human study Ethics Committee gave its approval to the study protocol.A total of 18 unique demographics, disability statuses, and information on the accessibility of 18 kinds of online instructional resources (such class websites and PowerPoint presentations) using a Likert-type scale from 1 (totally inaccessible) to 6 (totally accessible). The survey asked participants to identify three major issues they had using e-learning resources and explain how they overcame each one in an open-ended question with a text field to input their answers. A coding manual with 28 issue and 18 solution categories was used to classify responses by coders who were instructed to achieve an inter-rater reliability of at least 70%.

WHAT WE FINDOnline education's most and least user-friendly formatsAll eighteen of the e-learning platforms we looked at were easily accessible, as shown in Table 4. Email,

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course websites, online discussion forums, and Word documents pertaining to the course were deemed easily accessible by both groups, according to the findings. When asked about the accessibility of online resources, both groups voiced concerns about videoconferencing, online quizzes and assessments, CD-ROM lessons, and Flash-based online information. The visually impaired individuals had no trouble using several types of online learning materials, whereas the visually impaired participants had no trouble at all.Issues and resolutions pertaining to online educationThe 25 participants with impaired vision and the 5 participants who were blind all mentioned issues with the e-learning materials. At least 8% of each group reported issues, as seen in Figure 1. Absences - Accessibility issues with websites and learning management systems affected all blind participants, however those with impaired vision had far less trouble. Not all course materials, including those in portable digital format (PDF), were accessible, according to both groups. Inadequate understanding on how to utilize e-learning resources effectively was also mentioned by the participants as an issue, as did the absence of necessary adaptive computer technology. Participants with low vision faced challenges due to a lack of home access technology and software, while participants with visual impairments faced challenges due to time limits on online exams and the inaccessibility of Power Point and data projection during lectures.Figure 2 displays answers to the e-learning problems reported by at least 8% of each group. While the majority of participants in both groups expressed frustration that their e-learning issues were still unresolved, they did offer some solutions. These included trying out different formats, making more of an effort to learn how to use e-learning materials, and taking the exam at a different time than the rest of the class, which is not related to e-learning.

Subject under consideration

Strict Poses

Students with visual impairments made up a sizable and diverse group, spanning several years of school,

62 separate colleges and either junior or

Table 4

Accessibility of e-learning materials according to students with visual impairments in rank order.

Group, rank, and item	Mean
Students who are blind	
1. Course-related files in Word, PowerPoint, et cetera	4.60
2. E-mail	4.50
3. Course web pages	4.20
3. Web-based threaded discussion forum or bulletin board	4.20
5. WebCT, Blackboard, First Class, or other course- or learning-management system	3.60
6. Audio clips or files (such as recorded class lectures)	3.50
7. Course-related files in PDF	2.80
8. Video clips or DVDs	2.67
9. Additional content or resources that are included with course textbooks (such as CD-ROMs or URLs)	2.50
9. Online tests, quizzes, examinations, or other forms of online evaluation	2.50
11. In-class presentations using PowerPoint	2.00
12. Live online chat (such as MSN Messenger)	1.50
13. PowerPoint presentations viewed online using a browser	1.00
13. Videoconferencing	1.00
13. CD-ROM tutorials used in class or computer labs	1.00
13. Online content that uses Flash	1.00
Web-based lectures or presentations	NA

Live online voice-based chat (speaking and listening) NA Students with low vision

1. Course-related files in Word, PowerPoint, et cetera	5.46
1. E-mail	5.46
3. WebCT, Blackboard, First Class, or other course- or learning-management system	4.86
4. Live online chat (such as MSN Messenger)	4.78
5. Course web pages	4.71
6. Web-based threaded discussion forum or bulletin board	4.48
6. PowerPoint presentations viewed online using a browser	4.38
8. Course-related files in PDF	4.31
9. Audio clips or files (such as recorded class lectures)	4.29
10. Additional content or resources that are included with course textbooks (such as CD-ROMs or URLs)	4.14
11. In-class presentations using PowerPoint	4.08
12. Video clips or DVDs	4.00
13. Videoconferencing	3.92
14. Online tests, quizzes, examinations, or other forms of online evaluation	3.89
15. CD-ROM tutorials used in class or computer labs	3.81
16. Web-based lectures or presentations	3.70
17. Online content that uses Flash	3.63
18. Live online voice-based chat (speaking and listening)	3.00

Note: Scores range from 1 (completely inaccessible) to 6 (completely accessible).

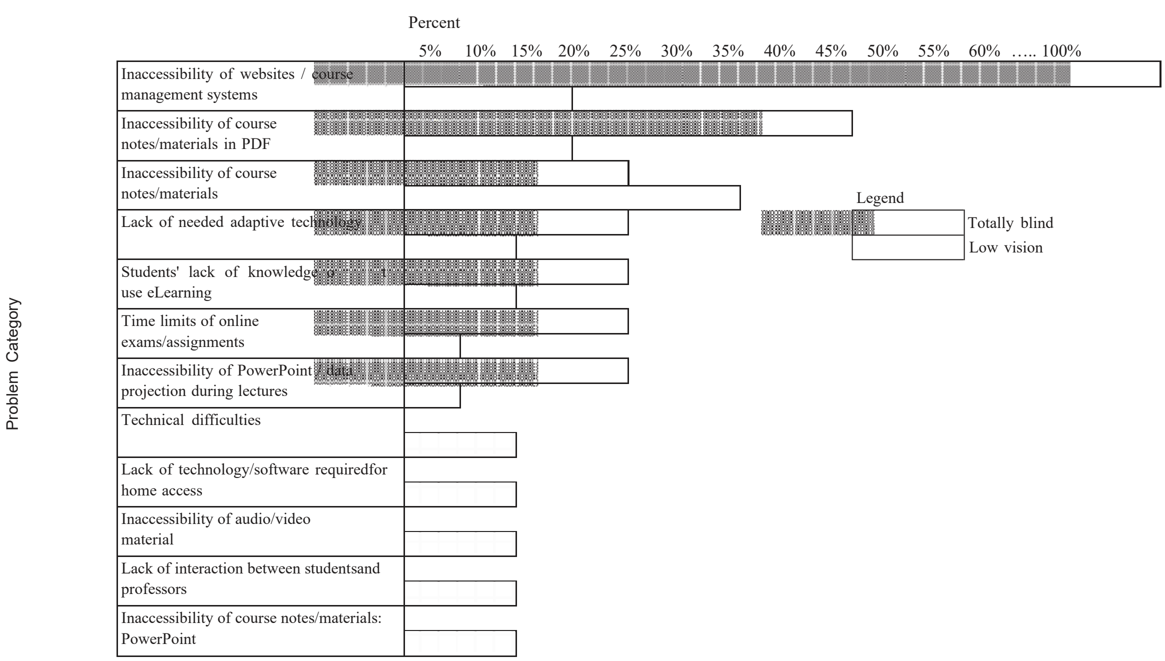

Figure 1. Student reporting rates for various types of problems.

individuals who were adept in the use of information and communication technology or who had prior experience with e-learning materials were overrepresented. The results for this group may not be generalizable due to the limited number of blind participants in Study 2. The fact that we were unable to determine a return rate due to the methods used to recruit participants was particularly concerning.The participants' traits, however, seem to mirror those of disabled postsecondary students in Canada, according to the published indices (Fossey et al., 2005). Some interesting facts about the samples

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include a higher proportion of women than males, an older age distribution compared to other postsecondary students, and a much larger percentage of students with limited vision compared to those who were blind. However, the capability-rather than the representativeness of the samples is the most important aspect of this study.

Which forms of electronic communication and information do students often employ?

Close to 90% of the blind participants utilized scanners with optical character recognition (OCR), over 2/3 used refreshable braille displays, and almost all of the blind participants employed screen-reading or text-to-speech software. More over two-thirds of the participants with limited vision employed screen magnification, and almost half of them used a large-screen monitor. Scanning using optical character recognition was employed by one-third of the participants, while half made use of screen reading software. Given that the majority of participants reported using two or more adaptive computer technologies for reading, it is crucial to make sure that

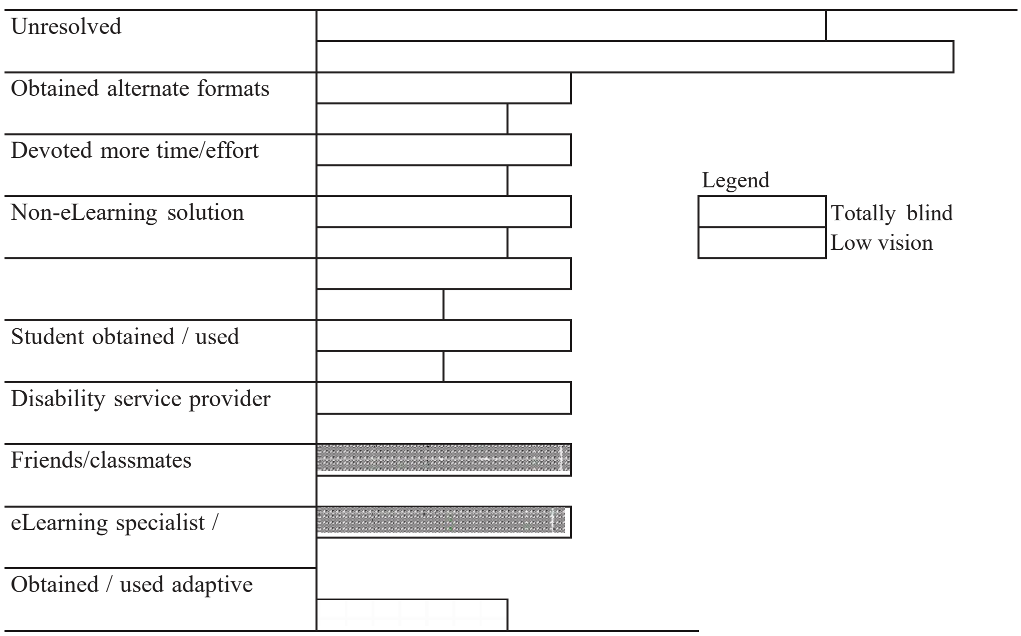

Figure 2. Percentage of students reporting each solution category.

1. blind participants did not fare as well as the seeing participants in most of the survey sections. The two groups brought up issues with the school's technology loan program, computer science training, technical assistance, adaptive computing in general and specialized laboratories, online learning as a testing tool, and so on. Distance education courses, informal school tech support, library computer access, and teachers' usage of e-learning were all major obstacles for the visually impaired participants. To a large extent, both sets of respondents felt that the following were satisfactory: access to appropriate adaptive technologies in the classroom, well-organized school websites, knowledgeable faculty members about online learning, electronic versions of course materials, and sufficient time to complete assignments. essential technology, the friendliness of the personnel, the accessibility of the Internet, and the availability of funds for the necessary ICT for individual usage. Also, the adaptive technology that was necessary in the classroom was easy for both groups to use.

WHAT KINDS OF ONLINE CLASSES ARE EASILY ACCESSIBLE?

It was expected that individuals with limited vision would find most kinds of e-learning more accessible than those who were blind, given the results on information and communication technology. Even while several of the 18 forms of e-learning we tested were passable, none of them were fully accessible to the visually impaired individuals. Online content that employs Flash, CD-ROM lessons utilized in class or computer labs, videoconferencing, and PowerPoint presentations watched online via a browser all have very low accessibility for these students. The majority of the e-learning resources were easily readable by the visually impaired participants; however, two were particularly so: the Word documents associated with the courses and the email correspondence.

Issues and Solutions Regarding Online Course Materials

Issues with

In general, individuals with impaired vision had less trouble navigating e-learning materials than those who were blind. For instance, although they were often considered doable, issues with certain websites and CMSes emerged, particularly for thethat students have access to all the infor- mation and communication technologies that they need.

How well are students' technology needs met?

Overall, the participants' technology-related needs were generally well met and were better met at home than at school. Also, the information and com- munication technologies students used at school were significantly less up todate than those they had at home; thiswas especially true for the participantswho were blind. These findings suggest that colleges and universities need to installthe latest versions ofadaptivesoftware. Stu-dents need to be able to use up-to-date tech-nologies off campus, as well.

Although the results show that the technology-related needs of the partici- pants with low vision were reasonably participants who were blind. Although themost popular web sites and course-management systems used in postsecond- ary educational settings have favorable accessibility ratings, the reported accessi-bility problems with these e-learning ma-terials are due to the fact that these arethe most common means of deliveringe-learning in post-secondary education (Malik, Asuncion, & Fichten, 2005). Ex- amples of difficulties with course websites or course-management systems in- cluded a web-based real-time chat facilitythat did not work with a screen reader; usability issues, such as having to navi- gate through a number of frames; andimages that lacked "alt tags" or descrip- tions that can be read by screen readers. Fixed font sizes on web sites and the incompatibility between the participants' adaptive software and the course manage-ment systems were also mentioned.

Both groups commented on the inac- cessibility of some course notes and ma- terials, including those in PDF. The prob-lem with PDF is that its accessibility depends on how it was made. Instructors often scan old, heavily annotated docu- ments to distribute to students and save them as image-based PDF files. If theoriginal paper document had handwrittenmargin notes, was heavily underlined, or was photocopied several times, attempts at OCR generally do not yield usable files. Similarly, unless specifically de- signed to be accessible (that is, tagged), documents with multiple columns and those with tables and figures, when ren- dered as a PDF files, can create difficul- ties because of the way screen readersinterpret PDFs. Those who intend to make PDF files accessible need either to create them to be accessible or to provide an accessible alternative (such as a Word version).

Inflexible time limits to complete ac- tivities that are built into online testing components of course management sys- tems was also a problem for both groups,a finding also noted by others (see Kamei-Hannan, 2008). This problem is due, in part, to poor accessibility of the interface and to timed features. The literature shows that individuals with visual impair-ments who use adaptive technology gen- erally take longer than do sighted individ-uals to accomplish the same online tasks (Craven & Brophy, 2003) and that stu- dents with disabilities are often entitled toadditional time to complete tests and quizzes (Harding, Blaine, Whelley, & Chang, 2006). But instructors can usuallyspecify only one duration for all students in most online testing systems, suggestingthat vendors of such e-learning products need to incorporate several time settings into their online tests.

The participants did not always have the adaptive technology they needed to access e-learning materials adequately, especially on campus, and had problems with course files in PowerPoint, which can have embedded materials that screen readers cannot read and text boxes that stu-dents often do not know how to navigate.Clearly, there is a need for training that isresponsive to students' needs for accessiblee-learning materials, such as in general-usesoftware, like PowerPoint, and in course-management systems and other technolo-gies used at the students' schools.

The participants also noted technical difficulties using e-learning materials and experienced problems connecting to web sites and course-management systems. They also had problems downloading and opening electronic files and had difficultywith web pages that would not load and video clips that took a long time to open. These concerns are probably shared by students without disabilities. Research that evaluates the similarities and differ- ences of the problems students with and without visual impairments experience with e-learning materials and their solu- tions to these problems is needed.

Solutions

The results show that most of the prob- lems with e-learning materials reportedby the participants remained "unre- solved," with approximately half theparticipants in both groups indicating that at least one of their three most important problems with e-learning was unresolved. Solving an e-learning prob- lem with a non-e-learning solution (such as a student's husband reading materials aloud), devoting more time and effort, and obtaining additional adaptive technologies were also popular "solutions," suggesting that students with visual impairments have a way togo before they can function indepen- dently in an educational environment that uses e-learning materials.

IMPLICATIONS

To support the academic success of stu- dents with visual impairments, colleges and universities, along with rehabilitationprofessionals and educators, need to iden-tify and assess what training they cur-rently provide to students in the use of computer technologies and fill any gaps, especially those identified by the studentsthemselves. Students, of course, need to be proactive in managing their own learn-ing experiences. They need to find out discover the many adjustments that may be made to enhance the effectiveness of online learning materials, become proficient in the use of adaptive technologies that can facilitate online learning, request necessary accommodations, and seek support when needed.

Challenges with access to e-learning materials will persist so long as developers and purchasers of postsecondary e-learning products do not prioritize accessibility in their work. This includes both software and hardware. The use of instructional methodologies and products that are accessible to all students, without any adjustments needed, is the goal of universal instructional design. This approach would greatly contribute to the elimination of access concerns. Despite all the talk, research evaluating the principles and practices of universal instructional design is desperately required.

There will be fewer unsolved accessibility issues if we make e-learning more accessible via universal instructional design and provide students with visual impairments, particularly the blind, the technology and training they need. Additionally, it will help kids who are visually impaired acquire the necessary skills to thrive in today's multimedia-driven, technology-driven society.

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