Commentary

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Computer Technologies and Postsecondary Students With Disabilities: Implications of Recent Research for Rehabilitation Psychologists

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Computer and information technologies have the potential both to enhance the lives of people with disabilities as well as to deny them equality of access to education, jobs, and community life. In particular, these new technologies have the potential to enable or to create difficulties for people with disabilities in the new knowledge-based economy. Concerns about these technologies and their accessibility are evolving issues for the next decade. The authors summarize the findings of a 5-year research program that involved over 1,000 participants from postsecondary educational institutions across Canada. They then highlight emerging issues. Finally, they make broad-based recommendations to rehabilitation psychologists.

Computer technologies are rapidly becoming a part of people's everyday lives: professionally, personally, and academically. Because computer knowledge is a necessity for effective participation in the new North American economy, computer literacy and know-how are part of most postsecondary students' formal education. The integration of computer mediated and online learning into curricula is a top priority at most colleges and universities. In parallel with this trend is the rapid evolution of both popular commercially available products and adaptive hardware (e.g., an adapted mouse) and software (e.g., software that reads what is on the screen). These trends have the potential to level the playing field and provide individuals with disabilities access to the same opportunities as their nondisabled peers. This outcome is, of course, contingent on persons with disabilities gaining timely access to the technologies and adaptations they need. Practicing rehabilitation psychologists often conduct evaluations of clients who want to enter postsecondary programs. Here we describe and discuss some of the practical and useful technologies that could be recommended in reports and consultations.

Computer, Information, and Adaptive Computer Technologies in Postsecondary Education

It has been estimated that between 5% and 11% of postsecondary students have a disability (cf. CADSPPE, 1999; "Disabled Students in Postsecondary Education," 1997; Greene & Zimbler, 1989; Henderson, 1999; L. Horn & Berktold, 1999). In the U.S., the Americans With Disabilities Act (ADA; 1990) and related legislation has had a major impact on all aspects of living for people with disabilities. This includes accessibility, postsecondary educational institutions (e.g., Bausch, 1994) and computer technologies (Department of Justice of the United States, 2001; United States Department of Justice, 1998; Waddell, 2000).

At most North American postsecondary institutions, there is at least one designated person whose responsibility it is to provide disability-related services and accommodations to students. There are several American (Burgstahler, 1992, 1993; Burris, 1998; Coomber, 1996; C. A. Horn & Shell, 1990; Jackson, Morabito, Prezant, & Michaels, 2001; Lance, 1996) as well as Canadian (Epp, 1996; Fichten, Asuncion, Barile, Robillard, et al., 2001; Killean & Hubka, 1999) studies on the views of individuals responsible for providing services to students with disabilities about

computer, information, and adaptive technologies. Several of these have relatively large samples (Burgstahler, 1992, 1993; Fichten, Asuncion, Barile, Robillard, et al., 2001; C. A. Horn & Shell, 1990; Killean & Hubka, 1999; Lance, 1996). Together, these provide a reasonably comprehensive picture of the computer- and adaptive-computer-technology–related views of professionals who provide disability-related accommodations to students on campus.

With the exception of learning disabilities, however, there have been few studies of the computer and information technology needs of the entire spectrum of postsecondary learners with disabilities. To the best of our knowledge, only a handful of investigations have studied the views and concerns of the students themselves (Coomber, 1996; Killean & Hubka, 1999; National Center for the Study of Postsecondary Educational Supports, 2000; Roessler & Kirk, 1998). Although these are important and timely investigations, a variety of concerns about each study limits their generalizability.

To evaluate student views, over the past 5 years we have been conducting a series of empirical studies involving more than 800 postsecondary students with disabilities and smaller samples of professors and personnel responsible for providing services to postsecondary students with disabilities on campus. The goals have been (a) to examine the computer, information, and adaptive computer technology needs and concerns of postsecondary students with disabilities, the personnel who provide services to them, and the professors who teach them and (b) to provide information to concerned individuals, groups, and organizations to ensure that new computer technologies are accessible to postsecondary students with disabilities. Here we highlight some of our findings, illustrate the types of computer technologies used by students with different disabilities, and make recommendations to rehabilitation psychologists. It is important to reiterate that although our focus is on students with disabilities, our findings and information are applicable to all persons with disabilities.

Description of the Studies on Which the Recommendations Are Based

AdaptCan Project

Between fall 1997 and spring 1999 we explored the computer, information, and adaptive computer technologies needs and concerns of Canadian university and community/junior college students. These involved more than 800 participants (Fichten, Barile, & Asuncion, 1999b). To obtain an overview of the important issues, we first conducted focus groups with postsecondary personnel responsible for providing services to students with disabilities, postsecondary students with various disabilities, professors, and other concerned individuals (Study 1). We then obtained in-depth information from structured interviews with larger and more representative samples of students with disabilities ($n = 37$) and individuals responsible for providing services to students with disabilities ($n = 30$; Study 2). Finally, we collected comprehensive information via questionnaire from a Canada-wide convenience sample of university and junior/community college students ($n = 725$; Study 3). Although the data were collected in Canada, the implications of the findings have broad-based applications to other countries.

ITAC Project

This recently completed project was conducted in the province of Quebec. Here, data from 97 community/junior college students with disabilities and 71 individuals responsible for providing services to them were obtained by using focus groups, interviews, and close-ended questionnaires (Fichten, Barile, Robillard, et al., 2000). This investigation sensitized us to (a) the realities of needing and using computer technologies when one's language is French rather than English, (b) the importance of taking into account the size of the institution, and (c) special concerns experienced in institutions with few students with disabilities.

DSSFocus Project

In our most recent work, we studied the views and concerns of almost 200 individuals at Canadian universities and community/junior colleges who oversee support services to students with disabilities (Fichten, Asuncion, Barile, Robillard, et al., 2001). This structured interview study investigated accessibility of computer technologies on campus and institutional and external factors that help or hinder access to these technologies. Results from this study also form the basis for some of the recommendations that follow.

Highlights of the Findings

Key findings are listed in Appendixes A and B. These are based on the empirical studies described above. Results are based primarily on 6-point Likert and Likert-type rating scales and on interview data that were subjected to content analysis. All instruments and measures are available in Fichten, Barile, and Asuncion (1999a) and in Fichten, Asuncion, Barile, Robillard, et al. (2001). Scientific articles that fully describe the method and results are available in both peer-reviewed journal articles (Fichten, Asuncion, Barile, Fossey, & De Simone, 2000; Fichten, Asuncion, Barile, Fossey, & Robillard, 2001; Fichten et al., 2001; Fichten, Barile, Asuncion, & Fossey, 2000) and Web-based resources (Fichten, Asuncion, Barile, Robillard, et al., 2001; Fichten et al., 1999b; Fichten, Barile, Robillard, et al., 2000).

Results from all stages of our investigations converge on a variety of important points. First, it is evident that computer technologies can form "electronic curb cuts" (Coombs, 1999). These have incredible potential to level the playing field for individuals with all types of disabilities. Second, although our data showed that the perceived advantages of computer technologies far outweighed the disadvantages, the data also showed that these technologies can act as either obstacles or facilitators. Postsecondary students with disabilities appear to have a high level of computer and Internet usage and literacy. What is also readily apparent from the data is that there are a variety of problems and issues regarding the availability of such technologies that need to be addressed. This includes a concern over inadequate funding for computer and adaptive computer technologies, both for the students themselves and for the institutions. It also refers to the need for better collaboration and coordination between rehabilitation organizations and agencies and the postsecondary community and the need for more information about adaptive technologies and for enhanced training opportunities for students and campus-based

individuals responsible for providing disability-related services to them. Finally, it encompasses the challenges around the minimal information about existing subsidy programs to help students acquire computer technologies. Lack of awareness about the computer-related needs of students with disabilities by both professors and other postsecondary personnel involved in designing and implementing campus-wide information and learning technologies also poses an important barrier.

Blurring Between Adaptive and Popular Commercially Available Products

Data were obtained in Study 3 of the AdaptCan Project from students who indicated that they needed adaptations to use a computer effectively. Appendix C shows, in rank order, the top 10 "adaptations" students considered could be useful in getting their school work done. The data are presented for students with all types of disabilities combined.

It is evident that what are generally considered popular commercially available products are, in fact, used as adaptive aids by students with certain disabilities. For example, most people use spell checkers. For students with some learning disabilities, this tool is used as an adaptive technology to help compensate for the disability. Dictation software, originally intended for professionals and executives, is now used as an adaptive technology by students with a variety of hand/arm impairments and some types of learning disabilities. Screen reading (synthesized speech) technologies, originally used by individuals with visual impairments, have crossed over into the mainstream and are increasingly available for wireless telephony-based e-mail enhancements. The same is true for such widely used technologies as scanners and optical character recognition (OCR) software that are used as adaptive technologies by students with visual and other print impairments. Screen magnification, too, is increasingly available as a mainstream product (e.g., wheel mouses have a built-in magnification feature in most Microsoft products).

Some technologies have remained disability specific: Braille printers, captioning on video portions of Web pages and CD-ROMs, head and foot mouses, and the audio-cord (cf. Phonak's [2000] MicroLink FM system), which allows people with hearing impairments who use an FM system to hear voice output from a computer.

Thus, there appear to be three categories of computer technologies used by people with disabilities: popular commercially available computer hardware and software (e.g., word-processing software), adaptive computer technologies (e.g., Braille printer), and those which are adaptable (e.g., dictation software). People also use certain computer technologies in creative, idiosyncratic ways, further clouding distinctions and demonstrating the incredible potential of computer technologies and the Internet to remove barriers to individuals with disabilities.

How Individuals With Specific Disabilities Use Computers

Individuals Who Are Blind

These individuals typically use synthesized speech to read what is on the screen as well as on toolbars, menus, dialogue boxes, and the like. Some also use a special hardware–software combination that takes a line of text on the screen and converts it into a line of text on a Braille display. To turn a printed page into electronic text for speech or Braille output, these individuals can use specialized systems that use a scanner and OCR software.

Individuals With Low Vision

Those with some useable vision use either magnification (software and/or large screen monitors) or synthesized speech. They, too, can use a scanner and OCR software to turn the printed page into electronic text. Persons with low vision can also use a variety of specialized software as well as built-in features of popular commercially available software packages to change the contrast and to enlarge and otherwise make text, cursors, and other visual elements more visible on the screen.

Individuals With Learning Disabilities

These students mentioned using many of the same technologies as students with visual impairments to help them better process printed materials and what is written on the screen. In addition, dictation software, document managers and schedulers, concept mapping software, electronic dictionaries, grammar and spell checkers, and word prediction software were frequently used.

Individuals With Hearing Impairments

Students with hearing impairments reported using writing aids such as spelling and grammar checkers, e-mail and chat programs, accessibility features built into the operating system of conventional software (e.g., visual flash instead of sounds), captions and subtitles for video clips (when available), and the C-Note System (a set-up that involves two joined laptop computers; Computerized Notetaking System, 2001).

Individuals With Speech/Communication Impairments

These students also used e-mail and chat programs. In addition, they used portable note-taking devices to interact with others in face-to-face contexts and multimedia projectors for oral presentations.

Individuals With Mobility and Hand/Arm Impairments

Students with a variety of mobility and neuromuscular impairments can benefit from a variety of ergonomic adaptations, dictation programs, and voice-control software that allows hands-free dictation and control of menus, as well as software-based keyboard adaptations, software, or hardware that allows for one-handed typing, along with a variety of alternative mouse and input devices.

Relevance for Rehabilitation Psychologists

Rehabilitation psychologists have many professional roles, including teaching, researching, providing direct services to clients, and advising rehabilitation organizations and agencies concerning policies and practices. Most rehabilitation psychologists are not adaptive computer specialists and are rarely called on to prescribe computers in their treatments. So why is it important for rehabil-

itation psychologists to know how computer technologies and the Internet can be used by persons with disabilities?

Computers are best seen as enabling technologies—"electronic curb-cuts"—that can level the playing field. From a rehabilitation psychology perspective, it is also important to note that computer technologies have been shown to enhance the well-being of persons with disabilities by alleviating loneliness and by fostering independence and autonomy (e.g., providing social contacts, access to information, online shopping, online banking). For example, e-mail was the most popular use for the Internet in Clark and Bellamy's (1999) survey of 89 adults with disabilities. This was followed by chat rooms, newsgroups, discussion groups, and electronic mailing lists. Their participants also indicated that the Internet provides them with access to information (90%), allows them to do things they could not normally do (72%), helps them make friends (47%), and provides something to do (38%). Data from other laboratories also indicate that Internet use has a variety of important psychological benefits for people with disabilities with regard to independence, isolation, loneliness, and general well-being (Hopps & Pepin, 1999).

Recommendations for Rehabilitation Psychologists

1. Explore the potential of computer technologies in improving the lives of clients.

2. Pay more attention in assessment reports, consultations, and treatment interventions, to the potential of training on computer technologies and the Internet.

3. Involve clients in decisions that affect their equipment and training.

4. Make informational materials intended for clients and colleagues with disabilities available in alternate formats (i.e., Braille, tape, diskette, regular and large print).

5. Post information for clients on Web sites, make sure these have accessibility features enabled, and publicize the locations widely.

6. In collaboration with individuals who have disabilities, advocate with rehabilitation and government agencies that fund computer technology subsidy programs. At the interface between clients and the government, rehabilitation psychologists are in an excellent position to advise policy makers and administrators to make modifications in programs to better meet the needs of individuals with disabilities.

7. Become informed and share information with clients concerning social and public programs offering technology-based assistance for persons with disabilities.

8. Advocate within your organization to make available to its clientele an adaptive computer workstation that is Internet enabled.

9. Make clients aware about what computer equipment is available to them for their personal use at rehabilitation centers and facilities.

Resources for Rehabilitation Psychologists

When conducting evaluations and consultation to rehabilitation clients who may be interested in postsecondary education, psychologists may wish to include computer and adaptive computer technologies among their recommendations. Often, it is not possible to evaluate whether a particular technology is likely to be helpful to a specific client. It is usually specialized high-tech occupational therapists who do comprehensive evaluations of client needs in this area. These individuals tend to be very scarce, and therefore, very busy. Lengthy waiting periods for evaluation appear to be common, at least in our experience in Canada.

Rehabilitation clients may not be aware of the technological options that can make their academic lives easier. For example, much to our astonishment, while we were conducting a focus group with postsecondary students with disabilities, we found that as we were waiting to get going, a student with a learning disability was providing information on dictation software to a student with quadriplegia, who had never heard of dictation software and was using his single functional finger to type. If one is interested in the types of computer technologies used in postsecondary education, one can arrange for an onsite visit to a college or university that offers computer-related supports for students with disabilities. This can uncover an abundance of real world examples of such technologies in action.

Thus, it seems safer to err on the side of recommending that clients and their therapists investigate computer technologies that could be useful. In our studies we also asked students about the brand names of computer technologies they used. We compiled these, for each disability group, in an informational booklet (Fossey, Fichten, Barile, & Asuncion, 2001). In locating sources for these products, we discovered that many of the full-featured adaptive products are extremely expensive. Also, persons with disabilities often have no opportunity to find out whether a certain type of product is likely to work for them. Moreover, those eligible for computer subsidy programs often need evaluations and training from busy professionals—these can take an inordinate amount of time. To assist with these problems, we compiled a listing of free and inexpensive computer technologies that can allow people with disabilities to experiment and determine their own needs. We also included these free and inexpensive computer products in our informational booklet (Fossey et al., 2001). This is available both online and in regular and large print formats from Catherine S. Fichten in both English and French (it is also available on diskette). The Web version available on our project Web site (Adaptech Research Network, 2003) includes hyperlinks to many products, both free and inexpensive, as well as full-featured versions. This handy resource for both professionals and individuals with disabilities can be found online (http://www.adaptech.org/pubs/booklete.htm). Additional information is also available in two recent user-friendly books: Cunningham and Coombs (1997) and Mates (2000). Mates's (2000) book, in addition to being available in print form, is also available free online (http://www.ala.org/editions/openstacks/insidethecovers/mates/mates_toc.html).

Our booklet also provides suggestions for Canadians about funding sources and sponsors for computer technologies for stu-

dents with disabilities (Fossey et al., 2001). We have not, however, compiled a similar listing for American funders. Yet, as T. Elliott (personal communication, July 22, 2001) stated:

> Information about funding sources and sponsors for these aids and devices . . . is of vital importance to practitioners in our country. Many third-party payers do not cover these items (and that includes state programs, as well). Rehabilitation psychologists need to consider the realities of sponsorship, and consider other means of advocacy at higher levels of involvement (so that funds are allocated for this kind of assistance).

"In a time of scarce resources, the money needed to make adaptations is too much to spend on just a few people! The numbers simply don't warrant it," is a frequently heard comment. The argument that "granting equality to the disabled population group is not justifiable because of the cost . . . or because of the inconvenience to mainstream society" (Nagler, 1993, p. 33) is often made in this context. We contend that this type of rationale needs to be rebutted wherever it surfaces. Our studies show that when it comes to postsecondary education and the new knowledge-driven economy, technology is the future and is a must for individuals with disabilities. Therefore, it is imperative that persons with disabilities have good access to the Internet and to computer, information, and adaptive computer technologies. A small investment today is likely to pay handsome dividends in the future in the economic, social, and occupational functioning of persons with disabilities, as well as in their psychological adjustment, well-being, and quality of life.

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Appendix A

Computer Use by Students With Disabilities: Summary of the Findings

- Computer technologies have numerous important advantages for students with all types of disabilities.
- Virtually all students with disabilities in our samples used computers (95%), mainly personal computers.
- The overwhelming majority of students with disabilities used the Internet (87%), mainly for research and e-mail.
- Almost half of the students had more than one impairment (42%)—this has implications for software and hardware incorporated into adapted work stations.
- There were no sex differences and older and younger students did not differ on computer use or attitudes (age: $M = 30$, $Mdn = 26$, $SD = 10$, range = 17–75; distribution skewed in favor of younger students).
- There was a clear tendency to cross-use technologies (i.e., technologies intended for students with one type of disability were used by students with a different disability).
- Students used popular commercially available products, such as dictation software, spell checkers, and scanners, as disability accommodations.
- There was an astonishing lack of information about existing subsidy programs to help students acquire computer technologies for off-campus use. This refers both to students with disabilities as well as to campus-based individuals responsible for providing services to students with disabilities.
- Only about a quarter of the students used adaptive computer technologies (e.g., screen magnification, adapted mouse), although almost half indicated needing these. The reasons they cited were cost and lack of information about what was available.
- Some students were reluctant to use computer technologies in class because they said it made them "stand out" and because of attitudinal problems related to classmates and professors.
- Individuals responsible for providing services to students with disabilities expressed the need for students with disabilities to be able to get up-to-date subsidized computer technologies for home use more easily.
- The high cost of acquiring and maintaining computer technologies was the single most important and common issue noted by computer users and nonusers alike—this applied to technologies both for on- and off-campus use and was noted by both students and individuals responsible for providing services to students with disabilities.

Note. Findings are based on data from close to 800 postsecondary students with disabilities and 36 postsecondary individuals who provide disability-related services to them in the AdaptCan Project (Fichten, Barile, & Asuncion, 1999b) and an additional 71 postsecondary disability-service providers in the ITAC Project (Fichten, Barile, Robillard, et al., 2000).

Appendix B

Computer-Related Services for Students With Disabilities: Summary of the Findings

- All universities and most junior/community colleges in our samples had some type of computer or adaptive computer technologies for students with disabilities on campus.
- Most individuals responsible for providing services to students with disabilities were interested in better links with agencies and professionals who provide rehabilitation services.
- When they experience difficulties with students' computer-related concerns, professors generally ask either the students themselves or the campus-based disability service providers for assistance.
- Both students and campus-based disability service providers expressed concerns about being poorly informed about what technologies are available and about new developments in technology.
- Knowledgeable service providers are mainly self-taught: They try it out at home, learn from the students, look on the Web, call on each other, etc.—there is no time for courses or conferences.
- Personnel responsible for providing services to students with disabilities indicated that they saw the use of computers not only as beneficial for the students but also as cost effective for the institution.
- Most individuals responsible for providing services to students with disabilities were interested in having broad-based collaboration of their postsecondary institution (e.g., computer support services).
- Both students and individuals responsible for providing services to students with disabilities were exceptionally poorly informed about the nature and availability of government and rehabilitation agency programs to assist students with acquiring computer technologies for off-campus use—in particular, students with hearing impairments were not taking advantage of available programs.

Note. Findings are based on data from 36 postsecondary individuals who provide disability-related services to students in the AdaptCan Project (Fichten, Barile, & Asuncion, 1999b) and an additional 71 postsecondary disability-service providers in the ITAC Project (Fichten, Barile, Robillard, et al., 2000).

(Appendixes continue)

Appendix C

Adaptive Computer Technologies That Are or Could Be Useful for Students: Responses of Students With Disabilities, in Rank Order

1. Spelling and grammar checker
2. Scanner
3. Portable note-taking device
4. Dictation software (voice-recognition software that types what the user says)
5. Having material available in electronic format (e.g., books, handouts)
6. Other specialized software for learning disabilities (e.g., word prediction)
7. Voice-control software (the user gives voice commands like "file," "open")
8. Large screen monitor
9. Screen reader (software that reads what is on the screen)
10. Mouse adaptations (e.g., track ball)

Note. This list is based on responses of the 284 students (41% of the whole sample of 725 students with disabilities) in Study 3 of the AdaptCan Project (Fichter, Barile, & Asuncion, 1999b), who indicated that they needed special adaptations to use a computer. Responses were made on a 6-point Likert scale, with higher scores indicating that this type of equipment is or would be useful. Almost half of the sample had more than one impairment.