COMPUTER AND INFORMATION TECHNOLOGIES FOR POSTSECONDARY STUDENTS WITH DISABILITIES

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ABSTRACT

This article deals with the present and potential roles of learning and computer technologies in the lives of students with disabilities in postsecondary education. We review the literature and briefly describe empirical research we plan to conduct by gathering data on academic and social outcomes from students with disabilities. Our goals include furthering knowledge, improving practice, and disseminating valuable information about the nature and accessibility of existing learning technologies to various concerned groups.

INTRODUCTION

In the quest to deliver high quality education on tight, limited or restrictive budgets, postsecondary educational institutions are increasingly investigating computer assisted teaching and learning as an integral part of their regular educational programming. Computer and information technologies as well as virtual group experiences offer exciting possibilities for people with disabilities, permitting them to achieve in an environment where their impairment has little or no impact on their performance or their educational or social outcomes (Resmer, 1997).

Our goal here is to summarize the state of the art in the use of information and computer technologies (1) as cognitive tools which can make learning and performance more meaningful (Lajoie, 1990; Reeves, cited in Staff Writers, 1997) and (2) as cognitive "orthotics" which correct and compensate for disabilities and limitations (Bergman, 1996). In particular, we plan to provide an up-to-date, well-referenced view of popular conceptions about current realities. Exploring important conceptual or theoretical topics, pinpointing key issues, and critically reviewing the research literature are not our goals; searches of the ERIC, PsycINFO, and MEDLINE data bases show that in spite of the proliferation of projects, web sites, on-line journals, and policy statements, there is virtually no **empirical** research which evaluates the use or the utility of computer or information technologies in the postsecondary education of students with disabilities. The research literature in this area is severely limited with the exception, perhaps, of the impact of various drill-type tutoring programs on children with intellectual impairments.

In the absence of hard data, we will (1) summarize the popular themes and concerns noted in past print-based sources (primarily non-empirical journal articles) and in recent electronic sources - most notably Internet-based on-line journals and resources, and (2) describe the goals and direction of the research we plan to undertake to answer some basic questions.

WHY IS THIS TOPIC IMPORTANT?

Computer literacy - the buzzword of the 1990s - is, perhaps, even more important for people with disabilities than it is for other students to enable them to succeed in higher education (cf. Bissonnette, 1995). Postsecondary education for people who have a physical disability is important for the same reasons as it is for non-disabled people; it helps to fulfil personal goals, allows for effective competition in the job market and contributes to independence and financial security. In fact, a college education is **more** important for people who have a disability. Higher education for women with disabilities is especially important (Barile, 1996). It has been shown, for example, that even though the employment rate of university graduates with disabilities is somewhat lower than that of their nondisabled peers, it is still substantially higher than that of students who did not complete university, who, in turn, fare better than those who never went to college (Government of Canada, 1993; Louis Harris & Associates, 1994).

WHAT ARE THE KEY CONCERNS?

Both American and Canadian colleges and universities have done much to make campuses and programs more accessible (e.g., Marion & lovacchini, 1983; Hill, 1992). This has permitted an increasing number of people with disabilities to enrol in postsecondary education (Henderson, 1992; Louis Harris & Associates, 1994; McGill, Roberts, & Warick, 1994; Wolforth, 1995).

Nevertheless, many problems remain (Hill, 1994, 1996; McGill, et al., 1994; NEADS, 1995; Tousignant, 1995), and students with disabilities still face many architectural, technical and human barriers (Fichten, 1995; Leitch, 1995).

Problems also exist regarding access to computer and information technologies. For example, students with hearing and visual disabilities are often unable to obtain proper technical or human aids in traditional classrooms (Gagnon, 1996; Harder & Doe, 1989). Students with visual and learning disabilities frequently find themselves without access to materials, such as textbooks, articles, and audio-visual materials that are available to their nondisabled classmates (Bissonnette, 1995). Students who are deaf have experienced difficulties in computer labs, where the contradictory demands of watching a sign interpreter while simultaneously pressing buttons on a keyboard can cause conflicts and confusion (Robbins, 1996).

Similarly, the characteristics of some existing learning technologies prevent access by people with various disabilities because these lack accessible features. For example, some educational CD-ROMs have small print or a very light background which cannot be changed, and many classroom videos have neither open nor closed captioning ("open caption:» similar to subtitles on foreign movies - caption is always visible because it is directly imprinted on videos/movies; «closed caption:» caption that requires a TV decoder to allow the captioning to show). Some people have difficulties accessing Internet web sites due to screen sizes and colors (Schoffro, 1996), while others, most notably people who are blind, have difficulties because graphic images do not have verbal descriptive tags for text-based browsers and screen readers (Vanderheiden, Chisolm, & Ewers, 1996).

Despite changes in sensitivity to students' needs and the availability of certain accommodations, people with disabilities continue to experience other types of difficulties in the traditional "on site" postsecondary educational environment. When students must enter a hospital for a prolonged stay, they frequently lose the whole semester because they are not able to obtain assigned materials, attend lectures, participate in group and class discussions, or obtain and submit assignments and exams. Other factors, such as fatigue and progression of illness frequently make continuing one's courses difficult. Problematic transportation to the educational institution as well as between buildings on the campus pose additional concerns. In addition to the burden of travel in the Canadian climate, such factors have presented substantial hardships for students with neuromuscular and medical impairments. These formidable environmental barriers can force students to take fewer courses or to drop them altogether, thereby delaying their progress and perhaps even preventing them from graduating.

THE HYPE

"Computers are opening up a whole new world for many disabled people..." trumpeted Wendy Dennis in Homemaker's Magazine (a popular publication intended for homemakers). What makes this statement so remarkable is that Dennis' article was published in 1984! Has the promise been fulfilled?

Traditionally, students who are blind have used computers to assist with their education. Recent advances in technology have allowed other people with disabilities access to computers and to the Internet through the use of equipment such as mouth wands, a variety of balls, and adapted keyboards and mice. Voice technology and sophisticated grammar and spelling checkers have helped make the computer an indispensable tool for many students with various impairments and disabilities. In many cases, access to computers can help postsecondary students avoid environmental barriers and socio-economic handicaps, such as restricted access to jobs.

Among academics and instructional designers who work with educational technology it has long been known that learning assisted by high technology tools does not necessarily produce superior learning or performance [see Hooper and Hannafin (1991) and Russell's (1997) review of 248 research reports]. In the special education community too, the realisation has come that in many cases a low technology alternative is often superior to state-of-the-art, expensive high tech options (see Blackhurst, 1997). What about the role of high tech solutions in the education of postsecondary students with disabilities?

EDUCATION OF POSTSECONDARY STUDENTS WITH DISABILITIES: HAVE THE PROMISES BEEN FULFILLED?

Is the hype justified? If so, for whom? What changes in this rapidly evolving area promise to help - or to hinder - the social integration and educational attainments of students with various disabilities?

The overall answer to the global question above is a qualified, "Yes" with the following caveats. High tech solutions seem to have been extremely effective (1) in assisting some postsecondary students to succeed (mainly students who are blind and use Braille - a very tiny proportion of the "blind" population), (2) if the educational institution had ample available adapted equipment - hardware as well as software - (3) both for home and college use, (4) in good working order, (5) with appropriate training and instruction in their use, (6) supported by knowledge-able and available resource people. In future, the stipulation, (7) "with free or low cost access to the Internet" will have to be added.

It may appear that we have included too many qualifiers. An explanation is in order. Students with disabilities vary widely, not only in their intellectual abilities, areas of study, and learning styles, but also in the types of interface and software they need as cognitive tools and orthotics. Coping with the requirements of courses involving math symbols, logic, chemistry labs, and Shakespeare recitations requires dramatically different solutions, even for students with the same disability (e.g., visual impairment). Of course, students have different impairments, with varying levels of severity. Different levels of severity require not merely more or less of the same assistive technology, but, frequently, dramatically different technology.

STUDENTS WITH VISUAL IMPAIRMENTS

Students who have visual impairments have a wide range of visual abilities. Those who are legally blind do not all use Braille. Indeed, most do not (Kirchner & Simon, 1984a, 1984b). Instead, they use audiotape and/or large print. Some students with visual impairments have sufficient vision to make them seem indistinguishable from the non-blind community. In fact, many legally blind students can use computers which use large print. In most cases, however, they need more magnification than that which unmodified computers, even those with Windows 95 (accessibility features) and equivalent Macintosh software can provide. Thus, many legally blind computer users need a screen magnification program, such as the popular LP-DOS (large print software which acts as a magnifier for all elements of the computer screen), and many use screen readers (mainstream speech synthesiser with text-to-speech capability such as SoundBlaster's Text Assistant or more sophisticated, specialised speech synthesis software such as Artic).

Input and output devices

Of course, all students must be able to produce regular print copies of their assignments and papers for submission in their courses. In addition, students with visual impairments may need Braille (Braille displays and printers), large print (screen and hard copy), and/or speech synthesiser outputs. Most people use more than one output modality although input is usually accomplished via a standard keyboard. People who use Braille are typically not able to use a mouse or other pointing device. This makes GUI (e.g., Windows–like) software very problematic. These students have generally continued to use text-based software (e.g., DOS, WordPerfect 5.1). Thus, exciting new software may be inaccessible. Many computer users who are partially sighted (i.e., legally blind, but possessing low vision) can use a mouse or equivalent input source. For these students, standard Windows 95 accessibility features such as high contrast and varied background colors can also help.

We should stress that this state of affairs is really a substantial advance over technology available as recently as 10 years ago. At that time, dedicated software was needed to run large print word processors, speech readers, and refreshable Braille. In those days, the dedicated software was often very poor in quality, in addition to being obsolete by non-disabled standards. There was only a small, non-lucrative market for such products and there was no legislation mandating accessibility of either software or hardware.

Empowerment

Two or three years ago, students with visual impairments who had good access to computers truly became empowered by the advent of powerful software and hardware. This allowed them to take notes in class using a laptop and to use conventional word processors to format print output. This became possible because the new software allowed for alternate output modalities, such as large print, text-to-speech capability, and Braille. Using scanners and optical character recognition software (OCR), students were enabled to "read" print electronically, without having to rely on human volunteers. In many cases, students were able to replace audiotaped books and lecture notes - which made for very slow reading - with sophisticated electronic bookmarks, search strategies, and annotation systems. Similarly, when college and university libraries went on-line, many students with visual impairments were able to tap into the text-based library programs - a substantial improvement for these students over conventional print catalogues.

People with visual impairments were also able to go on the Internet and locate information previously inaccessible to them, using tools such as Telnet and Gopher and text based browsers such as Lynx. This allowed them to carry out functions such as communicating using e-mail, accessing on-line telephone directories, downloading software, and reading books via electronic text (downloaded from e-text libraries such as that provided by the Gutenberg Foundation). In spite of ongoing difficulties with copyright problems and the reluctance of publishers to provide electronic versions of their texts (and more recently, since many key copyright and accessibility issues were settled, to make available texts where the print codes have been stripped from the disk), many people with visual impairments have a considerably easier time getting an education and accessing information than in the past.

Current concerns

Since the advent of GUI based software, however, people with visual impairments have once more been disenfranchised. Mouse pointers and icons do not fit well with the text based accessibility adaptations used by many people with visual impairments. Because they do not have sufficient vision to use a pointer, many students who are blind must navigate the screen with a keyboard. With some notable exceptions, most GUI based programs do not support a wholly keyboard based input system. Also, when it comes to accessing the World Wide Web, text based browsers and screen readers have great difficulty reading bit mapped images and coping with multiple page frames and the use of animation and Java. Some conventional browsers deal reasonably well with the task of allowing people to use the keyboard (e.g., Internet Explorer). However, most screen readers do not cope well with images, especially when the image is not described. Dedicated software, such as PW Webspeak (Productivity Works), reads the HTML and interprets it directly; but even this approach fails to be informative if the images are not described. Not wanting to once more be left out of the mainstream of information, many organizations advocating for people with visual impairments have sponsored sophisticated manuals and fact sheets to help web page and multimedia instructional designers construct accessible products and sites (e.g., Do-It, 1997; Vanderheiden, Chisolm, & Ewers, 1996). Fundamental to all of these are the recommendations that (1) there be a text-only version of each site or product, (2) that a no-frames option be provided, and (3) that graphics and photos are described.

Students with visual impairments have traditionally experienced difficulties with videotapes; here, much of the action is typically visual and there is generally no narrative description. The increasing use of video clips in multimedia, both on and off the web, poses similar difficulties. Video clips should be treated as graphic images - i.e., described.

STUDENTS WITH SPEECH IMPAIRMENTS AND THOSE WHO ARE HARD OF HEARING OR DEAF

For these students, too, information and computer technologies can be a real boon. Real time computerized note-taking such as the C-Note system have allowed students with hearing impairments to read - on their laptop - what is being said during lectures. This system also provides an electronic transcript of the lectures, allowing students to take their own lecture notes at a later time.

Students with poor speech, whether they have a hearing impairment, cerebral palsy, or other disabling condition, can communicate via a laptop. This may be done using a speech synthesiser or simply by written text. Of course, when e-mail is used, most students with hearing or speech impairments have no difficulties. Also, standard accessibility features on Macintosh and Windows 95 computers which transform sounds to flashing images can help Deaf and hard of hearing students to use their computers more efficiently.

Many students with hearing impairments also have difficulties with grammar and spelling. Sophisticated grammar and spell checkers (e.g., in Explorer Mail and News, Microsoft Word) are incredibly helpful. These cognitive tools help most of us improve our writing; for many students with hearing impairments, however, these are indispensable cognitive orthotics, rather than mere conveniences.

Students who have a hearing impairment have traditionally experienced difficulties with videotapes and audiotapes that are not captioned. With increasing use of audio and video clips on the web and in multimedia productions, the lack of captioning can serve to disenfranchise students with hearing impairments. The recommendation, of course, is to provide written descriptions of all auditory information (i.e., whatever is spoken should be written on web pages, CD-ROMs and on video and audio clips).

STUDENTS WITH MOBILITY AND NEUROMUSCULAR IMPAIRMENTS

The needs of students with mobility and neuromuscular impairments vary substantially. For some, the only accessibility option needed is ergonomic positioning of the computer equipment. For others, a sophisticated series of input devices - both hardware and software - are needed. For example, "sticky keys" and "filter keys" are standard accessibility options in Windows 95. These allow students typing with only one hand, as well as those who use a mouth wand or other pointing device, to control the computer, and permit students with poor fine motor control to avoid unwanted repeated keystrokes. For some students, alternate input modalities are needed. Examples include sophisticated artificial intelligence (AI) based dictation software (e.g., Dragon Dictate) and basic Morse code input via a "sip and puff" interface (the student uses a straw-like tube and controls various functions by sipping or puffing into it). Many of these students also need assistance with note taking. Electronic agendas, which can be accessed using a mouth wand or other pointing device, can also be helpful (for good documentation on input device adaptations, such as track balls, joysticks, etc., see Do-It, 1996).

E-mail and Internet based groupware (e.g., Lotus' Learning Space, Novell's GroupWise, SoftArc's FirstClass) allow students who experience frequent or extended hospital stays and those who have difficulty getting around during poor weather to stay in contact with professors and fellow students. These Internet based tools can also, of course, be used to submit assignments, receive handouts and notes, visit during "virtual office hours," etc.

Most of us are delighted with cognitive tools such as remote access of libraries. For example, using McGill University's dial-up system in the middle of the night allows us to use the MUSE library system and the PERUSE online literature search. What wonderful cognitive tools! For students with neuromuscular and mobility impairments, however, this type of accessibility is much more important. In a related vein, distance education - increasingly delivered using computer and information technologies - is also an option for students who have difficulty getting on campus.

STUDENTS WITH MEDICAL IMPAIRMENTS

As in the case of students with neuromuscular impairments, some students with medical disabilities miss classes frequently. Others, during bouts of fatigue or pain, are not able to take notes and need some of the same accommodations as those with visual, neuromuscular or mobility impairments (think of holding a heavy textbook and taking notes while lying flat on your back in bed). Of course, adapted keyboards and other input devices can also help students with arthritis, chronic pain syndromes, and shaky hands.

STUDENTS WITH LEARNING DISABILITIES

The abilities and dis-abilities of students with learning disabilities are extremely varied. While many have difficulty with reading, spelling and/or grammar, others have problems with math, handwriting, scheduling, or auditory processing. The adaptations used by students with learning disabilities vary widely. Electronic and computer based agendas and organizers can serve as cognitive orthotics for students with difficulties keeping organized. Similarly, vocabulary support software with sophisticated word prediction, speech, and highlighting capabilities (e.g., Lorien Systems' textHELP!) is available to students who have various learning disabilities to help improve their written work. In general, adaptations that are helpful for students with visual or hearing impairments are often helpful for students with learning disabilities as well. In addition, a variety of specialised software exists to help remediate and teach academic skills, rather than serve as cognitive tools or orthotics [the Journal of Learning Disabilities contains descriptions of many such applications - the July 1996 issue (volume 29, number 4) was devoted almost exclusively to the use of technology by students with learning disabilities].

WHAT NEXT?

Environments that handicap students with disabilities (cf. Fougeyrollas, 1990) need not exist in the virtual world. In the past, technologies have worked in the service of people with disabilities by reducing or eliminating barriers (Bissonnette, 1995). Learning and information technologies can continue this trend by working for - rather than against - students with disabilities. New information and learning technologies used for the purpose of assisting all people through life-long learning must continue to be inclusive of people with various impairments.

Adaptive technologies for people with disabilities have been designed with the intent of eliminating handicapping environments. Examples of this type of technology are voice synthesisers and computer assisted environmental controls to people who are quadriplegic in order to control their environments. The newer technologies are aiming at enhancing personal autonomy.

The existing trend to adapt mainstream software, on a routine basis, to the needs of people with disabilities has been fuelled by the all pervasive American with Disabilities Act (ADA) of 1990 and by powerful U.S. legislation (Government of the United States, 1996) such as the Telecommunications Act of 1996 (see Bissonnette, 1995 and Bausch, 1994 for an analysis of their political and economic impact). In Canada, while we currently have no such legislation with "teeth," the tendency has been to follow the lead - and use the products - of our neighbour to the south. This, of course, has had a salubrious impact on the education of postsecondary students with disabilities.

For example, Microsoft has built-in adaptations for people with disabilities; these include Windows 95 "accessibility options" which allow users to modify aspects of the keyboard, sound and display as well as commitment to support software developers in making their products accessible (Lowney, 1995; Microsoft, 1995). Companies such as Apple (Beale, 1997) and IBM have made substantial investments in designing accessible hardware for people with disabilities, and efforts are actively ongoing to create learning technologies that can assist people with disabilities (W3C, 1997; Microsoft, 1997a, 1997b). In addition, new specialised technologies have emerged: these include Aurora's communication station - a system of components that can be used to attach augmentative communication devices, laptop computer trays and other equipment suitable for mounting on wheelchairs, beds, and tables (Aurora, 1996a, 1996b).

Bill C78 deals with access issues for Canadians with disabilities. The next Canadian parliament will be asked to strengthen Bill C78 with new legislation know as the "Canadians with Disabilities Act." This new legislation will deal with telecommunication in the broadest sense, and will address topics such as accessibility of digital, computer, learning, and information technologies, including access to the Web. What is particularly interesting is that the proposed legislation is expected to have an enforcement component (i.e., «teeth»).

UNIVERSAL ACCESS/BARRIER-FREE DESIGN

The fast growing world of technology can be a source of great assistance in eliminating barriers for people with disabilities. Alternately, it can create enormous hurdles which would deny access to information - the most valuable commodity of the 21st century. To ensure that people with disabilities are equal participants in the communication and educational modalities of the next century, it is crucial that the concept of universal access be respected; this includes elimination of existing barriers that can limit people in accomplishing required tasks. To achieve this, clear and concise norms are needed to formulate guidelines for all forms of computer and information technologies.

Universal access involves access not only for individuals with disabilities, but also for those that are there to assist them. It recognises that designers of equipment, facilities, and technologies need to ensure that all individuals have access to society's goods and services; this ranges from buildings to conceptions of new equipment. Universal access promotes collaboration between the builders and the users so that the outcome provides an accessible and supportive environment for all. With respect to technologies, an evaluation of what is needed - a «needs assessment» - is an essential first step to ensuring universal access for all.

There has been too much progress, both in technology and in attitudes, to allow for backsliding. What is needed now is encouragement, sensitisation, and the requirement that producers and designers of learning and information technologies incorporate basic accessibility features into their products **on a routine basis**. A fundamental tenet of universal design is that good design is inclusive of all peoples' needs, and that planning a mainstream application that has built-in accessibility features as a matter of course is the most effective design strategy in the long run (Falta, 1992).

Concepts and metaphors from the "universal design" literature indicate that environmental adaptations designed for people with disabilities can benefit other population groups (Falta, 1992). For example ramps built for people using wheelchairs are useful to people with baby strollers, and lower counters are useful for most of the population shorter than 5'5". Our own data on recommendations made concerning what professors could do to make teaching and learning easier and more effective for students with a physical disability also show that most of the suggestions apply equally well to the teaching of nondisabled students (Fichten, Goodrick, Tagalakis, Amsel, & Libman, 1990). Such findings have also been reported for accommodations helpful for students with learning disabilities (Smith, 1993).

Retrofitting software and hardware is a very costly proposition. Designing it to be accessible in the first place, however, will add little to the price of development. Such accessibility features frequently have surprising and unexpected benefits for nondisabled users. For example, Vanderheiden (cited in Bissonnette, 1995) noted that MouseKeys designed as a Windows95 accessibility feature are also used by graphic artists and people doing computer assisted design (CAD). Thus, adaptations of learning technologies to make them more accessible to people with disabilities will probably also benefit other populations.

THE RESEARCH

Use of computer and information technologies by students with disabilities

As we have tried to emphasize, computer literacy and access to the new learning and information technologies are vital for students with disabilities. But are students with disabilities using computer related technologies? What aspects are particularly useful? How are these used? What educational and social goals are met by computer technologies? What are useless but popular computer technologies and what are shortsighted economies?

On the flip side, why do some people who could benefit fail to use computer technologies? How do systemic variables, such as the availability of free Internet access for students and characteristics of provincial programs which supply technology, interact with individual differences, such as computer anxiety, age, and sex to facilitate or hamper the use of computer technologies?

It is one objective of our research to explore these issues. The goal is to provide information needed to ensure that recent advances in computer technologies and in the delivery of postsecondary education and training reflects the needs and concerns of two groups: students with disabilities and the service providers who make technological and other academic supports available.

Equipment, training programs, opinion, technological adaptations, case studies, demonstration projects, web sites, on-line journals and policy statements proliferate. Nevertheless, there is virtually no empirical research which evaluates the use or the utility of computer technologies in the postsecondary education of students with disabilities. Computer technologies are expensive and can contribute to negative experiences and learning outcomes. Therefore, it is important to make available descriptive and correlational data to better advise students, service providers, planners, policy makers, as well as developers and suppliers of both mainstream and adapted technologies.

Computer supported cooperative learning

Another objective is to examine the potential of computer supported cooperative learning to enhance the educational and social outcomes of postsecondary students with disabilities. Johnson and Johnson (1994) stress that sharing information and learning new skills is greatly facilitated by cooperative educational methods. Cooperative learning differs from traditional small group instruction in that in traditional small group learning students may work together to learn the material; in cooperative learning they must (Abrami, Chambers, Poulsen, DeSimone, et al., 1995). Research has shown not only superior academic outcomes for students in cooperative learning groups, but also greater friendship formation as well as human relations and integration benefits compared to traditional learning groups (Bina, 1986; Johnson & Johnson, 1994).

Similarly, there is considerable literature on computer supported cooperative learning as well as on cooperative learning in children with intellectual disabilities (cf. Johnson & Johnson, 1994, Abrami et al., 1995). Nevertheless, almost nothing has been written about the use of computer supported cooperative learning by adult learners with disabilities in postsecondary settings.

Although empirical research on cooperative learning and the use of learning technologies has not yet reached the stage of looking at college students with disabilities, cooperative learning assignments may be especially helpful for postsecondary students with special needs. Building upon the solid bank of research demonstrating the benefits of cooperative learning (Slavin, 1995; Johnson & Johnson, 1994), we will investigate whether the findings generalize to postsecondary students with disabilities.

Recently, researchers have explored ways to combine cooperative learning techniques with computer-mediated communication (CMC) as a means to supplement regular class instruction and as a way to enhance distance education (Abrami & Bures, 1996; Savard, Mitchell, Abrami, & Corso, 1995). In particular, the use of two important aspects of cooperative learning - positive interdependence and individual accountability - have been shown to result in students working to help class members learn while taking increased responsibility for their own learning (Abrami et al., 1995). Positive interdependence requires that group members work actively and purposefully together to learn. Some of the ways that this is accomplished involve having all group members share a common goal (goal interdependence), having group members share resources (resource interdependence), dividing the task into specific chunks (task interdependence), assigning specific roles for each group member (role interdependence), and assigning grades based on the group's performance (reward interdependence). Individual accountability facilitates positive interdependence by ensuring that all group members are responsible both for their own learning as well as for helping other group members learn (Abrami, Chambers, Poulsen, DeSimone, et al., 1995).

The implementation of computer supported cooperative learning can provide both advantages and disadvantages for learners with disabilities. One of the major social benefits of virtual collaborative groups is that learner variables such as sex, age, and disability are not immediately evident to other group members. Thus, biases in interactions with people with disabilities are not as likely to apply, and students with disabilities do not start out from an unequal status position. Another advantage is that group members can be assigned tasks which they have the abilities to accomplish. One would expect that certain types of collaborative groups would particularly interesting for people with disabilities (e.g. "jigsawed" groups), as these allow nondisabled members to research information which is difficult for the student with a disability to obtain, and allow students with mobility, visual, hearing, etc. impairments to provide information components which are feasible for them to research.

Implementing computer supported cooperative learning requires that instructors consider very carefully how to structure the various components of the collaborative learning experience. They need to ask themselves questions such as: What would be the optimal group size be? What types of team-building activities would be most appropriate? What roles might be best suited to the group members given their particular strengths and weaknesses? What format should the evaluation take to best assess the learning that occurs? How should professors adapt their roles to meet the needs of all of the students in the group? These are the same questions that any instructor should ask when implementing any computer supported cooperative learning but they may be critical when using these strategies to teach students with disabilities.

One of the disadvantages of computer supported cooperative learning may arise from one of the factors that can be an advantage. The anonymity of the media means that students with disabilities may not receive support and assistance from their peers that might be available if the nature of their disability was evident. Under what circumstances computer supported cooperative learning is beneficial both for students with disabilities as well as their classmates is an empirical question that we plan to investigate. Because computer supported cooperative learning holds promise in facilitating the academic and social integration of college students with disabilities, we plan to evaluate academic (individual, group) and social outcomes of in vivo vs virtual problem solving groups (both jigsaw and other types) where some groups know about members' disability status while others do not.

On the Internet

On the Internet, disability relevant information abounds. For example, in addition to countless web pages, the most recent update of the list of health and disability related mailing lists contains over 300 entries (Rowley, 1997). Having access to such a wealth of information is truly empowering, as is the anonymity of e-mail and chat groups. "On the Internet nobody knows you're a dog" or a knockout, or a male, or a female, or old, or wealthy, or a person with a disability. Neither appearance nor the presence of an impairment is relevant. This permits exciting new developments in communication, collaboration, shared knowledge, and life-long learning.Therefore, in the context of our larger program of research, we also plan to evaluate the impact of the Internet on the social and economic aspects of the lives of students with disabilities.

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