JOURNAL OF DISTANCE EDUCATION
REVUE DE L'ÉDUCATION À DISTANCE
SPRING/PRINTEMPS 2005
VOL. 20, No 1, 84-103

The Roles of Emerging and Conventional Technologies in Serving Children and Adolescents with Special Needs in Rural and Northern Communities

Judy Roberts, Julia O'Sullivan, and Joan Howard

Abstract

More than a century of Canadian and international experience and research in open and distance learning indicates that traditional and emerging technologies can be used effectively, alone or in combination, to provide access to services and education for adults and children living in rural and northern communities. However, although there is an emerging literature about children with special needs, technology, and the North, it is at a preliminary stage and is fragmented across many professional communities, one of which is increasingly the field of open and distance learning. Research studies, pilot projects, and written reports need to be expanded and shared as a matter of priority. With appropriate research support and policy review, the promise of digital technologies can be realized to serve children with special needs, their families, teachers, and health care providers who live in rural and northern communities.

Résumé

Plus d'un siècle d'expériences canadienne et internationale et de recherche relatives aux systèmes d'apprentissage ouvert et en ligne nous ont enseigné que les hautes technologies et les technologies traditionnelles peuvent être utilisées efficacement, seules ou ensemble, pour offrir l'accès aux services et à l'éducation pour les adultes et enfants vivant dans des communautés rurales et du Nord. Cependant, malgré l'existence d'une littérature émergente relative aux enfants ayant des besoins particuliers, à la technologie et au Nord, celle-ci en est encore au stage préliminaire et est éparpillée dans de nombreuses communautés professionnelles, en particulier dans le champ de l'apprentissage ouvert et à distance. Les recherches, projets pilotes et rapports écrits doivent être développés et partagés prioritairement. Grâce au soutien à la recherche et à une révision des politiques appropriées, les potentialités des technologies numériques peuvent être réalisées, au service des enfants ayant des besoins particuliers, ainsi que leur famille, professeurs et fournisseurs de soins de santé habitant dans les communautés rurales et du Nord.

Introduction

Open and distance learning (ODL) has a long history in many countries of serving the needs of those who lack access to education because of geographic or time constraints. Authors such as Moore and Kearsley (1996), Rumble (2001), and Mugridge and Kaufman (1986) have documented a variety of traditional and emerging technologies from paper to the Internet. Adaptive or assistive technology ranging from a hearing aid to a wheelchair is also available to serve those with disabilities. In the past, these two fields of ODL and disabilities have remained separate, although examples could be found of innovative uses of ODL to serve those with special visual and hearing losses (Roberts, Brindley, & Spronk, 1998). Recently, however, these two fields seem to be converging from the perspective of both government policymakers and researchers.

Empowering children with special needs and those with disabilities, especially those in rural areas, through the use of learning technologies has been addressed by groups as diverse as the Ministerial Advisory Committee in South Australia (2000) and Canada's Centre of Excellence for Children and Adolescents with Special Needs (http:www.coespecialneeds.ca). Researchers such as Kinash, Crichton, and Kim-Rupnow (2004) have reviewed both the online and disability literatures and argue that these two previously disparate communities can and should work together if the potential of online technologies is to be maximized for both groups.

In this article, based on research done under contract to Canada's Centre of Excellence for Children and Adolescents with Special Needs, we review current examples of learning technologies used in special education that involve blended classroom and distance approaches (i.e., flexible learning) or "purer" forms of ODL.

Purpose

In this article we highlight the research findings about the types of technology that have been used successfully for service and education applications related to children with special needs, their families, teachers, and health care team living in the north and to relate these findings to research and practice that could occur in ODL. We draw conclusions about lessons learned to date and about the directions that future research and practice should take if we are to have a solid understanding of how and when ODL and/or blended flexible approaches can be taken to serve children with special needs.

Methods

The findings discussed in this article are based on an extensive six-month research process, described in a separate report (Roberts, 2004), which included literature and database searches, telephone and e-mail interviews with researchers and practitioners in Canada and the United States, and in-person and telephone meetings with various stakeholders in the Centre of Excellence for Children and Adolescents with Special Needs. Key definitions were established at the outset that reflected both the Centre's view of children with special needs and conventional practice in ODL.

Definitions

The term *special needs* is used to encompass all children and adolescents who require additional public or private resources beyond those normally required to support healthy development (OECD, 2000). It includes children and adolescents who require additional resources because of exceptional gifts and talents; physical, sensory, cognitive, and learning challenges; mental health issues; and problems due to social, cultural, linguistic, or family factors.

Children and adolescents are defined as infants, preschoolers, adolescents, and youth up to age 21. In the literature search, any article containing the word *rural* was included because so many definitions of rural are used in the literature. Similarly, any article containing the word *northern* was included, again because of the lack of any consistent international definition for northern regions.

Information and communications technologies (ICT). Both traditional and emerging technologies can be included under this broad term; lessons learned, best practice, and critical success factors from the former can be applied to the latter.

Emerging technologies. These are defined as technologies that use digital signals to convey text, audio, and visual materials, including both wired and wireless technologies, for example, the Internet, especially broadband and wireless applications, digital radio, e-books and audio and videoconferencing over the Internet. Two specialized subsets of emerging technologies are: first, adaptive technologies, designed to adapt to the needs of learners and based on inclusive design principles (other terms include assistive technologies and universal design), include keyboard and mouse systems, optical character and voice recognition software, and hardware and neural interface devices. The Adaptive Technology Resource Centre at the University of Toronto (http://www.atrc.utoronto.ca) is one example of a specialized facility in this field. Second are immersive multimedia technologies currently in prototype development. In Canada, for example,

a major funder of such work is CANARIE Inc. (http://www.positioning-research.com/feast/HTML/what.htm).

Traditional technologies. These are defined as technologies that use analog signals to convey text, audio, and visual materials: for example, telephone conferencing, correspondence courses, instructional television, and so forth.

Distance education (DE). In Canada DE dates to 1889, when Queen's University offered the country's first print correspondence course (Roberts, 1996); internationally, it is believed that the first correspondence course might have been offered as early as the mid 1700s (Moore & Kearsley, 1996). Although various terms have been used for the use of technology in education, for example, distance education, tele-education, e-learning, blended and distributed learning, and flexible learning (Bates & Poole, 2003; Moore & Kearsley, 1996; Rumble, 2001) and distinctions among them are sometimes blurred, certain features are common to all definitions.

1. Distance of place and/or time are central. Historically, the extent of face-to-face interaction in a DE program varied; today a blending of distance online learning with classroom contact is receiving growing attention in both DE and in-person research and practice;
2. Some type of technology is used to facilitate at least one of several types of interaction such as learner-content, learner-teacher, and learner-learner (Anderson, 2003; Moore & Kearsley, 1996);
3. The social goal of broadening access to education for those unable to attend an educational institution in person was a key driver in developing the field, which meant that projects often took place in rural and northern regions.

Telemedicine/telehealth/e-health. Some of Canada's earliest sustained work in this field dates to the mid-1970s when Memorial University of Newfoundland and Labrador and the University of Western Ontario mounted short-term telemedicine projects using one-way video and two-way audio via satellite to deliver continuing education for health professional and patient consultations respectively. Each project stimulated sustained research and service delivery programs. Two other pioneers in this field continue as leaders today: the Hospital for Sick Children in Toronto and the University of Calgary (2003), which has defined telehealth and e-health synonymously as "the use of information and communication technology (ICT) to deliver health services, expertise and information over distance, geographic, time, social and cultural barriers. Telehealth encompasses Internet or web-based e-health as well as video-based applications" (p. 7).

Literature Search

The literature search, conducted in January-February 2004, included journal articles, project reports, and conference proceedings from a wide variety of fields including, but not limited to, special needs, e-learning and distance education, Aboriginal communities, circumpolar health, e-health, emerging technology developments, and government. Sources included published as well as "gray" literature, in paper or electronic format, in both French and English, from 1995 onward.

Data sources consulted included education and health databases such as ERIC, CBCA (Education), Education Index, and MEDLINE; university holdings (to capture most of the gray literature not likely to be indexed in databases); relevant links from the *Links* page of the COE Web site; and government sites in Canada and abroad.

Although the terms that follow are based on a diagnostic-remedial model that does not reflect the Centre's ecological model, they had to be used in order to locate materials in the literature. Special-needs key words included, but were not limited to, special needs, attention deficit hyperactivity disorder, autism, chronic middle ear disease (otitis media), giftedness, talent, reading, literacy, hearing impaired, hearing loss and learning, visually impaired, orthopedic, learning disability, mental retardation, cerebral palsy, developmental delay, traumatic brain injury, children's rehabilitation, orthopedic, suicide, child abuse, substance abuse, inhalants, fetal alcohol syndrome, obesity, special education, disabilities, accessible technology (for people with disabilities), public health or community health, professional development, practicum, teacher training. Medical needs such as epilepsy, diabetes, and cystic fibrosis were excluded on the grounds that their effect on a child's education would be captured in the key words proposed for the research.

Our goal was to find the subset of literature that emerges when these special-needs key words are qualified by the following categories: distance and open learning, e-learning; telemedicine, telehealth, e-health; northern, circumpolar; rural; Aboriginal/indigenous/First Nations/Metis/Inuit; and assistive/adaptive/universal design technologies.

Findings

The promise of today's emerging digital technologies builds on past and current success in using traditional technologies. Two types of professional practice, historically known as distance education and telemedicine, have applied both new and traditional technologies to serve children with special needs. Findings about service and education applications are presented here in terms of what is known about how traditional and

emerging technologies can be used to serve children with special needs in rural and northern communities.

Services

Services are defined as assessment, intervention/treatment, and support to both children and their families. The few studies identified in the literature search indicate that both traditional and emerging technologies have been used successfully; however, they tend to focus on just one or two subsets of special need such as the hearing impaired and generally lack validated research instruments and frameworks. On the other hand, some argue that the anecdotal evidence is clearly positive and that rural schools do not have the luxury of waiting for proof before maximizing the use of technology to meet their needs (S. Astley, personal communication, March 1, 2004).

Using technology to provide services has indirect as well as direct benefits for those living in the north. For example, Fisher, Pearce, Statz, and Wood (2003) found that retention of qualified health care providers in frontier areas of Alaska improved significantly with the introduction of narrow bandwidth telemedicine work stations at approximately 30 remote sites in rural Alaska including remote Native villages, regional health care facilities, and the Alaska Native Medical Center. Results showed positive effects for the 1,000 health care workers participating in the study, citing in particular better access to information generally and a reduced sense of professional isolation. A University of Washington School of Medicine rural use study, using low-cost, low-bandwidth videoconferencing technologies for telemedicine consultations, found high levels of satisfaction among both physicians and their rural patients (Norris et al., 2002).

This same technology may also enable teachers of children with special health needs to provide assessment and treatment services. Building on work dating to 1996, when videoconferencing was used in combination with in-person sessions for pediatric consultations to primary-care physicians and clinics throughout the Pacific Northwest, Washington State University has extended its use of videoconferencing to schools, particularly to teachers of children with special health care needs (S. Sulzbacher, personal communication, February 4, 2004). The creation of a low-cost statewide video network (http://www.k12.wa.us/k20/) was a key factor in making such an initiative feasible. Highlights of the initial evaluation results, of which a high proportion (83%) related to referrals about psychiatric, behavioral, or learning problems, indicated (a) satisfaction with the service, with the overall consensus being that the technology "significantly impacts on or could impact on treatment provided in isolated rural communities" (p. 36), particularly in schools with low-in-

cidence special need; and (b) success in providing consultation services that clarify a diagnosis or provide treatment recommendations (Sulzbacher, Mas, Larson, & Shurtleff, 2004). The article notes that "nearly all published tele-health research has focussed on patient and provider satisfaction … Further research is needed … to demonstrate changes in teaching strategies, behavior management tactics, or medication regimens" (p. 37).

Another project targeting deaf and hard of hearing people explores the potential of the latest immersive technologies that bathe users in virtual reality, stimulating all the senses. The Remote Video Interpreting (RVI) using CA*net 3: Health Access for Deaf People project, funded by CANARIE, Inc., is an example of the type of research that can occur only in southern urban areas with access to the latest technology (http://www.canarie.ca/funding/anast/projects.html). Based on the rationale that sign language interpretation services are both difficult to obtain and costly, this project will develop a method of facilitating direct communication between an orthopedic surgeon and deaf patients in Montreal using an experienced sign language interpreter in another province. Both technical and human interface parameters associated with real-time delivery of sign language interpretation services will be explored. The lead partner is McGill University (http://ww2.mcgill.ca/icc/canarie/signLanguage/index.htm).

Support to families with a child with special needs has been provided using both traditional technologies such as videotapes and telephone and emerging technologies such as Internet and fiberoptic ISDN lines. Provision of support to parents of deaf and hard of hearing children living in rural areas was the most frequently mentioned application. Three studies in Canada reflect those done elsewhere and illustrate the range of technologies that can be used successfully.

1. A 1977-1978 pilot study used monthly videotapes and weekly telephone sessions to counsel parents of preschool deaf and hard of hearing children in rural Newfoundland and Labrador. The study found that 12 of 23 parents made considerable improvements by the end of the program, significantly in ensuring that the children wore their hearing aids and that the aids were maintained in a functional state (House & Neville-Smith, n.d.). The children themselves showed improved speech and language ability in pre- and post-assessments (12-month interval) that was statistically significantly greater than a panel of independent experts had predicted.
2. The Manitoba School for the Deaf (MSD) has used videoconferencing via the Internet to support deaf and hard of hearing students in Thompson, northern Manitoba. Students connect with a deaf educa-

tion consultant in Winnipeg for supplementary activities using the school computers that are equipped with desktop video CU-SeeMe and Ivisit (Mac) at 128 Kb. The first pilot project began in 2000 with no special funding. No formal evaluation was done. The MSD hopes to move from desktop to videophone technology in the future as they believe it will provide a more stable conferencing environment (N. Dupasquier, personal communication, February 11, 2004).

3. A British Columbia Provincial School for the Deaf (BCSD) pilot project in January-May 2002 provided 14 one-hour videoconferencing (VC) sessions to four other BC centers. Students attended sessions at the VC site with their itinerant teacher. Although no formal evaluation was done, questionnaire survey responses indicated that "the sessions were a tremendous success and were well received by students and teachers" (C. Gunter, personal communication, February 18, 2004). Costs of the pilot came out of the BCSD budget, with IT partners and Ministry of Education supplying bridging costs, room rental/setup fees, and long-distance telephone costs. Funding was sought to continue the program, but was not received.

Although not yet documented in the literature, the promise of emerging technologies as tools to link parents and families in online support groups is clear. Groups are available on line to support a wide variety of special needs such as the deaf and hard of hearing (http://www.hearingexchange.com/chat/chat2.shtml) and people with learning disabilities (http://www.ldresources.com/articles/support_groups.html). Our search, however, found nothing specifically related to those living in northern and rural settings. Online technology seems promising for those with access to computers and the Internet. We hope that research partners will come forward who can more formally indicate where the areas of greatest promise lie, what conditions lead to success, and what effect such online support has on children and their caregivers.

A key issue for decision-makers is how to choose the appropriate technology, given that the research on using behavior modification criteria has found that the type of technology used does not affect the program outcomes. Glueckauf (2002) and his colleagues at the University of Florida concluded that "mode of delivery did not influence initial treatment outcomes or adherence" (p. 49). The researchers compared home-based videoconferencing, home-based speakerphone counseling, and office-based counseling as means of providing family counseling for 22 teenagers with epilepsy and their families over six sessions. All participants reported significant reductions in both problem severity and frequency across all three treatment modes, as well as increases in prosocial be-

haviors during the treatment period and at six-month follow-up, although no change in the problem behavior as such was reported over time.

Randomized trials are now underway in Nova Scotia to evaluate telephone and Web-enabled interventions for five primary care mental health problems including behavior problems in preschool children and attention deficit disorder in school-aged children. Results are expected in 12-18 months. This Family Help program is part of a larger Bringing Health Home Project funded by the Canadian Institutes of Health Research, NS Health Research Foundation, Nova Scotia Health Districts 4, 5, and 6, HRDC and the Hospital for Sick Children Foundation (Principal Investigator is Patrick McGrath, Canada Research Chair, IWK Health Centre in Halifax). Funding is also being sought from the Ontario Ministry of Health by McGrath in collaboration with Bruce Minore (Lakehead University) to adapt the telephone-based approach to Aboriginal and non-Aboriginal children in northern Ontario (B. Minore, personal communication, February 11, 2004).

Education

Although important learning takes place in nonformal settings, education is defined in this article as occurring in the formal education system. Findings are highlighted from the limited literature on the use of traditional and emerging technologies to offer education to teachers of children with special needs, health care workers, and children living at a distance from specialized centers. Use of technology to serve children with special needs straddles both distance and classroom applications, including specialized fields such as adaptive technologies.

A research team at the Hospital for Sick Children surveyed four southern Ontario schools in 2003 to evaluate the effectiveness of Web-based education to help teachers, administrators, and staff better understand at-risk youth in the school system. Pre- and post-test data showed "a significant change in staff understanding of recognizing warning signs in students at risk for self harm and in staff confidence (self-perception) regarding the area of self harm in adolescents" (McClure, Chaban, & Warner, 2004, p. 4). Currently, the Hospital is exploring the possibility of using distance education to deliver workshops to teachers of ADHD children in northern Ontario (P. Chaban, personal communication, February 10, 2004). The hospital's partner was the Education Network of Ontario (ENO), which provides a community of practice for educators and caregivers called Child and Youth Suicide Intervention and Prevention, which offers access to Hospital for Sick Children Resources (the featured topic was ADHD in June 2003, the most recent material on the site) plus password-protected online Forums.

In Nova Scotia, a team of researchers, psychologists, speech-language pathologists, and occupational therapists created educational text and video materials as an orientation to effective practices for children with autism in child care settings. Two forms of instruction were evaluated: a traditional technology combination of print workbook/videotapes and an emerging technology pairing of online (WebCT)/video. Pre- and post-assessments of 89 participants using the Knowledge of Autism and Knowledge of Behavioural Principles measures provided statistically significant evidence that both versions of the training materials were effective in increasing the participants' understanding of autism and of effective practices for children with autism in child care settings. More important, qualitative evaluation indicated that participants tried new recommended strategies and acquired increased confidence in their ability to provide appropriate educational accommodation to young children with autism. The revised training package is now being distributed in DVD and CD-ROM formats. This initiative is being undertaken by one of the Centre's partners, Mount Saint Vincent University. Called Supporting Children with Autism in Child Care Settings: Distance Education Strategies (SCACCS), the project was funded by Human Resources Development Canada and carried out by a partnership of COEEI researchers Mary Lyon and Kim Kienapple, and Isabel Smith and Christine Ellsworth, of Dalhousie University and the IWK Health Centre.

More activity may well be occurring than is indicated in the literature. For example, in Canada, the Manitoba First Nations Education Resource Centre is collaborating with the University of Manitoba to offer special education qualification to teachers in First Nations schools using a combination of in-person classes, satellite broadcasts, and CD-ROMs to train teaching and rehabilitation assistants (D. Shackel, personal communication, May 6, 2004). There may well be similar developments in other countries.

In contrast to the situation for adults who work with children with special needs and who are isolated from urban educational opportunities, technology has long been used for children with special needs, especially in the classroom. Radio and audiocassettes were, and still are, valuable tools for those with visual losses, as are FM radio systems for those who have hearing losses. However, emerging computer technologies are rapidly changing the options available for teaching learners with special needs in the classroom. Two research projects using emerging computer technology targeted to the education of classroom-based children with specialized needs serve as examples. Results are pending from both studies.

In September 2003, the Ontario Institute for Studies in Education of the University of Toronto (OISE/UT), with financial support from the Office

of Learning Technology—New Practice in Learning Technologies, began to work with emotionally troubled adolescents (14-16) in a rural Aboriginal community in British Columbia, testing a knowledge-building pedagogy supported by Knowledge Forum®) technology. Working with the Elder Advisory Board, which constructed a recovery program for youth with an array of problems including alcohol and drug use, physical and sexual abuse, and a high rate of violence and suicide, OISE/UT researchers and local schoolteachers are working with youth in the recovery program to improve their reading, writing, and technology literacy. Although a full analysis of the qualitative and quantitative data is not yet available, initial data seem positive (M. Lamon, personal communication, April 30, 2004).

Since 2001, selected teachers in the state of Washington, each with five learning-disabled students in grades 4-12, were given special technology training and tools. Classrooms were equipped with desktop computers and accessories, each teacher was given a notebook computer, and the targeted learning-disabled students were given a notebook computer loaded with adaptive software. Teachers used "anchored instruction" methods and video production to promote mathematics learning (http://ncrel.org/engauge/resource/stories/nolimit.htm). Formative and summative evaluations are being carried out by RMC Research Corporation to examine both the implementation process and the outcomes of the program. Other evaluation activities will be carried out by Central Washington University, Western Washington University, and the University of Wisconsin-Madison. Evaluation tools include teacher surveys, interviews, classroom observation, monthly evaluation logs completed by teachers, and student surveys, as well as pre- and post-tests to assess their math skills. This project is funded by the US federal Enhancing Education Through Technology (EETT) program and is part of the New Outcomes: Learning Improvement in Mathematics Integrating Technology (NO LIMIT!) program in the state of Washington.

In addition to this type of work, which seems to focus on how standard computer equipment can be used alongside specialized adaptive technology in classrooms with mixed groups of students, other specialized advanced technologies are emerging. Three examples illustrate this.

1. All special-needs students in schools in 54 Manitoba First Nations communities have computers equipped with adaptive software made by Bridges Canada (http://www.bridges-canada.com) that will support both Roman and syllabic orthography (D. Shackel, personal communication, May 6, 2004). The Manitoba First Nations Education Resource Centre (http://www.mfnerc.com) employs 50 specialists, 10 of whom focus specifically on the 1,600 children with special needs.

2. Language instruction in oral deaf education is using an animated conversational agent, Baldi, in classrooms and the speech lab (Stone, 2001). Developed by a partnership of Tucker-Maxon Oral School, Oregon Graduate Institute and University of California at Santa Cruz, and Intel, Baldi functions as an instructional assistant who offers deaf students the chance to practice language skills using listening, lipreading, and talking.
3. Students whose condition requires extended absences from the classroom may benefit from technologies such as PEBBLES. The Providing Education by Bringing Learning Environments to Students (PEBBLES) project uses a modified videoconferencing (VC) system in which the child is represented by and controls a robot-like mobile unit located in the classroom. This allows students who must stay at home or in hospital to "attend" school through the VC robot (Fels, Williams, Smith, Treviranus, & Eagleson, 1999). A third-generation robotic tool is currently being tested in Toronto by a research partnership between the Adaptive Technology Resource Centre, University of Toronto, Ryerson University, and Telbotics.

In addition to this work taking place at the elementary and secondary levels, a literature addressing the intersection of online learning and disabilities has developed over the past three years, primarily at the postsecondary level. One of the drivers, at least in the US, seems to be legislation mandating that the individuals with disabilities be given equal access to education; another driver is the capacity of computer technology itself. Almost 60% of the literature at the intersection of online and disability practice can be found in proceedings from the Persons with Disabilities Conferences at California State University of Northridge (Kinash et al., 2004). "The resounding theme throughout the literature is that improving accessibility of online learning for students with disabilities will promote best practices in online learning for all students" (p. 5). A key reason for this assertion is that the planned redundancy of technologies (print, audio, and video) "in one course" needed to serve persons with disabilities means that the same course contains modes that will support the various learning styles of able learners. Kinash et al. cite O'Connor's (2000) view that persons with disabilities are really early adopters of media-rich technologies and function as the leading edge compared with more conventional learners. Proceedings from the conferences are thus a rich resource to be mined by researchers and policymakers (http://www.csun.edu/cod/conf/proceedings_index.htm).

However, Edmonds (2004) cautions that legislation mandating that students with disabilities be served is still a confusing patchwork of federal and state laws in the US and argues that the policy environment

has to be streamlined in order to ensure that technology will be installed *universally*, so that access to education is improved for those with special needs. The fact that technology exists, Stone (2001) argues, does not necessarily mean that institutions are adopting it, or that all accessibility and conversion issues have been solved to make it relatively easy for teachers to develop courses that are universally accessible. In Canada, a similar "confusing patchwork of federal and provincial/territorial laws" affects special needs education, even though these laws have a different focus from those of the US legislation. Moreover, the fact that policy frameworks are in place does not necessarily mean that activities take place or that they are documented. For example, in Canada, the Montreal School Board (MSB) has policies in place for ICT and children with special needs, but no initiatives have been evaluated and documented and there is no northern focus. Congruent with Kinash et al.'s (2004) thesis, the MSB guidelines for technology and special needs serve as a catalyst for innovative teaching and learning practices that can respond to a wide variety of individual and local needs beyond the needs of those with special circumstances (Chouinard, 1998).

Another area of converging interests exists between the disabilities, Aboriginal, and online communities (D. Scribe, personal communication, May 4, 2004). The First Nations Disabilities Association of Manitoba completed a needs assessment in 2000, the first of its kind in Canada. The Disabilities Coordinator of the Treaty 7 Economic Development Initiative in Alberta is beginning to explore the potential of online learning. And both organizations are now realizing that they may be able to supplement and complement each other, building on the pioneering work that each has done to date.

Given the small body of work that relates specifically to the area of education, special needs, technology, and rural and northern communities, it is fortunate that there is a long history of the use of technology in rural and northern education dating to the early 1900s. Initially based on traditional technologies such as print correspondence and radio courses, programs are now capitalizing on emerging technologies such as the Internet (Kim-Rupnow, Dowrick, & Burke, 2001; Roberts et al., 1998). For children, three initiatives highlight developments both in Canada and abroad.

1. Early initiatives were typically undertaken by ministries of education to serve children isolated by geography and/or illness. British Columbia's work is typical; it offered its first print course in 1915 (McKinnon, 1986) and its first radio broadcast in 1927 (Fleming & Toutant, 1995).

2. Later initiatives such as the Newfoundland and Labrador Rural and Small Schools project (Boone & Keough, 1994) used newer technologies such as telephony, audiographics, and computers to serve multiple needs in small rural schools (almost two thirds of all schools in the province are rural, and many of these are small and located in isolated communities). These technologies have been used to facilitate both course delivery to students and teacher education.
3. Australia's R-10 School (for students from reception, or age 5 years, to year 10) is part of the multi-campus Open Access College (OAC) of the Department of Education and Children's Services, South Australia. OAC began in 1991, growing out of Australia's School of the Air experience, which dates to 1951. Today the OAC uses a diversity of delivery modes: audioconferencing, telephone lessons, face-to-face camps, and electronic communications. Although there is no special focus on children with special needs, the school caters to a diverse community of learners, including those who cannot access a program at their local school due to "special circumstances" as well as geographic isolation (http://www.assoa.nt.edu.au).

Other examples from teacher education to formal degree programs illustrate developments in the application of traditional and emerging technology to adult education. Teacher education was one of the first applications of distance education (Perraton, 1993) and continues to be an area of significant activity (Robinson & Latchem, 2002). Started as print correspondence courses, teacher education initiatives now embrace new ICT when it is available; for example, Passmore (2003) identified over 15 articles on the topic of teacher education and videoconferencing. Research has indicated that no single technology is necessarily more effective than another; the critical success factor seems to be how any given technology is used, not which technology is used.

A mixture of technologies is often required. Gillis, Jackson, Braid, MacDonald, and MacQuarrie (2000) studied formal degree programs and noted that a mix of technologies seemed to be preferred by the students and necessary to the pedagogy. Russell and Perris (2003) make similar points when studying mentoring in rural and urban community nursing using the Internet. They also noted the importance of a collaborative model of learning. It is also important to note that because many so-called distance or online programs have an in-person component and many campus-based programs now mandate some online activity, the distinction between distance and in-person learning may be blurring for many learners, particularly those in urban settings.

Distance education is an effective approach as measured by student achievement (final course grades) regardless of which type of technology

is used. For example, two thirds of 86 experimental and quasi-experimental studies that met inclusion criteria for a meta-analysis demonstrated that students taking courses by distance education outperformed their counterparts enrolled in traditional courses (Schacher & Neumann, 2003). This historical finding is being nuanced as research is completed using the newer digital technologies. For example, a participant in the 2003 e-Learning Summit in Sestri Levante, Italy, noted that researchers were reporting that e-learning compresses the Bell curve and seems to be particularly effective for those at the lower end (J. Treviranus, personal communication, March 11, 2004). There may also be differences among technologies in terms of issues such as time taken to master content or facilitation of collaborative learning that indicate that independent online study (drill and practice) and networked technologies do have some unique strengths compared with either in-person classroom learning or other technologies. Finally, debate continues about the validity and reliability of the research methods and frameworks used in distance education.

A final point arises from using emerging technologies such as the Internet and the Web as tools for parents to seek information related to their children's needs. A key issue is the user support provided to parents if they are to make effective use of such resources. Findings from a study on early childhood education illustrate critical success factors. Cook, Rule, and Mariger (2003) evaluated a Web site on recommended practices in early childhood education. They cite a number of important database design principles for adult parent learners:

> In addition to design that incorporates basic usability concepts … a variety of tools and techniques that can enhance adult learning. These include (a) structured, discrete units of instruction, (b) guided instruction, (c) appropriate use of hypermedia, (d) encouragement of reflection, (e) provision of resources, and (f) communication with instructors and peers. (Section 3, para. 3)

Formative evaluation data were collected from 14 parents as a Web site was being developed for them.

> Only one major issue was noted: Approximately half of the (parent) evaluators found it difficult to download and access the videos. This suggests that, even though delivery of video-based content has improved in ease and simplicity, it remains a difficult and complicated process for many individuals. (Section 9, para. 1)

This caution from a US study of computer-literate adults with the connectivity to download videos is particularly relevant to rural and northern communities where levels of computer literacy and connectivity will affect the usefulness of online databases.

Discussion

Both traditional and emerging technologies seem to have a role to play in providing treatment, assessment services, and education to children with special needs living in rural and northern communities. Even this brief review shows that the benefits and challenges of using technologies in the special needs field are somewhat similar to those in ODL generally.

Benefits of using technology to deliver services include elimination of the need for patients to travel, increased retention of health professionals in remote areas, high levels of satisfaction among users, improved patient behavior regardless of which technology is used, and improved access to information through use of the Internet and the Web. Benefits of using technology to deliver education include increased staff understanding of how to recognize warning signs of self harm and increased self-confidence in staff dealing with at-risk youth. The special-needs community is learning, as did ODL researchers, that knowledge can be acquired regardless of the technology used; there is no single magic-bullet technology. Finally, and perhaps most intriguing for the ODL community, emerging adaptive technologies that contain "planned media redundancy" to meet varying levels and types of special needs could be ideal tools for more easily accommodating varying learning styles. Previously, physically different devices (i.e., a radio and a book) had to be used; in future, one appliance (i.e., a computer) will be able to present a course in either text, video, or audio format using cards such as Canada's Web-4-All (Euteneier & Potvin, n.d.).

Challenges include the lack of established research frameworks to assess the socioeconomic benefits of telehealth in general and in the special-needs field in particular. Moreover, many promising special-needs field trials were not formally evaluated. From a practical perspective, however, the need to gather research data to inform decision-making must be balanced against the immediate needs in northern and rural communities. Those from the special needs field who are new to ODL find the lack of consensus on the validity of much distance education research challenging. The difficulties inherent in evaluating and attributing results to one factor (e.g., technology) in a multifactoral process such as education may not be as transparent to those whose context is that adding a single technology such as a radio to a classroom for children with hearing losses can make an immediate and measurable difference. Furthermore, many jurisdictions face the challenge of uncoordinated legislation and scattered funding programs that affect children with special needs.

There are a few promising indicators. Future promise can be seen in significantly lower costs of technologies such as videoconferencing cameras and networks and the fact that well-designed research targeted to

children with special needs is underway in a few places. Moreover, if future research can confirm successful outcomes regardless of the type of technology used, then perhaps the North's current lack of access to emerging technology (Stapleton, 2001) may not prejudice the quality of outcome that can be achieved using existing technology until the access issue is resolved. Future promise can also be seen in the fact that the online and disability education fields seem to be finding points of convergence. It is being argued, for example, that special needs stakeholders will be key early adopters of the expensive, immersive technologies in today's research laboratories, thus testing multisensory technologies that will be able to meet diverse learning styles in the general population. The payoff to supporting research into technology and children with special needs could be much broader than previously expected.

Conclusions

Information and communications technologies (ICT) have a critical role to play in offering services and education to children with special needs, their families, health care providers, and teachers, particularly when they live in the northern and rural communities. Although literature related specifically to technologies serving special-needs stakeholders in the North is not extensive, the ODL research on using ICT to provide services and education to those in rural and northern regions dates at least to the late 19th century and points to approaches that could and should be tried to serve children and adolescents with special needs. The research highlighted in this article indicates that those in the special needs and disabilities fields who have used traditional and emerging learning technologies have not labeled their work as involving ODL, nor have they published in ODL journals—and vice versa. These two communities have worked in neighboring silos whose "walls" are only now becoming permeable. If the publication of this meta-analysis contributes to this process, it will have served a key purpose envisaged by those who initially commissioned the research excerpted in this article.

Acknowledgments

The authors acknowledge the contributions of the National Research Coordinating Committee (NRCC) and the Emerging Technology Consulting Group (ETCG), as well as other consultants to, and staff of, the Centre of Excellence for Children and Adolescents with Special Needs. For information on the work of Centre, please visit the Centre's Web site at http://www.coespecialneeds.ca. The authors also acknowledge the financial support provided to the Centre by Health Canada; however, the results and conclusions are the authors' alone, and no official endorsement by Health Canada or the Centre is intended or should be inferred.

References

Anderson, T. (2003). Modes of interaction in distance education: Recent developments and research questions. In M.G. Moore & W.G. Anderson (Eds.), *Handbook of distance education* (pp. 129-144). Mahwah, NJ: Erlbaum.

Bates, A.W. , & Poole, G. (2003). *Effective teaching with technology in higher education: Foundations for success*. San Francisco, CA: Jossey-Bass.

Boone, W., & Keough, E. (1994). The challenge of providing equality of education opportunities for secondary students in small schools in rural Newfoundland and coastal Labrador. In *Distance! Quelle Distance? Résumé des communications/Abstracts* (p. 16). Ottawa: Canadian Association for Distance Education/L'association canadienne de l'éducation à distance.

Chouinard, J. (1998). *L'outil informatique comme catalyseur du renouveau pédagogique et amorce de réponse aux besoins du milieu*. Montréal, QC: Commission scolaire de Montréal (CSDM).

Cook, R., Rule, S., & Mariger, H. (2003, spring). Parents' evaluation of the usability of a Web site on recommended practices. *Topics in Early Childhood Special Education*. Available: http://www.findarticles.com/

Edmonds, C.D. (2004). Providing access to students with disabilities in online distance education: Legal and technical concerns for higher education. *American Journal of Distance Education, 18*(1), 51-62.

Euteneier, L., & Potvin, M. (n.d.). *Web-4-All: Web access through sight, sound and touch*. Ottawa: Web Accessibility Office, Industry Canada.

Fels, D.I., Williams, L., Smith, G., Treviranus, J., & Eagleson, R. (1999). Developing a video-mediated communication system for hospitalized children. *Telemedicine Journal, 5*(2), 193-207.

Fisher, D., Pearce, F., Statz, D., & Wood. M. (2003). Employment retention of health care providers in frontier areas of Alaska. *International Journal of Circumpolar Health, 62*(4), 423-435. Available: http://ijch.oulu.fi/issues/624/624_Fisher.pdf

Fleming, T., & Toutant, T. (1995). "A modern box of magic": School radio in British Columbia 1927-1984. *Journal of Distance Education/Revue de l'enseignement à distance, 10*(1), 53-74.

Gillis, A, Jackson, W., Braid, A., MacDonald, P., & MacQuarrie, M.A. (2000). The learning needs and experiences of women using print-based and CD-ROM technology in nursing distance education. *Journal of Distance Education/Revue de l'éducation à distance, 15*(1), 1-20.

Glueckauf, R. (2002). Videoconferencing-based family counseling for rural teenagers with epilepsy: Phase 1 findings. *Rehabilitation Psychology, 47*(1), 49-72.

House, A.M., & Neville-Smith, C. (n.d.). *Home-centred videotaped counselling programmes for parents with hearing-impaired children (0-5 years of age) in rural Newfoundland and Labrador*. St. John's, NL: Memorial University of Newfoundland and Labrador.

Kim-Rupnow, W., Dowrick, P., & Burke, L. (2001). Implications for improving access and outcomes for individuals with disabilities in postsecondary distance education. *American Journal of Distance Education, 15*(1), 25-40. Abstract available: http://www.ajde.com/Contents/vol15_1.htm

Kinash, S., Crichton, S., & Kim-Rupnow, W.S. (2004). A review of 2000-2003 literature at the intersection of online learning and disability: Electronic curb-cuts. *American Journal of Distance Education, 18*(1), 5-19.

McClure, G., Chaban, P., & Warner, A. (2004). *Child and youth suicide intervention and prevention: Online training for educators' survey*. Unpublished report. Toronto, ON: Hospital for Sick Children.

McKinnon, N. (1986). Public elementary and secondary schools. In I. Mugridge & D. Kaufman (Eds.), *Distance education in Canada* (pp. 194-203). London: Croom Helm.

Ministerial Advisory Committee: Students with Disabilities. (2000). *Technology for learning: Students with disabilities*. Project Team: M. Cormack, M. Couch, & M. McColl. Department of Education, Training and Youth Affairs, South Australia. Available: http://www.dest.gov.au/schools/publications/2000/technologyforlearning.pdf

Moore, M.G., & Kearsley, G. (1996). *Distance education: A systems view*. Belmont, CA: Wadsworth.

Mugridge, I., & Kaufman, D. (Eds.). (1986). *Distance education in Canada*. London: Croom Helm.

Norris, T., Hart, G., Larson, E., Tarczy-Hornoch, P., Masuda, D., Fuller, S., House, P., & Dyck, S. (2002). Low-bandwidth, low-cost telemedicine consultations in rural family practice. *Journal of the American Board of Family Practice, 15*(2), 123-127. Available: http://www.jabfp.org/cgi/reprint/15/2/123

OECD. (2000). *Statistics and indicators on students with learning and behaviour difficulties and disadvantages*. Paris: Author.

Passmore, G. (2003). *Videoconferencing and teacher education papers*. Unpublished report. Thunder Bay, ON: Network of Centres of Excellence for Children and Adolescents with Special Needs.

Perraton, H. (Ed.). (1993). *Distance education for teacher training*. London: Routledge.

Roberts, J.M. (1996). The story of distance education: A practitioner's perspective. *Journal of the American Society for Information Science, 47*(11), 811-816.

Roberts, J.M. (2004). *Children and adolescents with special needs: A research report on technology issues that impact services, education and data management*. Internal Report. Thunder Bay, ON: Centre of Excellence for Children and Adolescents with Special Needs.

Roberts, J.M., Brindley, J.E., & Spronk, B. (1998). *Learning on the Information Highway: A learner's guide to the technologies*. Montreal, QC: Chenelière/McGraw-Hill.

Robinson, B., & Latchem, C. (Eds.). (2002). *Teacher education through open and distance learning*. London: Routledge-Falmer.

Rumble, G. (2001, January-April). Re-inventing distance education 1971-2001. *Journal of Lifelong Learning, 20*(1/2), 31-43.

Russell, A., & Perris, K. (2003). Telementoring in community nursing: A shift from dyadic to communal models of learning and professional development. *Mentoring and Tutoring, 11*(2).

Schacher, M., & Neumann, Y. (2003). Differences between traditional and distance education academic performances: A meta-analytic approach. *International Review of Research in Open and Distance Learning, 4*(2). Retrieved January 21, 2004, from: http://www.irrodl.org/content/v4.2/schacher-neumann.html

Stapleton, M.L. (2001). *Status of Internet access and connectivity in Northern Canada*. Canadian Polar Commission.

Stone, P. (2001, March). *Revolutionalizing language instruction in oral deaf education*. Portland, OR: Tucker-Maxon Oral School. Retrieved April 7, 2004, from: http://www.tmos.org/tech/papers/S0837.html

Sulzbacher, S., Mas, J., Larson, E., & Shurtleff, D. (2004). Pediatric tele-health consultation to rural schools and clinics in the Pacific Northwest. *Journal of Special Education Technology e-journal, 19*(1). Available: http://jset.univ.shared/volmenu19.html

University of Calgary, Health Telematics Unit. (2003). *Socio-economic impact of telehealth: Evidence now for health care in the future* vols. 1 and 2. Available: http://www.fp.ucalgary.ca/telehealth/AHFMR_State_of_the_Science_Report.htm

Judy Roberts has over 25 years' experience in national and international applications of learning technologies, with particular emphasis on distance and open learning and telemedicine. Before starting her consulting practice, she was a senior founding staff member of projects such as Telemedicine in Newfoundland and Labrador and Contact North/Contact Nord in Sudbury Ontario. Judy Roberts & Associates/Associés Inc. specializes in enabling clients to harness information and communications technologies to meet their learning and performance support needs. She can be reached at judyrober@istar.ca.

Julia O'Sullivan is Dean of the Faculty of Education at Lakehead University in Thunder Bay, Ontario and National Director of the Public Health Agency of Canada's Centre of Excellence for Children and Adolescents with Special Needs. A psychologist and licensed teacher, Julia's professional career spans the academic and public arenas. As National Director of the Centre of Excellence for Children and Adolescents with Special Needs (funded by the Government of Canada), Julia leads a team of academic, community, government, and private partners dedicated to improving the lives of children living with special needs through research, policy, and practice.

Joan Howard is a research associate with Judy Roberts & Associates/Associés Inc. She has worked on a wide variety of projects in distance education and training and in the application of learning technologies. Her other research interests include second-language teaching and learning, French immersion, and materials development. She can be reached at jhoward@istar.ca.