COMMUNITIES AND THE INFORMATION SOCIETY: THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN EDUCATION

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This overview of the state and potential of Information and Communication Technologies (ICTs) in education has been prepared by I. Byron and R. Gagliardi of the International Bureau of Education (IBE) for the International Development Research Centre of Canada (IDRC). The paper examines current uses and future possibilities of ICTs in education in both the industrialized and developing world in the light of policies and strategies which have been adopted by different countries for the introduction of these technologies into the formal and non-formal education sectors, specifically at the levels of basic, primary or secondary education. It discusses some of the principal factors which have impeded the incorporation and effective use of ICTs in educational institutions to date and considers some of the implications which present initiatives and future attempts to exploit the technologies in this domain have for the educational process, whether in immediate practical terms or in terms of more far-reaching socio-cultural and political issues. It ends with some proposals for future research and action in this area, particularly as related to the needs of developing countries.

Resources used include materials retrieved in the various databases available at the IBE, and from other libraries and documentation centres in Switzerland. Some data was also downloaded from the Internet, in particular information on current or planned educational initiatives in various countries. References to this data include the home page addresses of the information and the email addresses of the authors.

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THE [...] VISION OF THE INFORMATION SOCIETY IS BEST CHARACTERISED AS THAT OF AN INFORMATION COMMUNITY. IT IS A VISION THAT SEEKS TO SHIFT THE EMPHASIS OF THE ADVANTAGES OFFERED BY THE INFORMATION REVOLUTION TOWARDS A FULLER BALANCE BETWEEN INDIVIDUALS AND SOCIAL GROUPS, COMMUNITIES AND SOCIETIES.
[...] OUR VISION SEEKS TO ENSURE THE CREATION OF AN EQUITABLE INFORMATION ORDER, NATIONALLY, REGIONALLY AND INTERNATIONALLY. THE VISION OF AN INFORMATION COMMUNITY THEREFORE TAKES INTO ACCOUNT THE UNDOUBTED POTENTIAL OF COMMUNITIES AT VARIOUS LEVELS TO CO-OPERATE, TO BRIDGE DIFFERENCES, TO WORK FOR MUTUAL UPLIFTMENT AND FOR THE MEETING OF BASIC NEEDS, AND TO REDRESS THE SOCIAL IMBALANCES OF UNDER-DEVELOPMENT. THE DEVELOPMENT OF AN INFORMATION COMMUNITY PERSPECTIVE AIMS TO ENSURE THAT THE INFORMATION REVOLUTION BENEFITS SOCIETY AS A WHOLE. (THE INFORMATION SOCIETY AND THE DEVELOPING WORLD: A SOUTH AFRICAN APPROACH, PAPER PRESENTED BY THE GOVERNMENT OF SOUTH AFRICA TO THE INFORMATION SOCIETY AND DEVELOPMENT CONFERENCE, MIDRAND, SOUTH AFRICA, 1996)

1. Introduction

Since the early 1980s huge advances have been made in the field of information and communications technology with the rapid spread of microcomputers, the development of optical disks (CD-ROM and CD-I), and the gradual convergence of telecommunications, television and computer technology as the digitalization of data has become widespread, creating the phenomenon of ômultimedia telematicsË (European Commission, Industry Research Task Force on Educational Software and Multimedia, 1995). The emergence of the Internet in the 1990s as an international network of information available to the public at large has revolutionized thinking about how information can be processed, disseminated, accessed and used in every sphere of

human activity. It has now become almost rhetorical to speak of the ôinformation societyË, the ôinformation ageË or the ôinformation revolutionË when referring to the impact of information and communication technologies (ICTs) on economic and socio-cultural development during the latter half of the 20th century. Many are very optimistic about these profound changes, seeing them as having contributed to the emergence of a ôglobal societyË, in which the traditional barriers to communication, time and space, have been surmounted and new dimensions given to the concept of reality through the creation of simulated ôvirtual worldsË. The new technologies are seen as having the potential vastly to improve working conditions and the overall quality of life for human kind, making possible a more leisure-oriented society. On the other hand, others view the implications of ICTs for the future of human society with considerable scepticism or pessimism. The technologies which are replacing the need for human labour in a more and more domains are seen as an ever-increasing threat to the labour force. While they greatly facilitate access to information, they also have the capacity to create an increasingly isolated, artificial existence for individuals becoming ever more dependent on technology rather than direct human contact for the means of communication. Information and knowledge having become what Castells (1989) describes as both the raw material and the outcome of technological change, they are the principal source of power and control in the global economic and political order with the industrialized countries competing with each other for dominance while increasing their advantage over the developing world. The countries of the South find themselves under increasing pressure to develop efficient information accessing and processing capacities so as to avoid marginalization or exclusion. Yet these efforts often breed greater dependency on the North since poor countries lack the resources to build indigenous information technology infrastructures. (Hawkridge et al., 1990)

Thus, while all countries in the world have been affected to a greater or lesser extent by the influence of ICTs in various domains of daily life, it has been and continues to be a very uneven ôrevolutionË with its catalytic effects on development in the rich industrialized countries of the North, serving to widen the disparities existing between them and the South. Even in the developed world, access to the benefits of these technologies has by no means been equally available throughout all sectors of the population, with certain sections of society remaining deprived of many of the advantages offered by ICTs. In the poorest parts of the developing world, the means of obtaining, processing and disseminating information may remain very dependent on more traditional methods in the absence of the most basic infrastructure and devices for utilizing the ônew technologiesË.

As was the case with older technologies such as radio and television, these new ICTs are considered by many to have tremendous potential for enhancing the teaching-learning process. It is felt that they can increase not only the effectiveness of the educational process but also its overall efficiency, whether in terms of classroom activities or administration. The possibilities they offer have the potential to transform the organization and structure of schooling and may promote the development of higher cognitive processes. (Hughes, 1990) Their use in both formal and non-formal education

has profound implications for the traditional role of the teacher and the status of the student. Furthermore, their introduction into the education sector implies substantial changes in terms of modalities of control and distribution of authority within the system, raising not merely pedagogical but fundamental political issues.

As with most other areas of development, there is a huge gap between the North and the South in the exploitation of these technologies in education. The costs, infrastructure and expertise necessary for the production or acquisition of these rapidly evolving technologies as well as their installation, maintenance and full exploitation in the education sector is beyond the reach of many poor countries whose education systems lack so many other more basic teaching and learning resources. Nevertheless, since the 1980s there has been a growing trend in many developing countries to introduce these technologies into the education system not only at the higher education level, but also in secondary education and occasionally in primary schools. These efforts have been attempted in various ways with differing degrees of impact and success, but show a concern by many countries with the perceived benefits that knowledge and use of these technologies in schools will have on individual and national development. (Hawkridge et al, 1990)

These technologies have already brought many changes to the educational process in the industrialized countries and, albeit to a considerably lesser extent, are effecting change in aspects of education in parts of the developing world. Their potential to transform the educational process on a global level is very far from being realized, however. Clearly, these technologies are constantly evolving and it is unrealistic to expect them to have rapid and universal effect. Even in developed countries where numerous initiatives using the new ICTs have been undertaken at national or state/province/county level, their access and use are still limited at the levels of primary and secondary education. This appears to be due not only to the very considerable financial, administrative and time demands involved in their successful introduction into the system but also to the need for further research into effective means of incorporating these technologies into the curriculum. A variety of political and socio-cultural factors are also responsible for the limited impact of ICTs in education in some countries: resistance by the authorities and also by teachers to the loss of control that they may experience through the introduction of these technologies into schools; the linguistic and cultural inappropriateness of much educational software available for many countries; conflict with traditional ways of transmitting and receiving information.

In developing countries the difficulties faced in introducing ICTs into the education system in any meaningful way are enormous, as will be discussed later. Distinction must be made, however, between the various countries which are loosely grouped under the umbrella term ôdevelopingË. The newly industrialized countries of South East Asia and Latin America as well as South Africa cannot be compared with the least developed countries of Africa, Latin America and Asia. The economic and human resources possessed by the former have permitted some of them to make considerable advances in implementing ICTs in their education systems, although very significant disparities may

exist within these countries in terms of access to these technologies. For the worldÊs poor countries, on the other hand, the use of the new ICTs in education is severely limited or simply non-existent. (Tudesq, 1994)

For the purposes of this paper the term information and communication technologies will refer to what are commonly called the ônew technologiesË. These principally include the developing technologies of telecommunications, computing and microelectronics and their convergence which has created a range of new possibilities for information collection, storage, manipulation, transmission and presentation. Older technologies such as television and radio which are used in innovative ways through their combination with newer devices are included as well as ôuser devicesË such as optical and video disks. (Robinson, 1992) These developments have led to new, powerful means of communicating and of storing, disseminating and obtaining information permitting, for instance, the full integration of various media components, audio, text, graphics, animations, into one interactive ômultimedia packageË (Dwyer, 1993) and the emergence of electronic networks such as the Internet.

This paper seeks to provide an overview of the current use of ICTs in the education sector in both the developed and the developing world. With the fastest developments in this area taking place in the advanced industrialised world, far more has been written on the subject in relation to these countries. However, comparative studies and reports of current initiatives in countries such as South Africa, Chile, Singapore, China, Pakistan and Botswana give some idea of present policies and strategies adopted in parts of the developing world. Many aspects of the implications of the technologies for education; whether in relation to pedagogical, technical, economic or social factors, need further empirical research and evaluation, particularly as regards their current use and potential exploitation in developing countries. The scope of this paper permits only a brief presentation of some of the key issues relating to the use of ICTs in education with an attempt to provide examples of current initiatives at the levels of primary and secondary education, as well as some projects aimed at establishing links between schools and the wider community.

The first section summarizes the broad ways in which ICTs may be employed in the teaching-learning process with a focus on their potential for enhancing and expanding opportunities for open and distance learning.

The following section briefly describes some principal policy approaches to introducing these technologies into the education sector in developed and developing countries, and looks at the role of the non-governmental sector and international initiatives in the promotion of ICTs at the level of basic education.

The principal obstacles to the adequate employment of ICTs as pedagogical or administrative tools are then summarized, followed by a brief rΘsumΘ of the implications these technologies have for the issue of equity in education with reference made to some

gender considerations.

The paper concludes with a summary of the major trends emerging from this overview in the use of ICTs in the education sector, the principal lessons which can be derived from the findings and proposals for key areas identified for future action and research.

A series of case studies follow which attempt to give an idea of the diversity of current initiatives involving the use of ICTs in schools and the wider community.

2. Broad uses of the new technologies in education and their implications for the teaching-learning process

Basic modes of use

It has long been felt that ICTs hold huge possibilities for education at all levels and sectors. A wealth of research has been carried out since the 1960s into the role of computer technology in teaching and learning, and in school systems in the Western world the use of computers in some form in the classroom is widespread. However, with the advent of an ever-increasing variety of educational multimedia software in the form of optical disks, with the various possibilities offered by telematics and above all with the Internet, there is a growing interest particularly in the West, in developing ways of incorporating these ônewË technologies into the school curriculum so that teachers and their students may exploit their potential to the fullest. Additionally, there is an increasing preoccupation with the role that these technologies can play in education outside formal settings, within the community at large, for open and lifelong learning and how links between formal and non-formal sectors can be developed and strengthened, breaking down traditional barriers to communication and the sharing of information resources.

ICTs may be introduced into the education sector at any level of the system, from pre-primary to tertiary, in the non-formal as well as the formal sector. These technologies may be used as tools for aiding in the management and administration of the system or may be introduced into the curriculum, either specifically as subjects of study, for example where microcomputers are used to teach students basic computer awareness or programming, or as tools to improve or enhance the teaching-learning process in relation to other subjects in the curriculum. Where ICTs are fully integrated into the school system, they may be used for all three purposes. However, it has been observed that as regards the use of computers in schools, the development of increasingly sophisticated applications, such as word processors, databases and spreadsheets, has reduced the tendency particularly in industrialized countries to teach detailed computer awareness and programming, with more emphasis on teaching the use of the applications and applying them to other curricular subjects. (Hawkridge et al., 1990; Hebestreit, 1992) More recent focus in developed countries is thus on the pedagogical use of the technologies in education with much research still needed on how best to

employ them as effective teaching tools which can advance possibilities for learning in both formal and non-formal settings.

The Australian Computer Society and the Australian Council for Computers in Education (1996) have identified five basic ways or modes of using information technology resources in teaching and learning. These include:

- i) support mode: technology is used to increase accuracy and enhance presentation of work. Such tools include word processing packages, computer aided drafting and design, desk-top publishing.

- ii) exploration and control mode: the student is able to explore, examine, experiment with and build situations. Software packages include adventure games and other types of simulation, databases, expert systems, statistical analysis packages.

- iii) tutorial mode: here the information is presented at an appropriate level and pace for the user, giving the student the opportunity to receive feedback on progress. This is seen as technically possible in core areas such as Mathematics, Literacy and Science where more objective testing is possible.

- iv) resource mode: the technology is used to access information and other resources, whether on-line through means such as the Internet or off-line using CD-ROMs and other software.

- v) link mode : technology is used for communication between individuals. Examples are electronic mail and desk-top video conferencing.

These modes all have the potential to enhance the teaching-learning experience at primary and secondary levels of education. Some of the following ways have been cited:

- as a support mode the technology may raise the self-esteem and confidence of students.

- simulations allow students to experiment with virtual situations which it may be impossible to represent in real life within the school environment.

- The new technologies also make it possible for students to engage in new forms of creative design and production through combining various media in one product.

- using the technology as an information resource allows students to develop questioning and research skills.

- as a link with other individuals and communities, the technology exposes students to new socio-cultural perspectives on diverse issues. This mode is also felt to be helpful as a channel for self-expression for children, particularly adolescents.

Generally it is felt that the use of these technologies in the classroom can stimulate and sustain studentsÊ interest in ways that traditional teaching methods do not and encourage self-directed, student centred learning. Some experiences have shown the use of computers in teaching to motivate slow learners or ôat riskË students.

While ICTs clearly seem to have the potential to enhance teaching-learning processes, research has shown that classroom activities involving the use of these technologies need to be carefully structured by the teacher for them to promote higher order thinking and problem-solving skills. (Hughes, 1990) Research suggests that children only seem to perform at higher levels when teachers play a central and constant role in structuring the learning process, thus challenging claims about the value of computers in advancing learning through promoting independent discovery. On the other hand, these technologies have the capacity to promote collaborative learning which is considered to develop cognitive processes. (Light et al., 1990) Collaborative learning may take place either through isolated computer applications or through special software packages or networking which permit group work and sharing of data. (Tomlinson et al., 1995)

It must be emphasized, however, that the technologies by themselves are not going to bring about improvement or change in the teaching process, unless they are employed in innovative, effective ways by teachers. Delac ſte (1996) cites research in California which revealed that numerous schools linked up to internal and external networks simply used these facilities to perform traditional teaching functions, with no opportunities offered to students to explore new ways or means of learning. This tendency, he suggests, simply reinforces traditional teaching methods denying the chance for construction of knowledge: ôUne fonction technologique correcte, le rΘseau local, au service dÊune fonction pΘdagogique traditionnelle, la fourniture dÊinstruction, tend mΩme α renforcer lÊapproche traditionnelle, en dΘfavorisant la dΘmarche, centrΘe sur lÊΘlΦve, de construction de savoir.Ë (Savoir apprendre: les nouvelles mΘthodes, p.35)

Hawkridge et al (1990) suggest that using computers may in fact hinder effective learning, if they are employed simply because they are available or fashionable, rather than in ways which can enhance teaching: ôRegrettably, it is still the case that more often than not computers are being used by students to learn what teachers can teach better.Ë(Computers in Third-World schools: examples, experiences and issues, p. 20)

Distance education

The new ICTs have been recognized for the valuable role they can play in developing and improving distance education methods. Many of the advances in this area have been at the level of higher education, but innovative uses have also been introduced in some countries at primary and secondary levels and in the non-formal sector. The Internet obviously provides a wealth of opportunities for the development of distance teaching with universities and teacher training institutions delivering entire study programmes

through this medium. (See, for example, Case Studies nos. 6 and 10) The convergence of telecommunications and video has made possible video teleconferencing which is much in use in higher education institutions in some developed countries but is generally too expensive a technology for primary and secondary schools. (Dunnett, 1994). An example of an initiative to make a more affordable version of video conferencing available to schools is that being undertaken by the Education Department of South Australia. (See Case Study no. 12)

The new technologies make possible new methods and means of delivery for pre-service and in-service teacher education, as well as enabling the development of professional contacts for teachers through the Internet or other electronic networks. In theory, ICTs, through the possibilities they allow for distance learning, could greatly facilitate the provision of teacher education in situations where there are large numbers of untrained teachers, limited inservice training and few training institutions or teacher educators. But it is in these very deprived situations that the basic infrastructure for installing the necessary technologies is likely to be absent.

Electronic networking

The availability of powerful electronic networks at both national and international levels offers many new possibilities for teaching and learning both within formal educational institutions and in the wider community. Electronic networks do not just give access to vast amounts of information, they allow for valuable sharing of resources, ideas and experiences among student and teacher communities. In developed countries (as well as in some developing ones with the necessary infrastructure in place), numerous formal and informal student and teacher networks have been set up at regional, national and international levels. Examples of the use of electronic networking for professional development are LabNet in the USA and the Using EdNA in the Curriculum project in Australia (see Case Studies nos. 2 and 6), with ACTEIN in Australia being an example of a school student network (see Case study no. 1).

The current trend in developed countries as well as in some developing ones is to broaden school-based networks to include the wider community. Important links have been established between schools and universities or other tertiary institutions. (See, for example, Case Studies nos. 3 and 7) Initiatives are increasingly being undertaken to involve homes, community groups and various public and private sector institutions in school networks so as to share resources and generally to bring schools and the wider community closer together, in this way creating valuable support systems for schools. The Education Superhighways initiative in the UK is funding a number of such projects including the Government, Education, Medical, Industrial, Social Information Superhighway or GEMISIS 2000 which aims to link more than 30 schools and colleges in the city of Salford with libraries, community and health centres by fibre-optic cable and the Acorn Home-School Links Project which will link schools to homes in Cambridge through a cable network. (Times educational supplement, March 22,

1996, p. 11-15). In Chile, the national Enlaces Project, among a range of other activities, is recording the oral culture of the Mapuche indigenous people from the accounts of students and teachers and disseminating this information on the national interactive education information network. (See Case Study no. 4)

In isolated areas and in economically deprived countries and regions, the opportunity of access to the wealth of information and contacts available on the Internet could greatly enrich teaching-learning situations where there may be a dearth of more traditional educational resources and where teachers have little or no opportunity for professional development. How such opportunities can be made possible in poor developing countries is the crux of the matter. A project such as EDUNET in Pakistan provides an example of one initiative taking place in a developing country which seeks to use network possibilities for disseminating curricula-relevant materials to teachers and students. (See Case Study no. 5)

An analysis of experiences shows that there are two basic systems for schoolsÊ networking. One of them is a centralized system, where national or district educational authorities organize the network. The other is a decentralized system where schools start to connect with each other, or where an existing network permits new connections. The centralized system allows the organization of a school network following a plan of activities that connects the use of new educational tools with curricula. It ensures control of the use of the network and permits the provision of common educational software to all the connected classrooms. It can facilitate the connection between universities and training centres with teachers and school administrators. This mechanism is usually the outcome of policy-making at national or district level in the education system and is a useful mechanism in situations where educators lack adequate awareness about the use of computers in education. Good examples of the centralized mechanism are the ôProyecto EnlacesË in Chile and CERNET in China. (See Case Studies nos. 3 and 8)

The decentralized system is characteristic of societies where Internet is a widely used and popular information and communication medium. Some pioneer schools start a small network, perhaps in conjunction with another institution such as a university, and they are followed by other schools. The basic advantage of this mechanism is its spontaneity and that the participant schools act voluntarily, facilitating their transformation. The disadvantage of this mechanism is the gap that develops between the participant schools and the schools which continue to use more traditional pedagogical approaches. A good example of this mechanism is ACTEIN in Australia. (See Case Study no. 1)

However, the degree to which a network may be defined in terms of a system is debatable. In referring to the implications of networking for the educational process, Spitzer et al write: ôUltimately, electronic communities could transform the nature of education, especially as scientists, educational researchers, administrators, curriculum planners, informal and community educators, and parents become part of the discourse about teaching and learning.Ë It is important to point out the very profound implications

such a change would have on the fundamental nature of the education system itself. The growth of electronic networks in education, as in other institutions, challenges the static concept of the system at every level. Traditional power structures based on the centralized control of information and knowledge and on fixed hierarchical relationships are ultimately threatened by the concept of electronic networking which allows participants equal access to information resources and an equal chance to express their views and opinions (anonymously, if desired) within a dynamic national or international forum. (Tedesco, 1995) The challenge to systems will come not only from within a country but without, as traditional physical barriers are removed through technology. However, as Tedesco points out, the ultimate functioning of any network depends on its members, the human and social relationship, rather than on technological facilities.

Spitzer et al., like many others, see this as a positive consequence of technology on education, leading to a more genuinely democratic, participatory process in which decision-making is shared and learning is controlled by the individual. The challenge that electronic networks pose to traditional roles and positions of power may on the other hand cause concern not only at the top of the hierarchy but right through the system down to the teachers who will no longer be the controllers of knowledge in the classroom.

Towards open learning

The possibilities of almost unlimited access to information and global communication offered by ICTs give a new dimension to the concepts of open and lifelong learning. These new media provide a means of overcoming traditional barriers to education available within the limited framework of formal institutions. They can potentially offer individuals the opportunity to control and direct their learning and continually extend, renew and update their knowledge and skills by providing the possibility of easy access to new developments in all fields of knowledge. When put at the service of the wider community, particularly in educationally and socially disadvantaged areas, the new technologies can become catalysts for both individual and collective development and change. The South Bristol Learning Network (see Case Study no. 9) is an exciting example of an initiative seeking to exploit ICTs for the benefits of an entire community, based on a policy of community-wide, grassroots involvement and service. The Mamelodi Community Information Services (MACIS) in South Africa which seeks to apply the new technologies in the provision of non-formal education to disadvantaged communities is an example of what is being attempted in a developing country.

Introducing ICTs into the education sector: policies and strategies

Writers on the subject repeatedly emphasize the need for the active support and involvement of governments and for clear-cut integrated national policies if the new

information and communication technologies are to be successfully introduced into the education system. For instance, David Walker, former Director of the Scottish Microelectronics Development Programme includes the following among his list of ôpre-conditions for a successful introduction of new information technologies [...] into an education system:

.an appreciation by government of the financial, resource and operational requirements and the resulting consequences;
.a commitment by government to give time and take responsibility for decision-making and implementation strategies;
.a commitment to a policy of an integrated support service encompassing teacher and technician training, curriculum and assessment - together with software and hardware provision.Ë (Higher education policy, vol. 2, no. 4, 1989, p. 41)

Hawkridge et al. (1990) identify four principal rationales for introducing computers in schools, namely, social, vocational, pedagogic and catalytic. These seem applicable to the new technologies in a broader sense. The social rationale is concerned with the overwhelming importance of the computerÊs role in modern society which seems to make it imperative for all students to become familiar with it at school as a tool for everyday use, thus ôdemystifyingË it for them. The vocational rationale relates the need for computer education to the possibility of better access to the job market. This sees the teaching of computer applications or programming as providing skills vital for employment in the information technology society. The pedagogical rationale asserts that computers assist the teaching-learning process and enhance the instruction of traditional subjects in the curriculum. The catalytic rationale sees the introduction of computers as improving the overall performance of schools (teaching, administration, management), increasing their effectiveness and efficiency and thus making a positive impact on the education system in general.

Ministries of education and other actors in the policy-making process will base decisions to introduce ICTs into the education sector on one or more of these rationales, which can be seen to overlap in some respects. Hawkridge et al. (1990) suggest that the general trend in developed countries has been to proceed from policies based on the social and vocational rationales to the pedagogical while paying lip service to the catalytic rationale whose goal of radical transformation of the system is difficult to achieve and may not in reality be so desirable for those holding the reins of power. A similar view is shared by Duguet (1989) who distinguishes between two types of policy approaches adopted by numerous industrialized countries during the 1980s, namely, ôrestrictedË and ôcomprehensiveË. Restricted objectives conform to the vocational and social rationales and comprehensive approaches to the pedagogic rationale. According to Duguet, most developed countries have moved towards the adoption of comprehensive policies. The vocational and, to a lesser extent, the social rationales have primarily informed the efforts of developing countries which have introduced ICTs

(notably computers) into schools. (Hawkridge et al., 1990) These two rationales which emphasize the teaching of computer awareness, computer literacy, programming or applications, often to a limited number of students in secondary schools, involve fewer costs in terms of hardware, software and teacher training, with objectives that are more clear-cut and somewhat easier to achieve. With the advent of Internet, the social rationale would also include familiarizing students with this new and powerful mode of receiving and transmitting information. Some of the more advanced developing countries such as Chile, South Africa and China have recently undertaken broad initiatives which reflect more comprehensive policies.

The speed with which ICTs are evolving means that educational policies have to be regularly updated if they are to respond adequately to the challenge of effectively exploiting these constant changes to the technologies and their applications. In 1989, Lally wrote of the need for countries to have ôa good, relevant and up-to-date-policy document on informatics and education, one which is appropriately balanced between informatics and educational practice.Ë (Higher education policy, vol. 2, no. 4, 1989, p. 52) National information policies will obviously shape educational policies relating to the exploitation of the new technologies. (Hawkridge et al.)

3.1 Developed countries

Efforts by the governments of technologically advanced countries to stay abreast of the developments in informatics and telecommunications of the last few years are evident in the national policies of the USA, Australia, the UK and Japan. The USA has passed legislation in the form of the High Performance Computing Act (1991) and the National Information Infrastructure Act (1993) which is intended to improve the information, computing and communications infrastructure while promoting the development of new computing and communications technologies. These Acts have important implications for educational policy-making. (Bishop, 1993) Australia has established the Education Network Australia initiative (EdNA) as part of an overall national strategy drawn up to exploit the opportunities offered by Internet and other information networks. EdNa will deliver educational services and products and limit the costs of access to the ôinformation superhighwayË. The UK has no current integrated national policy on the use of IT in schools but in 1995 launched the Education Superhighways initiative with the aim of identifying best strategies and working practices for using the Internet in education. (Cole, 1996)

Japan, which for a long time had a deliberate policy of not introducing computers into primary or secondary schools, restricting them to post-secondary institutions, launched a six-year plan in 1994 to equip all elementary schools with 22 computers (1 computer to every 2 pupils) and each lower secondary school with 42 computers (1 computer per pupil), and has launched in the last two years two initiatives for linking schools to Internet with the long-term objective of nation-wide school Internet connectivity. (Hishimura, 1996) In late 1994, the ô100 Schools ProjectË was initiated under the joint

auspices of the Ministry of Education, Science, Sports and Culture and the Ministry of International Trade and Industry with the aim of introducing the Internet into schools through the development of a thematic approach to information use. The project has initially selected 100 from 1543 applicants and supplied them with free Internet connectivity for a fifteen-month period. (Goto et al., 1995) The second initiative is the Child Network Plan being developed from this year jointly by the Ministry of Education, Science, Sports and Culture and NTT which is aiming to link a total of 1000 schools (primary, lower and upper secondary) to the Internet and ôpromote the development of information-oriented education through the activation of a high level information communications networkË. (Hishimura, 1996) It seems likely that the advent of Internet and the growing interest in the use of computers in enhancing the teaching-learning process have influenced JapanÊs recent policy.

The types of policies formulated will also vary according to the level of centralization or decentralization of a countryÊs education system. In federal countries, state policies are likely to exist along with national ones as in the case of the United States and Australia. In highly centralized systems such as France, policies will tend to be administered in the ôtop-downË model, while in decentralized systems such as the UK approaches may tend to be more oriented towards a grassroots approach, encouraging decision-making at the level of local education authorities and schools. For example, the present Education Superhighways initiative invited ideas for pilot projects from educational establishments around England and Wales, selecting twenty-three for evaluation as the first phase in promoting the use of the Internet in schools throughout the country. The potential weakness of decentralized approaches is that the lack of central co-ordination and funding may lead to severe disparities in schoolsÊ access to the new technologies and the expertise needed to exploit them effectively, resulting in considerable differences in levels of development of the use of ICTs between schools and regions. (Hebenstreit, 1992; Becker, 1993) At the same time, active support and involvement at the level of school districts, local educational authorities and individual schools is vital if initiatives to use ICTs in schools are to be effective.

3.2 Developing countries

Some newly industrialised countries such as Singapore are also actively pursuing policies at national level for the integration of ICTs into the education system. The Singapore government which introduced computers into schools in the early 1980Ês with an initial focus on a vocational rationale is now seeking to develop a broader approach. (Wang et al., 1995) In 1993, a pilot project entitled the Student and TeachersÊ Workbench was introduced with the dual purpose of developing computer-aided instruction for enhancing self-learning, both in the classroom and at a distance, and as a means of addressing the problem of teacher shortage in the country. The project, which initially involves six secondary schools, includes an important teacher education component and the development of a learning materials repository. An interesting feature of the Singapore approach has been to develop computer clubs in secondary schools as an

extra-curricular activity. These have known considerable success. Malaysia has also developed this approach. (Hawkridge et al., 1990)

In South Africa, an inter-departmental team has been established to oversee the development of a comprehensive information policy framework for the country. This initiative, entitled called ôNetworking 2000Ë, is co-ordinated by the Department of Arts, Culture, Science and Technology. In the meantime, the Department of Posts, Telecommunications and Broadcasting recently issued a White Paper on telecommunications restructuring for the country. In April of this year, the National Information Technology Forum was launched with the aim of mobilising the various sectors to participate in the formulation of the national information policy framework. This global approach includes a specific focus on education and training with a ôcomprehensive project planË being proposed for ôresearching, analysing, evaluating and implementing a process leading to IT qualification and human resource frameworkË which includes a plan for an Information Technology Qualifications Framework (IT-NFQ). (The information society and the developing world: a South African approach, 1996) A clear concern is also expressed with providing equitable access to ICTs outside a formal educational framework, to the wider community with a proposal for the establishment of multipurpose community centres ôfor universal access to a range of services meeting community needs, with information technology as the backbone.Ë(Ibid.)

Botswana recently formulated a national strategy for the use of computer technology at the level of secondary education, in its Revised National Education Policy of 1994. This has led to the development of a Computer Awareness Programme for the Junior Community Secondary Schools and will be part of the Nine-Year Basic Education Programme. The aim is to develop a basic awareness of computers and then to teach computer applications through incorporating them into other subject teaching. Several other countries in sub-Saharan Africa presenting national reports to the Second International Congress on Education and Informatics (Moscow, 1996) indicated that they had no formulated policy for introducing the new technologies into education at primary or secondary level, with existing efforts being concentrated in the area of higher education. Such initiatives as exist in countries such as Kenya and Zimbabwe have been primarily set up by private schools and donor agencies. (Hawkridge et al., 1990)

3.3 The role of the non-governmental sector

Hawkridge et al. observe that where no State policies exist, action taken by other sectors of society will nevertheless bring ICTs into the education system and may well serve to shape any future policy-making in this domain. This has been the case both in industrialized countries such as the USA during the 1960s and 1970s, when commercial firms or private schools led the way in bringing computers into the lower education system, and in numerous developing countries today, where donor agencies, multinationals and parents have all contributed to providing schools with the new

technology.

Recent State-led policy approaches in some countries are actively seeking to involve these other significant actors in decision-making processes and strategies for developing ICT use in education. Corporate industry and commerce and academic and research institutions play a leading role in this respect particularly in industrialized countries. The involvement of such groups and their influence on policy and practice should be seen as being far from neutral or incidental, all having particular interest in the impact of the technologies on the educational process.

3.3.1 Industry

Private sector enterprises and corporations are extremely powerful actors in this domain, due in large part to their control of the telecommunications and informatics industries. In the industrialized countries, government authorities have sought to establish collaborative efforts with corporate industry, as have individual educational establishments. Industry, too, recognizes the benefits of fostering the potentially huge educational market and in educating populations to become increasingly competent in and dependent on the use of the new ICTs. The example of the Education Superhighways initiative in the UK indicates the dominant role that industry plays in advancing the use of ICTs in education. About 80 percent of the ú10 million initiative in the UK is funded by industry including leading telecommunications and informatics firms like Microsoft, IBM, Intel and British Telecom. Several of the twenty- three projects selected by the Department for Education and Employment (DFEE) for evaluation under the scheme had already been established prior to the launching of the initiative largely with industry funding. (John, 1996)

The theme paper of the Information Society and Development Conference (1996) stated that ôeven in developing countries, the private sector should be primarily responsible for financing the development of the information societyË. The implications of such involvement by industry in education should be carefully considered, however. The ômarket drivenË interests of industry are likely to be at odds with broader educational and socio-cultural values.

At the same time it should be recognized that, apart from its funding role, industry has much to contribute in terms of technical expertise, whether assisting schools in designing suitable educational software, or publishing guides such as the Education technology toolkit, designed by Apple Computer to provide both developed and developing countries with essential information about the application of computers and related technologies in schools. (Hill, 1989) However, the development of educational software, which has been spearheaded in most countries by commercial interests, has resulted in much material produced being of dubious pedagogical quality. Much of the multimedia software presently produced targets home computer users and is more appropriately classified as ôedutainmentË rather than being truly educational. Ideally,

industry should work along with education professionals in developing materials which are innovative but curriculum-related and which meet clearly defined criteria for classroom use.

3.3.2 Academic and research institutions

There are a number of recent initiatives involving collaboration between universities and other research and development institutions, and schools and the wider community. Successful projects may be financed by industry or state funding with technical know-how provided by the academic institutions. Universities have valuable contributions to make to curriculum development, teacher training or the development of appropriate educational software. They are usually better equipped than schools in terms of the necessary infrastructure and equipment and may be able to link up with schools, libraries and other public sector institutions for a sharing of resources. Examples of an innovative university/school initiative is the CQ-PAN project in Australia. (See Case Study no. 7)

3.3.3 International initiatives

Walker (1989) includes international co-operation as a vital component of policies for developing the use of informatics in education. International initiatives may result from the policies of international organizations such as UNESCO and the European Community or they may be the outcome of bilateral arrangements between countries, whether North-North, North-South or South-South.

An example of international collaboration among developed countries is the European Commission Industry Research Task Force on Educational Software and Multimedia set up in 1995. The Task Force has a dual mandate: i) to present a survey of the current situation as regards educational multimedia; ii) to present a draft action plan to make European research more effective, to strengthen the position of the European educational media industry and to enable users (households, enterprises and educational institutions) to derive maximum benefit from the new technologies as applied to education and training. The field covered by the Task Force concerns educational and cultural products and services which can be accessed via television sets or computers whether or not connected to a telematics network, used in the home, in educational and training institutions or at work and offering a high level of interactivity.(Industry Research Task Force on Educational Software and Multimedia, 1995)

In developing countries, aid agencies, whether non-governmental or intergovernmental organizations have influenced policy on the use of ICTs in education. International organizations such as UNESCO and the International Telecommunications Union (ITU) play a role both in formulating policies and in developing initiatives for incorporating ICTs into schools and communities. International funding agencies such as the World

Bank and the United Nations Development Programme (UNDP) are major actors in the development of projects. While intergovernmental organizations can play a valuable role in assisting countries in formulating appropriate policies, donor agencies may persuade governments to develop projects which they cannot sustain or expand and cause educationally and culturally inappropriate software to enter the system. Sub-regional indigenous initiatives may be a partial answer to effective collaboration.

Main factors impeding adequate use of ICTs in schools and communities

The potential benefits which the new technologies can bring to education if implemented and exploited effectively do not seem to be in question. However, fundamental issues need to be considered relating to the possibilities and practicalities of integrating them in a meaningful way into education systems. There are major obstacles to their use in schools and the wider community in developing countries while even the rich industrialized nations are confronted by numerous problems related to the effective exploitation of these technologies in education. While the problems faced by developing countries are clearly of a very different magnitude, and often of a different nature, to those factors affecting developed countries, there are many issues which are common to them all. The principal factors will be summarised in the following section with reference to the implications that these obstacles have for questions of access and equity.

4.1 Costs

ICTs constitute a very expensive resource for schools even in industrialised countries where the necessary infrastructure for their installation is in place. The price of hardware although constantly decreasing remains considerable for school budgets as does software, with many schools in developed countries under-equipped with PCs, CD-ROM drives, appropriate and adequate software packages. In addition to ordinary maintenance costs, the rapid evolution of information and communication technologies implies constant upgrading of equipment and facilities if educational institutions are to keep abreast of these developments in the classroom. In the UK, one of the countries considered to be at the fore in the use of ICTs in education, forty per cent of computers in schools are considered obsolete. (Kenny, 1996)

The cost of on-line telephone charges for use of the Internet remains high unless it is subsidised by government or private institutions. Studies have shown that concern about telephone charges is a major deterrent to teachersÊ use of Internet in the classroom. Installation of faster connections such as ISDN digital telephone lines or fibre-optic cable which would in theory reduce time spent on the network is also expensive. An initiative such as CQ-PAN in Australia provides one possible economic measure for schools to take.

A 1990 cost analysis of computer instruction in Belize showed recurrent, non-capital costs including personnel, maintenance and miscellaneous expenditures to account for an average 70 per cent of all annual costs. (Rock et al., 1991) This study observes that ôdeclines in the price of computer hardware will most likely have only a limited effect in technology accessibility for a large number of developing countriesË, equipment costs for schools in their study never being higher on average than 20 per cent of total annual costs. (International journal of educational development, vol. 11, no. 1, 1991, p.74)

The huge costs involved in the adequate provision of these technologies to schools is evidenced by the $270 million with which state education departments in the USA are funding telecommunication networks for schools. (Kenny, 1996)

Developing countries are often severely lacking in even the most basic technological infrastructure for widespread installation of ICTs in schools and communities, with wide disparities between urban and rural areas. (Tudesq, 1994; Daudpota et al., 1995) All the countries of Africa combined have an ôaverage telephone density that is in order of magnitude smaller than that of the European CommunityË with the number of telephones per 1000 persons ranging from 12 to 50. (Odedra et al., 199?) The rate of electricity consumption in many African countries, while always low, has decreased, at times sharply, since the mid-1980Ês. (Tudesq, 1994) In some countries even where there is Internet connectivity, access to the network is severely limited by the low frequency connection available. (Daudpota et al., 1995)

In addition to the poor infrastructural facilities, the costs of hardware and software plus those of maintenance and teacher and technician training are likely to be prohibitive for these countries. Foreign exchange is often scarce, education budgets are usually very low, and the scarcity or non-existence of more traditional educational facilities and equipment in many areas often makes suggestions for introducing the sophisticated new technologies into the education system or into grassroots communities seem a denial of reality.

4.2 Professional competence

Teacher education is considered to be the single most important factor in ensuring the successful use of ICTs in education. (Walker, 1989; Duguet, 1992; Lally, 1989) Its importance has tended to be overlooked or underestimated in the development of initiatives for introducing these technologies into schools with the result that projects may fail outright or are never developed to their full potential. This is true not only of developing countries but also of industrialized ones. Teacher education is not only vital for equipping educators with the necessary skills for using ICTs effectively in the classroom, but for helping teachers to overcome their often strong resistance to these technologies and to develop positive attitudes towards them.

Adequate teacher education poses difficulties for various reasons which apply to both developed and developing countries, the latter in particular. The costs of training are not visible and are often underestimated in the development of projects. In reality they represent a very significant part of any adequate budget for the introduction of ICTs into education at any level, as mentioned earlier. Training is not only costly but has to be ongoing and regularly updated to meet the ever new demands posed by the rapidly evolving technologies. If ICTs are to be effectively integrated across the curriculum, all teachers will have to receive initial or in-service training (or both), not simply a few for the purposes of teaching computer literacy and programming as has often been the case in the past. Organizing training on such a massive scale is a major challenge for any education system.

Walker (1989) indicates the need for two levels or types of training: 1) an introduction to the technologies and preparation to operate and manage the hardware; and 2) training in the pedagogical use of the technologies. The latter poses a particular challenge since it remains a relatively new area of teacher education with further research needed into the most effective ways of using the technologies to promote learning. Studies suggest the need for new theoretical approaches to teaching, which will transform important aspects of the traditional role of the teacher in teacher-centred classrooms. (Knight et al., 1995) It has been suggested furthermore, that the vast range of ideas and viewpoints available to students through the Internet gives a new dimension to the need for training in the teaching of values, a task which is seen as more urgent and more difficult than before. (National report on the development of education in Australia, 1996)

The vast amount of loosely structured information on the Internet poses a particular challenge to teachers intending to integrate regular use of this technology into their lessons. Stahl et al. list a number of tasks facing such teachers:

. Teachers have to locate sites of curriculum ideas scattered across the network; there is currently no system for announcing the location of these sites.
. They have to search through the offerings at each site for useful items. While some sites provide search mechanisms for their databases, each has different interface tools, and indexing schemes that must be learned before the curricula can be accessed
. They have to adapt items they find to the needs of their particular classroom: local standards, the current curriculum, their own teaching preferences and the needs or learning styles of their various students
. They have to organize the new ideas into coherent curricula that build towards pedagogical goals
. They have to share their experiences using the curriculum or their own new ideas with others who use the resources (Computers in education, vol. 24, no. 3, 1995, p. 237)

Teachers are thought to need up to five to seven years to become sufficiently comfortable with the new technologies to use them effectively in the classroom. (Eurich-Fuller et al., 1995)

The huge investments of capital, time and research necessary for training confound developed countries and seem an insurmountable barrier for poorer ones which face far more basic problems relating to the preparation of an adequately prepared teaching force.

4.3 Teacher attitudes

Teachers are likely to resist the introduction of the ICTs into the classroom for a variety of reasons, including their unfamiliarity with the technologies, the additional time and effort necessary for their effective use, and perhaps the feeling that ICTs pose a threat to their professional role and image. Many students, particularly in the industrialized world, are often far more familiar and competent than their teachers in the use of computer technologies, and teachers will have to adjust to this reversal of traditional classroom roles. Studies have shown that where teachers are resistant to the use of the technologies in the classroom, they will have little impact in this domain. (Brummelhuis et al., 1993)

4.4 Conflict with the curriculum

The specific reference earlier to problems posed to the teacher by the Internet indicates the challenge that the network poses to the existing curriculum. Problems also arise with much educational software which may be imposed on teachers without their being involved in its selection, development or evaluation. Educational software is very costly and time-consuming to produce, with most available on the market being commercially manufactured. The result is that much multimedia material is more entertainment than seriously educational, ôseriousË educational software often not being seen as a commercially viable product (Cole, 1996; Industry Research Task Force on Educational Software and Multimedia, European Commission , 1996) Educational CD-ROMs are often not curriculum-based and teachers have to spend a lot of extra time devising appropriate ways to incorporate them into the regular curriculum. (McFarlane, 1996) Ideally, teachers should be involved in the development and evaluation of educational software in order for it to genuinely meet their needs and be accepted by them as valid teaching material. In the developing world the issue of educational software poses far greater problems, these countries producing few or no indigenous materials, depending on imported software. The implications of this are discussed below.

4.5 Language and cultural issues

In 1989, Murray-Lasso cited the ôalmost complete dominance of English over other languages in the computer fieldË as one of the principal obstacles to the widespread use of computer technologies in education in developing countries in particular. (Higher education policy, vol. 2, no. 4, 1989, p. 38) This linguistic and cultural dominance (further increased with the emergence of the Internet on the world scene in the 1990s) continues to be a serious barrier for non-English-speaking countries wishing to integrate the new technologies into their education systems. Most educational multimedia available is in English (or a few other European languages) which limits its potential use in many other parts of the world, particularly at primary school and community levels. Furthermore, the bulk of material available is culturally irrelevant in various ways to much of the non-Western world. Costs of translating and adapting software for other languages and cultures are high, indigenous production even more so, requiring a high level of technical expertise. Translation problems will go beyond language to the issue of different characters in the case of countries using other than Roman script.

The authorities in some countries may oppose the use of the Internet in the formal education system for fear of its potential for ôcultural colonisationË. Thomas (1987) has referred to the resistance by governments to the transfer of technology on such grounds.

4.6 Lack of technical expertise

Developing countries lack technical expertise in this domain at all levels. Their limited resources mean that they usually have neither the local capacity to develop the necessary human resources in this field nor the means to attract highly skilled and expensive experts from abroad. Many developing countries which succeed in training personnel lose them to more highly paid jobs abroad. (Hawkridge et al., 1990)

4.7 Lack of information

A significant obstacle to the use of ICTs in education, again particularly in the case of developing countries is the lack of information that is available both to educational decision makers and practitioners. The type of information lacking is broadly of two categories: information about the role and value of these technologies in education and more specific information relating to available hardware and software and how to use it in the curriculum.

4.8 Lack of centralized, co-ordinated administration

The IEA 1989 study of the use of computers in education in 21 countries produced data suggesting that successful efforts to introduce computer technology into schools in the USA are dependent on support from education authorities, not merely at the national level but in terms of local/district administration. (Becker, 1993) While recognizing the

potential decentralization has for professionalizing the teaching profession, and improving the decision-making process and ultimately student performance, Becker emphasizes the need for ôsubstantial district-level involvement in school-level decision-makingË (Computers and education, vol. 20, no.4, 1993, p. 352)

In addition, Becker stressed the importance of schools having ôan on-site full-time curriculum development and staff development computer co-ordinatorË, a role revealed by the US study to be essential to successful project outcomes.

5. Implications for equity and access

The new technologies are seen as holding great potential for improving access to education, thus increasing the chances of equal educational opportunities among populations. Through these technologies, various new possibilities are offered for distance learning, home schooling, informal and lifelong learning, reducing the dependence on traditional formal structures of schooling and permitting the development of more community-based learning facilities. Through electronic networking, more democratic educational processes may be fostered. Computer and telecommunications technologies have considerable capacity for facilitating access to education for the disabled permitting their fuller integration into mainstream society, as well as for other traditionally marginalized or disadvantaged groups.

However, despite the potential of ICTs for providing more equity in education, the reality is quite different. As discussed in the preceding section, numerous factors impede equal access to these technologies for all sections of the population even in the most developed countries. There is considerable variability in the degree to which schools are equipped with the technologies or with the teachers skilled in exploiting them to the studentsÊ advantage. Even in the USA, the country with the highest global figures for Internet utilization, a large percentage of schools remain without access to the network. (Goodenow, 1996) In the wider community, disparities are also great in terms of the possession of home computers, access to Internet, the equipment of libraries and other community service organizations. Government policies may foster inequity, while at the same time lack of State support and monitoring of initiatives can cause disparities between the privileged and the disadvantaged to widen. Existing inequalities between the technologically advanced countries and developing nations are likely to grow if the latter remain on the edge of processes of information production, dissemination and consumption, as is presently the case for the majority. Current figures indicate that the USA accounts for 70 percent of global Internet utilization with developing countries representing only about 10 percent of Internet access. (Goodenow, 1996)

6. Gender considerations

The International Association for the Evaluation of Educational Achievement (IEA)

international study on computers in education found that in many countries computer use in schools is dominated by males with female teachers having less regard than male teachers for their skills and knowledge. (Computers and education, vol. 20, no. 4, 1993) It has been suggested that the dominance of computer technology by men has give it a ômale imageË which may discourage girls in their use of it. (Cole, 1994) British studies have shown that boys not only dominate computer use and are represented in far greater numbers in computing studies courses in primary and secondary schools, but have revealed that boys are far more likely to have computers bought for them by their parents, thus having greater access to them outside school as well. (Ibid.)

Conversely, an Australian study showed girls using computers marginally more on average than boys in school with, however, use outside of school by boys doubling that of girls. (Fluck, 1994) A UK study also showed that when girls had equal access to computers as tools to support their studies, there was no evidence of gender bias. The difference in amount of time spent using computers seems to have to do with attitude as well as issues of access, boys appearing to be more process- oriented in their use, girls more goal-oriented. (Times educational supplement, June 23, 1996)

The gender issues in the use of the new technologies is an area which seems to require more research particularly as it relates to socio-cultural factors pertaining to girlsÊ education in many developing countries. It might be that where the full integration of ICTs into the curriculum is possible, rather than limited use in computer studies classes, disparities may be reduced.

7. Conclusions

7.1 Major trends

This section will identify what appear to be some of the major trends in the use of ICTs in the education sector, as revealed by some of the recent literature.

. a growing concern shown in many developing countries for building up the means of access to and use of these technologies in education as well as in other sectors of development. This is apparent in policies adopted at national level as well as by numerous intersectoral initiatives taking place in some countries.

. a movement in industrialized countries and in some of the more advanced developing ones towards integrating the use of ICTs across the curriculum rather than limiting their use to teaching about the technologies to selected student populations.

. collaboration between numerous actors in the public and private domain in the development of projects and initiatives for the use of ICTs in education. This trend indicates the potential importance of the non-governmental sector in educational

development and the usefulness of participatory/collaborative approaches, but raises questions concerning the possible dominance of interests by certain groups, particularly industry.

. rapid evolution of technologies: the rate with which ICTs are developing has very important implications for their use in education. The pace at which they are evolving seems set to continue, posing increasing challenges for educational research and policy- making, teacher training, the provision of information for their day to day use in the classroom, the development of sustainable structures to ensure their expansion into the wider community, the building of viable indigenous production processes for hardware and software in developing countries.

. growth of networking: this seems to be a trend taking place not only in the advanced countries but also in various parts of the developing world. This means of communication could have many possibilities for education and bring about profound changes in traditional structures and processes as discussed earlier.

. continued predominance of English language, Anglo-Saxon products and services will maintain linguistic and cultural barriers to these technologies unless concerted efforts are taken by countries of other languages and cultures to redress the imbalance. For developing countries this is obviously a major problem for whose solution sub-regional and international collaboration is essential. This trend poses a particular threat to minority languages and cultures.

. the plethora of educational multimedia products poses an ever greater need for the systematic cataloguing of available materials, as well as the establishment of standards for the production, selection and evaluation of educational software.

. the daily increase of information disseminated on the Internet similarly calls for greater efforts to catalogue information and direct teachers and learners to relevant material.

. decreasing costs of hardware and improved telecommunications links should offer greater opportunities for access to the technologies in industrialized countries. This may not be the case in developing countries with severe foreign exchange problems, limited infrastructural capacity and other fundamental obstacles to development.

Main lessons learned

From the overview presented, it is possible to pinpoint some key issues which emerge from past and ongoing efforts to introduce ICTs into the education sector.

. Before any attempt to develop initiatives of this nature, it seems imperative to establish clear rationales for doing so. Technology introduced for ôtechnologyÊs sakeË will not be a successful venture. Once rationales have been determined, a clear-cut implementation policy is essential as outlined by Walker (1989).

. The central involvement of education authorities seems to be crucial to the success of such initiatives. Studies have shown that despite the many advantages of decentralization of decision-making to schools, the support of the central authorities for such major innovative change is vital. The State should play a regulatory role, helping to clearly define objectives, ensuring equitable distribution of resources and ongoing evaluation of innovative change.

. At the same time there seems to be a clear need for the active involvement of other sectors of society in launching and sustaining such efforts. The private industrial sector and academic and research institutions have a particularly important role to play, but participatory approaches involving all sectors of society are likely to be the best means of integrating the technologies in formal and nonformal education.

. While all elements of an implementation policy are essential to the success of an innovation, teacher education seems particularly crucial to the successful introduction and sustaining of the use of ICTs in formal education. Teachers are likely to lack even basic computer literacy and other technical skills, with too few having the opportunity of regular access to the technologies, and need careful and ongoing training in new pedagogical methods and approaches. Teachers have been found to be likely to resist innovation if they are not adequately prepared for it or involved in its development. The more familiar they are with the technologies, and the more they are aware of how ICTs can be of assistance to them and their students, the more likely they are to incorporate them into their lessons. At present, research shows that in many cases, teachers are using the new technology in old ways.

. The traditional role of the teacher seems likely to change to a greater or lesser extent with the increasing use of ICTs in schools. They will no longer be the unique sources or controllers of knowledge in the classroom, but it seems clear that they will be needed in new and more varied roles. (National report on the development of education in Australia, 1996)

. students generally exhibit very positive attitudes towards use of the new technologies and it is felt that their acceptance of ICTs in education may act as a catalyst for eventual change in the system.

. products on the market should better meet curricular needs and standards and more collaboration is necessary between technologists and educators. Commercial interests should not be allowed to dominate educational objectives.

. introducing ICTs into education should proceed through a pilot approach despite the implications this has for fostering inequity among schools or communities. Various efforts have shown this to be the best way for initially implementing and evaluating such projects. Mechanisms for the transfer of pilot efforts to large scale implementation must, however, be included in strategies at the outset if long term success is to be possible.

. the cost-effectiveness of using ICTs in education remains uncertain. Their use in administrative work in ministries and schools could increase efficiency in management, and allow teachers more time for actual teaching. Their use in the curriculum, however, will involve considerable initial outlay of funds and important recurrent costs with it remaining uncertain what the returns are in terms of student performance. The cost-effectiveness rationale put forward by Carnoy et al which argues that computer-assisted instruction can replace teachers in the classroom has been rejected on the grounds that it adopts a purely techno-economic approach to problems requiring ôhumanË solutions. (In Hawkridge et al. 1990). Delac ſte (1996) usefully proposes that hardware used in schools be rented to facilitate the constant upgrading of equipment demanded to respond to the rapid evolution of ICTs.

. international collaboration seems more urgent than ever before, if developing countries are to be able to exploit properly the new technologies for educational purposes. In addition to collaborative efforts with technologically advanced countries, developing countries need to find ways of working together at regional and sub-regional levels in order to share limited resources and address common problems.

. it seems unrealistic to foresee the large scale introduction of ICTs into education any time in the near future in poor developing countries when the obstacles to their implementation are so great. It seems more reasonable to suggest that focus be placed on introducing them so as to respond to needs in specific areas where they may have considerable impact such as in distance education for teacher training or in community resource cen·res where they would be accessible to a broad range of learners.

7.3 Areas for future research and action

I. Some of the recommendations in the paper presented by South Africa to the Information Society and Development Conference in May, 1996, are very relevant to other developing countries seeking ways of introducing ICTs into the education

sector in a sustainable manner. One such proposal is for the development of research centres in key areas of information technology for the purpose of developing local expertise and building up a bank of knowledge and resources related to local needs and experience. These institutions or ôCentres of Excellence, Expertise and ResourcesË would be set up as joint efforts between universities, local businesses and the public sector possibly in conjunction with similar institutions in developed countries. Part of their focus would be on the development of ICT applications in different areas. Such centres if established could perhaps function on a sub-regional or regional basis with joint funding.

II. A second South African proposal is for the establishing of ômultipurpose community centresË equipped with the necessary technology for ônetworking, information provision, communication, administration and trainingË and offering ôa range of community support facilities and government servicesË. It is proposed to use existing public buildings such as schools or churches and provide alternative sources of electricity to centres set up in areas with no electricity supply. This initiative has already got underway in South Africa and seems a pragmatic and viable model for other developing countries to follow.

III. Where ICTs have been introduced into schools, research must be carried out into effective ways of maximizing limited resources within large classes, looking at methods of group dynamics, peer teaching, lessons involving different activities for various groups, etc.

IV. Research is needed into innovative and cost effective methods of teacher education to deal with the huge and ongoing demands for training which the introduction of new technologies into the classroom creates.

V. It seems vital to develop information sources for educators and decision-makers in developing countries to guide them in the use of ICTs in education. Information is needed for teacher trainers and also for teachers themselves who are expected to use new tools and courseware, involving unaccustomed teaching methods in their lessons.

VI. Efforts must be taken to develop strategies for endogenous software production in developing countries as well as collaborative efforts to translate/adapt imported software. These efforts should be regional/sub-regional initiatives although the assistance of industrialized countries and international organizations may be necessary.

The aim of this paper has been briefly to try and put the concept of using the new technologies in education into the ôright perspectiveË. Decisions about whether to introduce technologies into the education sector, particularly in developing countries, need to be based on very clear and realistic objectives taking fully into account the

numerous economic and socio-cultural obstacles to be overcome. The tendency is sometimes to see the introduction of technology as inevitable and imperative. Perhaps it is. But fundamental questions have to be asked about its relevance, practicality and effectiveness in education in particular contexts. It is important also to develop new ways of transmitting information and knowledge and of developing learning abilities through the more traditional means which may be all some countries can afford for a long time to come.

8. Case Studies

School-based and school-support networks

8.1 Case study 1: The Australian Capital Territory Information Network (ACTEIN)

The experience of the ACTEIN Programme (Australian Capital Territory Information Network) shows the value of active participation of students and teachers in the use of Internet. This programme is the result of a local university initiative for introducing Internet in primary and secondary schools in the Australian Capital Territory. One of the interesting characteristics of this programme is the low cost of the technologies for connecting the participant schools. Another important characteristic is the emphasis on the training about Internet, developed by experts who visit the schools frequently and train the teachers until they feel confident about the use of Internet. The training includes the pedagogical elements for using Internet in classroom activities. The training has led to high motivation of the participant teachers and students and the development of a rich set of contacts and shared activities.

The value of the use of e-mail is demonstrated by the fact that participants in the programme communicated with countries around the world, organizing common activities. The programme also shows the importance for teachers and students of exploring the possibilities offered by Internet. Teachers use the network for obtaining resources for classroom activities and information about the themes they are teaching.

Probably the most important element provided by this programme is the possibility for teachers and students to participate in world projects using the Internet network. The wide range of choice permits each teacher to select and develop a different activity, adapted to the curriculum and pupilsÊ characteristics. For example, 5- and 6- year-old pupils provided information about koala bears to the Indianapolis Zoo, USA, that had added this animal to its collection.

Address for correspondence: michele.huston@anu.edu.au

Source: Huston, M. (1995) The ACTEIN Program: bringing the Internet to Australian schools, http://rs.krnic.net/HMP/PAPER/202/abst.html

8.2 Case study 2: LabNet (USA)

Labnet is a network of over 1,000 US primary and secondary science and mathematics teachers operating through a commercial service, America Online. This networking facility provides user-friendly software, extensive user support, and access to many Internet services as well as competitive pricing. Teachers access the network via modem dialup to packet switching nodes or via a TCP/IP connection. The project is funded by TERC, a non-profit research and development organization dedicated to improving quality and accessibility of science and mathematics education at primary and secondary levels.

The network structure which was developed as a collaborative effort between project staff and teachers is constantly evolving to meet new needs and interests. A system of teacher moderators has been devised to welcome new members into the network community and to initiate, monitor and sustain dialogue among teachers, creating links between individuals with similar concerns. Project staff have developed a six-week on-line course including a 40-page guide to provide training and support to moderators so as to improve both their technical and moderating skills. A modest stipend is paid to those fulfilling this role.

Network activities include subject-specific message boards; discussion groups; on-line courses on a variety of science teaching and technical topics; a file library with hundreds of teacher-contributed science materials, project ideas, software, and archived conversations; and a clearing house for information about workshops and grant opportunities. When teachers join Labnet, they are asked to make a commitment to active contribution in the electronic community, including contributing messages. Despite the fact that it takes teachers time to become active users, 90% of members have described themselves as active participants in the network. Membership is open to any mathematics or science teacher.

The most common purposes for which teachers use the network include: to gather ideas and teaching materials; to share experiences in an ongoing way; to experiment with telecommunications to feel less professionally isolated; to experiment with project-based learning; to learn more about teaching science or mathematics; to inform others about their work. The four areas of impact on their profession most frequently cited by teachers are: gathering ideas and materials; promoting use of project-based learning; enhancing teaching and student learning, and providing access to a community for support and collaboration.

The possibilities of Labnet operating on a self-sustaining basis are being explored. These consider financial and administrative aspects as well as ensuring active and committed membership. Basic staff requirements of two full-time staff assisted by part-time moderators and volunteers would need to be increased as membership grows. Participating teachers already pay membership fees and the combination of these funds with corporate sponsorship is seen as a possibility for future financing.

Plans relating to administration and membership include transferring leadership of the

network to teachers; putting in place an elected governing board representing teachers, professional organizations and TERC; providing incentives for members such as continuing education credit; finding ways of increasing teacher access.

LabNet is considered superior to other professional networks involving teachers which have developed through Internet listservs and newsgroups. AOL provides a very user-friendly service, minimizing the need for the type of training necessary for using many Internet-based tools. The moderator system provides support, professional experience and guidance which is not available on many other networks.

Address for correspondence: TERC, 2067 Massachusetts Ave, Cambridge, MA 02140, USA. Fax: 617 349 3535; e-mail: Billy-Spitzer@terc.edu, Kelly-Wedding@terc.edu

Source: Spitzer, W. and Wedding, K. ôLabNet: an intentional electronic community for professional developmentË, Computers and education (London) vol. 24, no. 3, 1995, p. 247-255.

8.3 Case study 3: Common Knowledge: Pittsburgh (USA)

Common Knowledge: Pittsburgh (CK:P) is a collaborative project of the Pittsburgh Public Schools (PPS), the University of Pittsburgh and the Pittsburgh Supercomputing Center. The project seeks to develop new environments for teaching and learning using the technology of wide area computer networks for developing an expandable networking infrastructure to support curriculum activities and educational reform.. The project's focus spans the entire school district, with an emphasis upon curricular applications of the technology, a constructivist approach to implementation at all levels and a goal of institutionalizing the use of networking technology across the school district. These broad aims have enabled the project to learn something of the dynamic of organizations undergoing significant change and to develop technological solutions appropriate to the school environment. The lessons of this project should be widely applicable to other school districts. Both the technology of Common Knowledge: Pittsburgh and its methodology have applications beyond the school environment, and efforts are under way to extend the project's scope to a broader community focus.

CK:P is funded by the National Science Foundation's Networking Infrastructure for Education (NIE) Program, which lays a foundation for the appropriate use of technology to enhance teacher professionalization, student achievement, and school restructuring. NIE's goal is to develop synergy between technology and education researchers, developers, and implementors so they can explore networking costs and benefits, test self-sustaining strategies, and develop a flexible educational networking infrastructure.

During the first three years of CK: P (1992-95), two sets of educators were trained in Internet navigation. Thirty-one educators from two elementary and two high schools

were involved during the 1993-94 school year, receiving initial Internet training during a one-week workshop in the summer of 1993. Ninety-eight educators from four elementary, one middle, and two high schools were involved during the 1994-95 school year, receiving their training during Spring 1994. The participating educators were primarily teachers, but also included librarians, PPS professional staff, aides, and principals. The educators attended a basic skills workshop (Workshop I) and an advanced skills workshop (Workshop II). Workshop I combined lectures, demonstrations, and hands-on skill building. Participants were taught basic e-mail techniques and how to subscribe to mailing lists and access newsgroups; they were shown educationally relevant databases and how to do online searches. In Workshop II, participants looked for curriculum materials on client/server interfaces (which were expected to be available in the schools once networks were installed), and developed site-based implementation plans or action plans. The goal was for educators to think through a plan for the school year, enabling CK:P project staff to plan their support activities.

Workshop training in the second year was similar to that of the first but was scheduled differently to manage the 98 participants. Also during the project's second year, PPS attempted to institutionalize network technologies. A total of 29 schools acquired wide area network access. The technical infrastructure provided for scalability, interoperability, and remote management, and a support infrastructure offered ongoing and immediate support for students and teachers who were using the Internet in curriculum activities.

Currently, CK:P is working on a constructivist approach towards staff development, an internal request for proposal for new sites, curriculum-based activities using the Internet, and ongoing support. Specific hardware products currently under development include: 1) project servers that link schools on a variety of UNIX programming platforms, with the ability for common source maintenance, local user administration, and remote system administration; 2) client setup services for Windows PCs and Macintoshes that allow for the automated restoration of a computers' corrupted software and the rapid set-up of new user devices; and 3) network architecture models that establish a network hierarchy of school-based local area networks, a city-wide Metropolitan Area Network, and wide area networks to provide teachers and students with access to a wide range of on-line resources and to allow them to present their work to a world-wide audience. In addition, CK:P is providing Internet access at a community center for parents and community members.

As a result of CK:P professional development efforts, approximately 700 teachers have established Internet accounts and are using the Internet both as a professional development and a curriculum resource; hundreds of educators have participated in area workshops to gain advanced Internet training; and peer training activities have increased. A variety of classes are being offered to students and staff in order for them to upgrade their Internet skills and more general computer awareness.

The project is being assessed by an independent evaluator to illuminate the educational and social consequences of wide-area computer networking in the public schools. The evaluator is using case studies designed to identify the factors that shape how networking technology is used and how its use influences teachers and students. In addition to the case studies, some formative evaluation activities will also be conducted to assist project staff in developing training materials and procedures, and in adjusting such activities to fit changing circumstances.

An important element of the project's proposed architecture is the utilization of site-based servers which provide the scaling necessary to reach all students and teachers at each participating school. From a support perspective there is much more to this step than the simple deployment of site-based servers. Teams - user administrators - at each site are being instructed in the operation of these servers for such tasks as account creation, disk backups and quota management. These teams also provide support and maintenance for local user devices. These project sites are becoming more self-sufficient.

From a curricular perspective, first year CK:P schools have matured in their use of wide area networks. Each site has created powerful models of how wide area networks can be used to further education and professional development goals. Teachers from these sites are taking a leadership role in the expansion of the project into their schools and the district. They are beginning to provide workshops for PPS staff at their schools and on a district level in subjects such as Research on the Internet, Using HTML, Going Online, and Using Email. These sites use the CK:P model of developing local experts to provide ongoing support and expansion. To facilitate these changes there have been shifts in the structure of the CK:P collaboration itself and in the approach which the collaborators are taking toward the deployment and support of networking activities. First of all, there has been an effort to identify a set of ôproducts", which are being made available to participating schools and will be available, in the future, to other schools in Pittsburgh and other cities. These "products" include not only the obvious pieces of hardware, such as school-based information servers and networked client machines, but procedures which support these activities. These procedures include activities relating to the hardware, such as machine setup and maintenance protocols, as well as activities relating to the presentation of project activities and the project's outlook to teachers and school district staff.

A second shift in the CK:P collaboration relates directly to the desire to transfer responsibility for network operations from the Supercomputing Center to the Pittsburgh Public Schools. It has been found that the development of CK:P's hardware and software products require major input from the project's educational staff and are best handled in the context of actual school use. Efforts towards making this change are underway.

The third element of the project tests the concept of Ethernet connectivity via cable TV. In theory, this architecture offers the possibility of low-cost, high-bandwidth connectivity

to schools and homes around the city. This connectivity option has been found to be more difficult to implement than was first expected. Issues regarding hardware, cable lines and building access have slowed this project down.

Address for correspondence: zinga@pps.pgh.pa.us

Source: Carlitz, R. D. and Zinga, M. (1994) Common Knowledge: Pittsburgh. Creating common knowledge: school networking in an urban setting http://www.pps.pgh.pa.us/publications/articles/ckp_6.html

8.4 Case study 4: Proyecto Enlaces (The Link Project) (Chile)

The Programme for Modernization of Secondary Education (Programa de Modernizaci≤n de la Educaci≤n Media - MECE) is a project of the Ministry of Education of Chile and some Chilean universities. The goal is to implement at national level an Educational Computer Network, develop computer awareness on the part of the different actors in education and incorporate the new technologies of information and communication in learning. The ôProyecto EnlacesË (Linking Project), part of the above-mentioned programme, was started in 1993 as a pilot project, looking for the identification of the different roles, impacts and benefits of the use of computers and telecommunications in Chilean schools. In 1995, the Proyecto Enlaces was developed as a project covering all the country for basic and secondary education. The schools receive equipment (computers, printers, modems), educational software, initial training and ongoing support by means of the network, in person (visits) and support materials (texts, multimedia-based self-training software and videos). The equipment is incorporated gradually, with priority given to the teachersÊ work. The computers are connected to each other by telephone, occupying the lines mostly during the night when telephone rates are low and only occasionally during the day. The network is open, allowing the gradual incorporation of all the schools and institutions that wish to participate with their own resources and projects. Network priority will be given to collaborative inter-school projects.

The Enlaces project has developed the ½ La Plaza ¶ software, initially a Hypercard prototype, now a C++ application which permits very easy access to the computers whether for using educational software (mostly multimedia based applications), to take advantage of communications (local, municipal, regional, inter-regional and international) or to participate in educational projects and deliver and receive information by means of the network.

The Enlaces project is experimental in nature and will permit the identification of the role, cost, impact and benefits which the use of computers, multimedia and telecommunications in the schools may have. Some of the emerging roles are:

Pedagogical: As a support tool for the teacher and the student in educational work; promoting motivation, sociability and communication.

Social and professional: Establishing personal ties and an exchange of experiences as much among teachers as among students at the local, regional, national and international level.

Cultural: Providing access to information and participation in projects through inter-regional and international educational networks; expanding the studentÊs global vision.

Administrative: Helping with routine tasks in the schools.

Educational Computing Centres were installed in the participating universities. These centres administrate network traffic, design and implement strategies for network insertion, computer training and computer use in the schools, support projects proposed by the schools, develop and evaluate software and provide technical and pedagogical support to the schools connected with the project.

In November 1995, the participation in the project was 148 schools, 22 colleges and 31 institutions.

Projections: for the year 2000: 100 per cent of secondary education and 50 per cent of basic education. (5,200 schools in all the country).

Address for correspondence: Universidad de la Frontera, Av. Francisco Salazar 01145, Casilla 380, Temuco, Chile. Fax: 56.45.250.759. Email: enlaces@enlaces.ufro.cl

Source: Chile. Ministerio de Educaci≤n. (1994) Enlaces Year 1 - 1993, Monografφa, 1i., Temuco.- REUNA Proyecto Enlaces http://www.enlaces.cl/

8.5 Case study 5: EDUNET (Pakistan)

In Lahore and elsewhere in Pakistan, the Sustainable Development Networking Programme (SDNP) will work closely with EDUNET, a project of the Education Support Trust, which has received support from UNDP. The Education Support Trust has almost twenty years experience of running an educational project. To overcome the severe shortage of resource material at this level, they have used their extensive library of books, journals and CD-ROMs to extract material relevant for the curriculum and extra-curricular activities and put it into a large database. Schools, teachers and students with e-mail facility can access this resource at reasonable cost. EDUNET will provide online access to CD-ROMs of general interest and to standard encyclopaedias that would normally be inaccessible to most educators and students.

EDUNET has given a great deal of thought to cataloguing their information and this should facilitate access to relevant material. To date all the material is in English, but there are plans to translate most of this into Urdu.

Educational material is being produced at a phenomenal rate globally and it is almost impossible for a country such as Pakistan to take advantage of these developments without access to CD-ROM resources and the Internet. Apart from down-loading free material Internet connectivity allows students and teachers to communicate globally with their peers. It is here that SDNP experience will help in connecting EDUNET's users to national and global information services as well as to people.

EDUNET and SDNP will soon be operating jointly in Lahore and shortly thereafter in Karachi, Quetta and Peshawar. They will hold free weekly workshops in these cities to popularize networking for education and other needs.

Address for correspondence: daudpota@sndpk.undp.org; zambrano@undp.org

Source: Daudpota, I. and Zambrano, R. (1995) The Sustainable Development Networking Programme: concept and implementation, http://www.net.edu.cn/HMP/PAPER/119/

Teacher education

8.6 Case study 6: Using EdNA in the Curriculum (Australia)

This teacher education project was initiated by the Curriculum Corporation in co-operation with the National Schools Network, Australian Education Union and the Research in Computer Education Group, Deakin University. Funding is provided by the National Professional Development Project.

The objective is to develop through an initial pilot phase, a flexible school-based professional programme for teachers delivered entirely through the Internet (WWW) with the option of telephone, fax and e-mail communication. The content of the course will focus on the use of new computer technology in teaching and learning. Specific areas include basic skills necessary for using computers in the classroom, use of Internet in school settings, current research on best practice models of teaching and learning with particular reference to computer technology, and project work on using computers in education.

The focus of the content of the course will relate to the workplace and university attendance will not be required. Teachers may enter the course at any time and pace their own learning and involvement. Completion of four modules will lead to the Certificate of Effective Teaching awarded by Deakin University and the Curriculum Corporation. Course delivery and management is the responsibility of

Deakin University. Teachers are expected to contribute actively to the development of the content and process of the proposed course and their work will be peer reviewed. These teachers will receive a certificate of participation which will be equivalent to one fully completed module of the Certificate of Effective Teaching offered by Deakin University.

Address for correspondence: Ms Heather Watson, Curriculum Corporation, 141 Rathdowne Street, Carlton, Victoria 3053, Australia. Fax: (03) 9639 1616; e-mail: heather@curriculum.edu.au

Source: Curriculum Corporation and Deakin University. (1996) Using EdNA in the curriculum: teacher professional development on the Internet, http://rice.edn.deakin.edu.au/CurrCorp/Currcorp.html

University-school links

Case study 7: The Central Queensland University Public Access Network (Australia)

The Central Queensland University Public Access Network (CQ-PAN) is a research project within the UniversityÊs Department of Maths and Computing. One of its outcomes is the provision of cheap and easy to use Internet connections to schools in the local community. Since 1993, the project has accomplished the following for local schools:
- developed a cheap simple off-line system that can provide access to Internet e-mail and news for an entire school body
- provided on-line Unix accounts with Internet access to a small number of local school teachers
- installed the off-line system in four Rockhampton schools (three secondary and one primary)
- started development of an on-line system that will provide full IP access to local schools at minimum cost.

The Central Queensland University provides free of charge to the participating schools the Internet connection, modems and a server machine located on the university campus. The CQ-PAN project team provides the software, documentation and training necessary to use the Internet. All the software used in the project is in the public domain but since much of it is difficult to use or is not designed to work together as a whole system, the project team incorporates it into a user-friendly working system. All the team members of CQ-PAN are computing students participating in the project as part of their final year project work.

The off-line system is the cheapest and easiest way for an entire school to gain access to the Internet. Users read and reply to e-mail using a local drive on which the information is recorded and stored. Each day the school dials up the university computer and the

two computers automatically exchange incoming and outgoing e-mail and news. The exchange of information can be timed to occur at any time of the day, thus making the use of cheap STD rates possible and enabling students and their teachers to collect mail at times convenient to the schoolÊs day.

The drawback of the current system is that it only provides access to e-mail and Usenet news. However, staff and students report that this provision is adequate for their current needs. It has the advantage of allowing schools to use e-mail within school programmes in existing circumstances with existing equipment, giving them an introduction to the potential educational uses of Internet. The system allows all teachers and students to have separate Internet accounts.

The basic equipment required for using the system is an IBM PC with at least 10 megabytes of disk space, a 2400 bps modem and a phone line. Electronic mail and news are read using a user-friendly MS-DOS-based news reader that is freely available off the Internet. A single stand-alone machine may serve as both the communications machine and the reader machine, the information may be downloaded onto diskette and read on several stand-alone machines or a local area network may be set up.

The plan is to extend the system to schools within the wider Central Queensland area by making use of the UniversityÊs branch campuses.

Address for correspondence: Rex Boggs, Glenmore State High School, Rockhampton, Queensland, Australia. E-mail: rex@cq-pan.cqu.edu.au or David Jones, Department of Maths and Computing, Central Queensland University, Rockhampton, Queensland, Australia. Fax: (079) 309729; E-mail: d.jones@cqu.edu.au

Source: Boggs, R. and Jones, D. (1995) Lessons learnt in connecting schools to the Internet, http://cq-pan.cqu.edu.au/david-jones/papers/papers/1994/lessons.html

8.8 Case study 8: The China Education and Research Network Project (CERNET)

This project funded by the Chinese government and directly managed by the Chinese State Education Commission seeks to establish over the next few years a nation-wide education and research network infrastructure to support education and research in and among schools in China using the latest technologies. CERNET will be directly connected to the Internet, becoming a major part of the Chinese network community. The specific aims are:

- to establish a nation-wide backbone which connects eight regional networks;
- to establish connections to the Internet;

- to set up a national network centre and several regional network centres;
- to adopt TCP/IP as the major network protocol and provide Internet applications;
- to develop ChinaÊs information resources and applications.

In addition to the national and regional network centres, the administrative structure includes an administrative and a technical board. The planning strategy is as follows: 1) centralized planning and decentralized implementation; 2) based on the open/standard principle, adopting TCP/IP as the major network protocol; 3) strategically supporting the promotion of the regional network nodes and the construction of campus networks; 4) centralized management and operational control of the backbone and decentralized management and control of the regional networks.

The first phase of implementation (1994-1996) foresees the establishment of the national network centre, ten regional network nodes, the nation-wide backbone as well as Internet connectivity. More than 100 universities and institutes should be connected. During the second phase (1997-2000) all schools and other education and research institutions in the country will be included in the network.

ChinaÊs 1,900 universities, 39,412 middle schools and 160,000 primary schools will make CERNET the largest education and research network in the world.

Address for correspondence: xing@cernet.edu.cn or jianping@cernet.edu.cn or liangyn@)tsinghua.edu.cn

Source: Xing, L., Jianping, W. and Youeng, L. (1995) Connecting China education community to the global Internet - the China education and research network project, http://aleph.ac.upc.es/HMP/PAPER/077/html/paper.html

Community-wide initiatives

8.9 Case study 9: The South Bristol Learning Network (UK)

The South Bristol Learning Network (SBLN) was set up in 1993 with initial funding from the Department of Employment through the national Training and Enterprise Council (TEC) ôChallengeË competition sponsored by Avon countyÊs TEC branch. The SBLN aims to give local people and organizations the opportunity to produce and shape information that reflects their needs, thus creating a model of community development, taking both educational and economic advantage of the potential of the very latest multimedia interactive information technology. A sustainable prototype has been developed through the collaborative work of a partnership including the education

community (schools and further education), local and national government, other private and public sector organizations such as the Bristol Chamber of Commerce and Initiative and the regional television company. The Network comprises a total of nine different projects including a community development unit; a partnership resource centre; business services; management initiatives; teleworking; and workstore. These are based across the area linking local community, education and business organizations.

The projectÊs strategic objectives are:
- to raise the awareness of individuals, groups and organizations of the potential for new and existing information and communications technologies to enable them to identify, shape and use the technological infrastructure for the services they require;
- to work with other partners to establish a sustainable public access electronic information network and local broadcast channel;
- to develop the potential of new technology to assist in lifetime learning for individuals, companies and organizations;
- to create new jobs and small businesses for local people through the provision of newly identified information and communication services;
- to establish a training platform for the development of a new skills base in South Bristol for ôinformation workersË; and
- to act as a centre of expertise and information to inform and support similar development elsewhere in the UK and Europe.

The individual projects target different sectors of the community and their needs in information and communication. Schools and community organizations in the area have been audited and their needs and interests noted for the development of pilot projects and provision of services. A partnership resource centre serviced electronically is being developed to meet the needs of companies in the region of South Bristol. A vital aspect of the SBLN is the development of a public access electronic network to support the civic network. Opportunities will be provided for access to electronic means of communication such as e-mail and bulletin boards, with the interests of specific groups such as the elderly and the disabled taken into consideration. Access will be provided to local public information as well as to information at national and international levels, through facilities such as the Volnet database, Compuserve and the Internet. All SBLN sites are to be linked electronically with an on-line education and training course being run on each site with partners in the UK and Europe. Collaboration is foreseen between local libraries and partners in the Netherlands and Portugal for the development of a multimedia networked Community Information System for use in a variety of public access points in Bristol.

Another means of public access to information is to be provided through a local television channel which will provide both local text-based information and programmes. Efforts are being made to involve the local community fully in the provision of input to the channel.

The Workstore project will co-ordinate the provision of various types of multimedia

materials and will provide training and support for schools, community groups and other organizations. It is expected that this project will develop into a sustainable production company providing employment, perhaps on a self-employed basis, to its original members. Income will be generated from programme financing for local and national channels, commercial video production, information and training materials using multimedia approaches, and sponsorship for key feature programmes on the local channel.

With the majority of project workers coming from previously long-term unemployment, training has been a vital aspect of the SBLNÊs work. All project workers are undertaking training linked to recognized qualifications, in addition to core training in the use of the latest ICTs, work skills and interpersonal skills. The project has employed over fifty previously unemployed local people and planned to provide training opportunities for thirty additional long-term unemployed persons in 1994/95.

The SBLN has sought to rationalize, formalize, monitor and evaluate its management with financial and technical assistance from academic institutions and the private sector. It aimed to develop sustainable operations in 1994/95 and planned to establish a charitable company with a linked trading company to facilitate these plans. The personnel structure, salary levels, commercial opportunities and funding arrangements were to be reviewed at the end of 1994.

Address for correspondence: John OÊHara, Director, South Bristol Learning Network, South Bristol College, The Hartcliffe Centre, Bishport Avenue, Hartcliffe, Bristol BS13 0RJ, UK. Fax: +44 1272 641021

Source: OÊHara J. ôThe South Bristol Learning Network - a 21st century cable-based telecommunications infrastructureË. Educational media international (London), vol. 31, no. 2, 1994, p. 86-91.

Case study 10: Telematics for African Development Consortium (South Africa)

This initiative involves the active collaboration of a variety of institutions including the countryÊs leading broadcaster (SABC), telecommunications company (Telkom), research centre (CSIR), a specialized distance education university (the University of South Africa- UNISA), other universities, a leading secondary school (St AlbanÊs College), private sector enterprises and community organizations. The Consortium is focusing on distance education as its first priority.

The Consortium has launched a multi-phased project expected to last at least five years and reach out to other African countries. The first phase involves a series of pilot projects intended to prove concepts and keep costs and overheads low while reducing technology and other risks. It targets people who have previously been excluded from educational opportunities either through the Apartheid system or economic

disadvantage.

The Consortium is attempting to address the educational needs of the disadvantaged where practical solutions can be developed quickly. For this reason, pilot projects are being tested in peri-urban rather than in rural areas with the longer term objective of replicating the project throughout Africa.

The projects in the first phase are expected to be completed by September 1996. They include the following:

- a prototype Internet-based academic English reading skills course for 7,600 tertiary level first year English medium students at UNISA. This course will also be part of a UNISA Access Course which is aimed at raising students to a level where they can gain access to a tertiary level institution. Once evaluated and tested, the course will be available to all UINISA students and as a free public service to anyone with Internet access through the UNISA server.
- a prototype Internet-based Standard 7 biology syllabus and course for use by secondary level teachers and students.
- wireless wide area bandwidth connectivity in the disadvantaged township of Mamelodi and a rural school outside Pretoria. Initially, only the teacherÊs college, library and two high schools will be connected in Mamelodi. An informal essential information service will be provided to the community through this infrastructure. The groundwork will be laid to develop this concept into a system that can be replicated throughout Africa, providing wireless access in areas where there is no existing telecommunications infrastructure.
- tools which will facilitate and accelerate further growth of the project will be developed including a curriculum creation and management tool and an intuitive multimedia educational interface.

If successful, the project could be replicated in other African countries providing a partial solution for education in poor regions. The Telecommunications Foundation for Africa (TFA) based in Kenya and the SADC Secretariat, based in Gaborone, are involved. Negotiations have also started with the Informatics Center of Eduardo Mondlane University in Maputo.

Source: Knight, P.T. (1996) Destined to leapfrog: why a revolution in learning will occur in Brazil, Russia and South Africa. http://www.worldbank.org.html.emc

8.11 Case study 11: The Amazonia Programme (Brazil)

The Project ôGrito de Alerta em Defesa da Floresta Amaz∫nicaË (ôCry of Warning for Defence of AmazoniaË) is an educational project carried out through field research in Amazonia. It started in 1996 in the College ôSanta Cecilia in CΘarß, with pupils from 7 to 1 years. The goals were to organize a world project in defence of

Amazonia, stimulate pupil participation in Brazil and in other countries, build a communication channel between governments and NGOs to identify the environmental problems in Amazonia and look for solutions, build an NGO with adolescents in defence of Amazonia, organize local and distant field research about the forestÊs resources using information systems, use Internet as a fundamental tool for the dissemination of the studies and build an ecological conscience. The activities were centred in expeditions to Amazonia and were multidisciplinary: history, geography, biology, physics, chemistry, religion, sciences, arts, sociology, philosophy, mathematics, Portuguese and educational informatics as an integrative element for stimulating pupilsÊ participation.

The tools for the field research included a 486 PC, three notebook computers, one laptop, scanner, modem, photography equipment, cellular telephone, video-conference cameras, electric generator and software for establishing communication using Internet and for the multimedia productions of pupils. The activities included keeping a journal, organizing a catalogue of species, developing a dictionary of local vocabulary, producing games about the fauna and the flora of the region, compiling an album of multimedia, collective building of the home page of the project, observation of weather and plant germination and observation of animals. Pupils analysed the environmental situation of Amazonia and the social situation of indigenous people and wrote short reports. The results are incorporated in a site on Internet and more than 200 persons from Brazil and other countries have sent messages supporting the activity.

Source: Projecto Amaz∫nia. Grito de Alerta em Defensa da Floresta Amaz∫nica (1996) http://www.trend.com.br/amazonia

New applications

8.12 Case study 12: Video conferencing from the desktop (Australia)

The medium of interactive video conferencing has been very successful at higher/tertiary level but normally involves the use of expensive equipment needing special digital (ISDN) telephone lines. In 1992, a new device called the ôV÷neË appeared, a video conferencing telephone which worked on a single telephone line. This was a distinct improvement on earlier attempts to produce cheaper video phones and low bandwidth ISDN uses. The quality of the image was reasonable and it was available at a more affordable price. The V÷ne promised interactive computing facilities as it could reside on the desktop computer. An improved device has since been released. In Australia, Telecom AustraliaÊs subsidiary, Advanced Network Management Pty Ltd (ANM) in conjunction with COMTECH Laboratories in the USA are developing this video telecommunications technology which uses specially developed educational software. The jointly developed US and Australian technology will enable fully interactive video conferencing to be available on the desk top and connected only to a single analogue telephone line. It will also have the capacity to work on a ISDN link.

The PC version of the V÷ne developed in Australia is called the personal Computer video Codec (PCVC). It creates a window on a PC screen letting callers see each other as they work, and permitting them to work jointly on documents, texts and graphics. It is designed to work with IBM compatible PCs and will comprise a PC, a small video camera, video board and software. Using videoconferencing on the desktop, teachers and students will be able to communicate with each other in a similar manner as in a normal classroom, and, importantly, teachers will be able to gauge studentsÊ unspoken physical behaviour as a way of monitoring their understanding, interest level and general attitudes. Daily lesson plans, textbook and other images, assignments, etc. can be electronically transmitted for student viewing, retrieval and modification in their own time. Networking technology will allow teachers to communicate directly with many students at a time and students to communicate directly with each other. However, this last facility is presently rather complex and costly.

While the video image used over a simple telephone line may not be of broadcast quality, still pictures and diagrams are. The resulting components of a presentation can be selected for a lesson in any mix desired by the teacher. An added advantage is the ability to be able to record the activity.

With the rapid development of modems, the quality of the video provided through these devices will improve, over-riding the need for ISDN networks, thus making use of such a system more possible in developing countries. Much effort needs to be made to establish the most effective way of using desktop video conferencing devices as a teaching and learning tool.

Address for correspondence: Applied Learning Technologies, 26 Hauteville Terrace, Eastwood, South Australia 5063.

Source: Dunnett, C. Telecomedia! - telecommunications and media in distance education. Educational media international (London), vol. 31, no. 3, 1994, p. 197-201.

International initiatives

8.13 Case study 13: The Sustainable Development Networking Programme.

The Sustainable Development Networking Programme (SDNP) is a United Nations Development Programme (UNDP) initiative that links users and suppliers of information in developing countries via computer mediated communications on a participatory basis and thus creates a national space where the flow of information on topics related to sustainable development can occur in a steady and sustainable manner.

The concept of SDNP was initially developed in 1989. At that time, the key concern

was to provide timely access to adequate information sources for policy and decision-makers in developing countries with the aim of helping them in the decision-making process.

In 1993, UNDP launched Capacity 21, the initiative that follows up the implementation of Agenda 21 in developing countries. SDNP has been integrated into this initiative since then, indeed most SDNP projects are now being supported through this channel.

The implementation of SDNP in any developing country is based on the following principles:

. Participatory process: includes all sectors of society (government, academia, NGOs, businesses, etc.)
. Complementarity: seeks national partners with similar goals; avoids duplication of efforts.
. Appropriate technology: countries are provided computer and networking technologies that are adequate for existing infrastructure and available human resources.
. Catalytic funding: UNDP's financial support is limited; sustainability of the project is emphasized since its very beginning.
. National ownership: the project is owned and run by nationals for nationals.
. Round table approach: provides a meeting place for stakeholders to meet and discuss relevant issues.
. Capacity building: fosters the creation of the necessary body of expertise at the national level.
. Agenda 21: direct association with the preparation and implementation of national Agenda 21 plans.

One of the main targets of SDNP is the creation of the national body of expertise to implement, support and sustain the process of information dissemination and exchange in the context of sustainable development. This includes the following:

. Training in the use of information technologies for specialized personnel; training of end user trainers.

. Training of end users in information sources (where to look for information, etc.). SDNP nodes emphasize meta-information to facilitate this and create catalogues and directories of information relevant to sustainable development, according to the needs and requirements set by the feasibility study.

. Training of end users in how to use information obtained through the network.

. Capacity building at all these levels will provide the necessary basis for long term sustainability and national ownership of the process.

At the moment, SDNP has 16 operational nodes in developing countries namely, Angola, Chad, Morocco, Tunisia, Bolivia, Honduras, Indonesia, Pakistan, Philippines, South Korea, South Pacific, Estonia, Lithuania, Poland and Ukraine.

Furthermore, activities have already been initiated in another 16 countries namely, Cameroon, Malawi, Mozambique, Zambia, Jordan, Lebanon, Chile, Colombia, Costa Rica, Guatemala, Mexico, Cambodia, China, India, Latvia and Lithuania.

SDNP has prepared the SIDSNet feasibility study, a proposal on providing Internet connectivity for the Small Islands Developing States (SIDS). SDNP has also financed Internet Training for several former CIS countries and is currently deeply involved in donor discussions regarding Internet access for the African continent.

SDNP's activities have had an enormous impact on the process of networking in Pakistan at the policy level. Through continuous publications in the national media, SDNP has contributed to a radical change in the way connectivity and networking is perceived within the country. SDNP efforts have also helped in the process of privatization of the national telecommunications sector.

Address for correspondence: daudpota@sndpk.undp.org or zambrano@undp.org

Source: Daudpota, I. and Zambrano, R. (1995) The Sustainable Development Networking Programme: concept and implementation, http://www.net.edu.cn/HMP/PAPER/119/

9. ANNEX 1

The use of information and communication technologies for community development

The use of ICTs should be part of a global programme for development that provides clear goals for education. The coherence between the goals and the tools used for achieving them is fundamental for the success of developing programmes and for their educational component.

ICTs could be very useful for community development, facilitating communication within the community as well as between the commmunity and training and research centres, government agencies, NGOs and international organizations. ICTs could be used in the development of community education programmes aimed at sustainable development. However, it is important to bear in mind that ICTs are tools and not magic solutions for all problems. It is also important to consider the impacts that could be provoked by the

introduction of ICTs in the life of a community, such as cultural changes, changes in the social structure, conflict between generations and increasing disparities between rich and poor. It is difficult to foresee all possible impacts.

ICTs could facilitate the relationships between schools and the community and the process of transformation of schools in centres of sustainable development.

The use of ICTs in basic education and in community development could promote new positive attitudes concerning sustainable development and could be an important element for education towards sustainable development and improving the quality of life. Not only could the information obtained using ICTs facilitate decision-making for sustainable development, but the use of the technologies could provide useful information for problem-solving, for developing participation, for a better organization of activities and for improving the relationships between training centres and the population.

ICTs could be useful for conserving traditional knowledge that should be used as a basis for education towards sustainable development. An example is the ôIndigenous Knowledge ProgrammeË, which focuses on the development of indigenous communities and the protection of biodiversity. The programme is supported by Bellanet, which provides specific tools for enhancing communication and information-sharing.

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