World Education Forum

Dakar, Senegal
26-28 April 2000

Education for All 2000 Assessment

THEMATIC STUDIES

Applying New Technologies and Cost-Effective Delivery Systems in Basic Education

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Co-ordinating agency: Department for International Development (United Kingdom)

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UNESCO

Applying New Technologies and Cost-Effective Delivery Systems in Basic Education

This thematic study was originally published by UNESCO for the International Consultative Forum on Education for All, as part of the Education for All 2000 Assessment leading up to the World Education Forum held in Dakar (Senegal) in April 2000. The present document is a re-issue of the original study with minor editorial modifications.

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Printed by ▶ Graphoprint

Printed in France 2001
ED.2001/WS/20

Contents

I. General introduction

For many centuries education meant people talking and listening: teachers talking to students, students listening to teachers, sometimes teachers listening to students. The invention of the world's first alphabet in Greece, followed after a millennium and a half by the development of printing in China, Korea and later Germany, meant that fortunate students could now also use blackboards and books. Over the past 150 years new communication technologies have brought new opportunities. Railways and cars meant that teachers could travel, allowing the walls of the university to stretch to the borders of the state. Cheap and rapid mail and lowered paper costs made correspondence education possible. Educational broadcasting followed. Computers have come into the classroom. A rich variety of experience has been matched by a baffling coining of new terminology: telematics, educational technology, new information and communication technologies, open learning, distance education, computer-based learning and more. This study sets out and assesses the record of using these technologies to support basic education.

Principles

We start from three principles. First, there is no substitute for school. Children need to learn within a social environment and there is ample evidence that those who do not get to school are at a disadvantage when compared with those who do. It follows that the major role of the various technologies is to strengthen school, not to provide an alternative to it. Care must be taken not to compromise existing school provision by the diversion of much-needed resources. But, second, many adults and some children cannot get to school; technologies may have a role to play in meeting their needs. Third, it makes sense to look at the technologies together – from print to radio to computers – both because of the blurring of the engineering distinctions between them and because of the need to make allocation decisions in which the decision-maker often asks whether to bother with any of these technologies – and if so which – or to stick with salaries, chalk and a few books. That said, there is a useful practical distinction between the production of books for schools and these other technologies. The book industry is well established, well understood and occupies a well-illuminated niche in the education system. The other technologies are newer and more complex, and marked by sharp divisions of opinion between sceptics and enthusiasts.

Defining terms

The following definitions come from various sources and have got some degree of acceptability from use.

Educational technology is the systematic planning of teaching and learning within a process that compares the appropriateness of alternative methodologies as means of achieving defined learning outcomes.

Distance education is an educational process in which a significant proportion of the teaching is conducted by someone removed in space and/or time from the learner.

Open learning is an organized educational activity, based on the use of teaching materials, in which constraints on study are minimized in terms either of access, or of time and place, pace, method of study, or any combination of these.

Computer-based learning is the use of computers in education either to provide programs that deliver instruction, or to facilitate communication between learner and tutor, or to enable students to have access to remote sources of information.

Telematics is the combined use of telecommunication and computer technology.

New information technologies, and information and communication technologies, are synonyms for telematics.

Open and distance learning is an umbrella term covering distance education, open learning, and the use of telematics in education.

In practice, the choice of terminology is shaped by geography. In North America the words 'distance education' are likely to be used mainly for video-conferencing or computer-conferencing while in Africa, Asia and Europe they are more likely to refer to the use of print or broadcasting. 'Open learning', with its implicit value judgements about opening access, is used more in industrialized than developing countries. 'Open and distance learning' has been adopted by the European Commission as a marker for projects that may attract funding; the term has, understandably, gained currency in Europe.

The World Declaration on Education for All, adopted in Jomtien, Thailand, 1990, defined basic learning needs; we use the term 'basic education' to cover any educational service that aims to meet them.

> [Basic learning] needs comprise both essential learning tools (such as literacy, oral expression, numeracy, and problem solving) and the basic learning content (such as knowledge, skills, values, and attitudes) required by human beings to be able to survive, to develop their full capacities, to live and work in dignity, to participate fully in development, to improve the quality of their lives, to make informed decisions, and to continue learning. The scope of basic learning needs and how they should be met varies with individual countries and cultures, and inevitably, changes with the passage of time. (World Declaration on Education for All, Art. 1, para. 1.)

We are taking basic education to include the primary cycle, together with the junior-secondary cycle, at least where this is becoming part of universal education, and equivalence programmes out of school. A broad definition of basic education will also include non-formal activities for adult from literacy work to some of the activities of extension agencies.

Limits and methodology

Limits have to be drawn in a study of this scale and we have excluded from discussion the use of technology in the management of basic education (either at Ministry of Education or at school level) and private out-of-school teaching.

Data for the thematic analysis of developments from 1990-2000 are drawn from variety of sources. The main ones are:

- information provided by some of the UNESCO Regional Technical Advisory Groups;
- literature and web-based searches of specialist databases, including the International Centre for Distance Learning (ICDL), the International Extension College specialist collection, ERIC and the International Development Information Network (IDIN);
- United Nations agencies, including UNESCO and its IIEP, UNICEF, FAO, WHO, ILO and the World Bank;
- bilateral donor agencies, including DFID, USAID, CIDA and SIDA;
- research and development think-tanks, and agencies, including AED, IIR, EDC and ADEA;
- contact with professional organizations in basic education, open and distance learning, communication technologies and broadcasting agencies;
- discussions and meetings with professionals in the field;
- other basic education research project reports and publications at the International Research Foundation for Open Learning (IRFOL); and
- intergovernmental agencies, including the Commonwealth Secretariat and the Commonwealth of Learning.

Throughout the study we consider questions of gender and of access to technology for different groups within society. While our main concern is with developing-country experience, we have also taken some account of industrialized country experience both for breadth of coverage and because of the relevance of some Northern experience to the solution of Southern problems.

Structure of the study

This study reviews the use of open and distance learning to support basic education ten years ago (Chapter II), examines and assesses the current state of play (Chapters III and IV), considers costs and conditions of success (Chapter V), and then proposes lines of development for the next decade (Chapter VI).

In order to set these discussions in context, we can distinguish a number of different uses of open and distance learning to support basic education. These can be classified into eight groups which are set out in Table 1. Computers have been used to provide part of the curriculum, although on only a limited scale at primary level, for more than ten years. More recently they have been used as a means of communication, allowing access to data-bases and links between schools. School broadcasting is older and has been attracting little research interest. Interactive Radio Instruction is a variant, sponsored by USAID, that has proved effective but not always sustainable. Open-learning techniques, many of them mainly dependent on print and/or broadcasting, have been widely used at this level on a modest scale and, in a handful of countries, on a much larger scale, although there is more experience at secondary than at primary level. Distance education has been applied to teacher training and there are the beginnings of the use of Internet technologies to support teacher training. Finally, extension agencies and non-governmental organizations are using the technologies for a wide range of non-formal programmes. ■

II. Overview of the state of development in 1990

World education was in a worse state in 1990 than we realized. While the report of the World Conference on Education for All (1990), recognized that the 1980s had been a bad decade for education, the time-lag in getting figures meant that the scale of deprivation was not then clear. At that time we thought that 130 million children were out of school; by 1995 the reported figure for 6-to-11-year-olds had risen to 145 million (Colclough, 1993, p. 1; UNESCO, 1998, p. 18). We can also now see that, in real terms, developing country expenditure fell, in constant 1998 $$, from $192.7 billion in 1980 to $149.5 billion in 1985 and had only crept up to $194.0 billion by 1990 (UNESCO, 1998, p. 110, with figures deflated using US CPI). The figures for sub-Saharan Africa and for expenditure per student or per head of population are worse than this. There is a mood of optimism about the Jomtien documents that sits oddly with the figures, at least as we now see them.

In terms of technology, the mood was of hope unfulfilled. Ministries of education were using most of their budget and much of their energy seeking to keep schools staffed and open, using conventional approaches, with little time or money left over to explore the new. In consequence, the record of using distance education and communications technology to support basic education was patchy. The Jomtien background document said, 'It can be argued that the literacy and basic education potential of the *new communication technologies* (and educational innovations) has never been fully realized' (World Conference on Education for All . . ., 1990*a,* p. 63).

With hindsight, we can distinguish five kinds of initiative: alternative secondary institutions, programmes for raising school quality, adult education and extension work, teacher education and the work of open universities in relation to basic education. Two more were coming over the horizon: the use of computers in schools and the creation of two new international agencies, the Commonwealth of Learning (COL) and the Centre international francophone de formation à distance (CIFFAD). This is a wider set of categories than those used in the Jomtien roundtable paper that concentrated on interactive radio, radio for out-of-school learners and in-service teacher training (Nielsen, 1990, pp. 5–7). We look at each of these areas in turn.

Alternative institutions

Both governments and non-governmental organizations have been attracted by the idea of using technology to create an alternative to schooling, usually to reach remote children who could not get to school. The Latin American radio schools, stimulated by the Roman Catholic church, the Mexican Telesecundaria, set up by government to offer television-based secondary education, and the correspondence study centres for junior secondary education of the governments of Malawi, Zambia and Zimbabwe are all variants of the model. (In the 1990s they were joined by the open schools of India and Indonesia.)

Nielsen reported on this work, mainly in Latin America, and distinguished between programmes leading to a primary-school qualification and those that provided 'basic education in the form of literacy and numeracy (often in combination with training in livelihood skills and consciousness raising activities)' (1990, pp. 6–7). He noticed that the programmes were under-documented but suggested that there were at least fifteen programmes of the former type and more of the latter. The radio schools combined a concern for basic education with programmes of political and social mobilization. With hindsight it looks as if the radio schools may in fact have played a more dominant role in the 1970s than the 1980s. The effect of the depression in Latin America in the 1980s seems to have been to leave *campesino* families with too few resources even to meet the modest demands in finance and time of the radio school system (cf. Kay, 1989, p. 202; Schmelkes, 1994). Their work also tended to bring them into conflict with both church and state authorities. The first radio school, Acción Cultural Popular of Colombia, which had enrolments of over 150 000 in the 1970s, fell foul of both and closed in 1989 (Gallego, 1993; Fraser and Restrepo-Estrada 1998, p. 159).

The work of the radio schools was significant both socially and methodologically. Their existence demonstrated that, within some jurisdictions, it might be possible to create a parallel system of education, reaching both children and adults, and working where the state was unable or unwilling to do so. The decline of the radio schools and the fact that they have few equivalents in other parts of the world suggest that the model is fragile and difficult to transplant. The methods they used demonstrated the potential strength of radio, with its relatively modest costs and its power for change when linked with some kind of face-to-face study.

Africa by 1990 had experimented with out-of-school education mainly for the growing number of primary-school leavers who could not get into secondary schools. Malawi, Zambia and Zimbabwe ran study centres that widened access to junior secondary education, using some radio but relying predominantly on correspondence lessons. They were not particularly efficient (offering what was seen as a worse method of teaching, run with minimal resources, for the children who had performed worse at the end of primary education) but, with modest costs per student, were able to offer some educational opportunities to children who might otherwise have had none. By 1990 study centres in Malawi were attracting more students than the

regular secondary schools: enrolments were around 28,000 in Malawi, 11,000 in Zambia and 31,000 in Zimbabwe (cf. Perraton, 2000, pp. 41–5). Again the model looks fragile: all three systems were to come under strong pressure in the 1990s to move from being an alternative kind of school towards being a regular secondary school.

Raising school quality

Up to 1990 the most ambitious attempt to use technology to raise the quality of basic education and widen access was the television project in Côte d'Ivoire. The programme was launched in 1971, with the intention of reaching 21,000 first grade children in the first year, expanding to the other five grades at the rate of one grade per year. By 1975 it was reaching 235,000 children but, while long-term forecasts suggested that eventual costs per student would fall to a level lower than those of the conventional system, the actual costs falling on the government reached a level that it could not sustain. The programme also failed to attract the support of teachers, parents and politicians that might have acted as a counterbalance to its unhappy economics. In 1981 the government of Côte d'Ivoire closed it down. Its shadow fell upon subsequent proposals to use technologies, or distance education, within schools. The funding agencies that had financed the early stages of the project now showed the deepest scepticism. A review of World Bank experience in 1987 referred to the 'apparently disastrous Ivory Coast [*sic*] educational television experiment. Although evaluation studies showed some positive outcomes, the project has "sunk without trace" and educators say that never was so much wasted, including Bank funds, on such poor television broadcasts with so little effect. This project coloured attitudes towards distance education throughout the international aid and lending community' (Hawkridge, 1987, p. 2).

The collapse of instructional television led to a new interest in radio. Nielsen (1990, p. 2) notes that almost all countries were already using radio to support primary schools but that there was no comprehensive review of the field and that documentation was sketchy. It still is. In contrast, investment by the United States Agency for International Development (USAID) in Interactive Radio Instruction has led to well-documented research on this particular variant. By 1990 it had been tried out in six locations in Latin America, two in Africa and two in Asia. There was evidence of effectiveness in terms of learning gains and it was hoped that, by encouraging success among children, the projects would do something to raise completion rates at primary level. The costs were additional to the costs of regular schooling but were then estimated at $0.25-$1.00 per student (roughly equivalent to 1998 $0.35 to $1.30 if we assume the earlier figures were at 1989 prices) (Hawkridge, 1987, pp. 5–9). More recent information on costs is in Chapter V.

Adult education and extension

We can distinguish three main approaches to the use of information and communication technology to adult education. One is to press mass media into service in support of state literacy campaigns. Short-term advances in literacy have been claimed (e.g. in Cuba, Nicaragua and United Republic of Tanzania) but longer-term maintenance of adult literacy has proved more difficult. As a variant of this approach, Kenya used distance-teaching methods to train literacy teachers. In 1990, as in 1999, powerful national literacy campaigns were the exception rather than the rule. For the most part their costs, in terms of adults made literate, had been too high to be sustainable. Second, as we have seen above, mass-communications methods have been used to offer equivalence to schooling, both for adults and for disadvantaged children. Third, extension agencies and public-education programmes, especially in agriculture and health, have used mass media to reach their scattered audiences. By 1990 there was widespread international experience of farm broadcasting and of health education through mass media, often by public agencies and sometimes by non-governmental organizations. Practical experience and theory together demonstrated that the combination of broadcasting with group study could be an effective way of providing non-formal education for adults.

As with school broadcasting this work was under-documented. One important review of world experience concluded in 1988 that 'most efforts to use communication technology do not do what they are meant to' (Hornik, 1988, p. ix). He went on, however, to demonstrate that there was sufficient experience of running mass-media public-education programmes for the world to know how to do so successfully. There was, however, then – and now – little political will to put the lessons into practice. The 1970s and 1980s had seen radio forums in India and Ghana, intensive radio campaigns in Botswana, United Republic of Tanzania and Zambia, but by 1990 all were in retreat. The conclusion of the International Commission for the Study of Communication Problems, ten years earlier, can stand as an assessment of the position in 1990:

In recent years the importance of communications for development has been constantly stressed both at the political and technical levels, in many United Nations forums and above all in UNESCO. . . Nevertheless this recognition has not been reflected in assistance to communication projects. . . Neither the legislators nor the managers of development assistance have followed in the path mapped out by the policy-makers. (MacBride et al., 1980, p. 221)

Teacher education

By 1990 distance education had been widely used for teacher education where its strengths, in reaching remote students and

allowing them to work on the job, had attracted the support of Ministries of Education. In Nigeria, United Republic of Tanzania and Zimbabwe, large projects had been set up to educate the increased number of teachers required as each country announced a target of universal primary education. There was gradually growing experience of attempts to link learning at a distance with guided supervision of classroom practice, the nub of successful distance education for teachers. Nielsen notes that the numerical imperative to recruit and provide some training to trainee teachers had taken precedence over studies of effectiveness, but identified sixteen, out of some forty projects, where there was some evidence of effectiveness. He found the evidence on cost-effectiveness moderately encouraging, with costs per student generally between one-eighth and two-thirds of conventional alternatives, but noted the shortage of studies on the classroom effectiveness of trainees. There was some evidence that student teachers trained at a distance gained prestige within their communities and were more likely to stay in their communities than those who went away to study (Nielsen, 1990, pp. 10–11).

Distance education for teacher training still faced problems of acceptance and integration. While it had been used, in most continents, as a way of providing either initial training or upgrading, it was seldom integrated into the regular structures for teacher education, curriculum development and teacher support. Much more often it had been adopted as an apparent way of eliminating untrained teachers from the system, to be abandoned once that job was done. Botswana, Malawi and Swaziland, for example, had run projects of this kind only to find that untrained teachers remained obstinately in the system. Radical and imaginative programmes of teacher support – such as the establishment of District Education and Training Centres (DIETs) in India – often explored other ways of raising teacher quality but did not embrace distance education which remained under a different jurisdiction.

Open universities and basic education

Open universities were playing two roles in relation to basic education. First, their rapid growth had given distance education a new legitimacy. Second, through outreach and teacher education programmes, they were directly affecting basic education.

Distance education had been transformed between 1975 and 1990 by the establishment of large open universities, especially in Asia. China, India, Indonesia, Iran, the Islamic Republic of Pakistan, the Republic of Korea, Sri Lanka, Thailand and Turkey had all set up national open universities by 1990; by this date most of these institutions had more than 100,000 students with 400,000 at the China Radio and TV University and 480,000 in the correspondence departments of Indian universities. They joined well-established open universities in the industrialized world and gave a new impetus to basic, as to higher, education. Allama Iqbal Open University in Pakistan, for example, was running experimental projects of adult, non-formal education (and was to be followed, in its concern for basic education, by open universities in Bangladesh and India in the next decade.) In Indonesia, Pakistan and Sri Lanka the open universities had taken on major responsibilities for the in-service training of teachers. China was using distance-teaching methods for the initial training of a large proportion of its teachers.

But the major significance of the open universities was existential: open and distance learning was no longer an educational distraction, dominated by shabby institutions of no prestige and within the private sector, but part of the mainstream of world education.

Computers

Computers were playing a minimal role in basic education in 1990. They were, however, at the time on their way into the classroom, with experimental projects completed or under way in countries as varied as the United Kingdom, Fiji, India and Kenya. They were being used within the curriculum, to support the teaching of existing subject matter and to introduce computer studies of various kinds as a new element in the curriculum. But, at this stage, they were not being used, as they came to be a decade later, as a means of communication or for access to data banks of information.

The specialized agencies

Both the Commonwealth of Learning and the Centre International Francophone de Formation à Distance were set up in the late 1980s to promote educational co-operation in and through distance education, within the Commonwealth and the French-speaking community respectively. They were represented at Jomtien but it was too soon for their work to have an impact on basic education.

In his assessment Nielsen did, however, look at the potential for international co-operation, arguing that 'compelling cases can be made for cross-national transfers and co-operation' (Nielsen, 1990, p. 17). Institutions were already sharing information, mainly through journals, and there was a handful of examples of the transfer of courses from one jurisdiction to another and of co-operation in the development of course material. The economic benefits of this kind of co-operation were demonstrated by the example of Interactive Radio Instruction where it was difficult to justify investment in course production unless material could be reused repeatedly and used across frontiers.

Conclusion

Many of the institutions needed to apply technology to basic education were already in place in 1990. Most countries had educational broadcasting services. A growing number had either state or non-governmental organization distance-education institutions that were working in basic education, either by offering courses direct to adults and children out of school or through teacher training. To illustrate the diversity of approaches, Table 2 identifies some of the institutions that were already working in this area in 1990 in sub-Saharan Africa and Latin America. Development was geographically patchy, with more and more varied activity in these subcontinents than in much of Asia or the Arab region.

While there have been dramatic changes in technology over the past decade which may bring significant changes to the practice of higher education, many of the technologies that can benefit basic education were already established by 1990. Radio and television were widely used for education. Computers had started to arrive in the classroom, although they were not yet being used for communication – the big change of the 1990s. Satellite links were in regular use and there had been important demonstrations of satellite broadcasting in, for example, the Indian SITE project. The use of technology to raise quality in the classroom or widen access beyond it was constrained more by cost and credibility than by institutional or technological development.

There were four obvious growth points for distance education and the new communication technologies in 1990. First was teacher education where projects all round the world were helping to meet the demand for a better educated workforce. Projects were attracting large numbers and, by using methods that were an alternative to conventional teaching, were demonstrating savings in terms of cost per students.

Second, there had been a number of attempts to change, strengthen and even reform education through technology. This was the aim of the Côte d'Ivoire television project and of the curriculum projects using Interactive Radio Instruction. It lay behind the early experiments with computers in the classroom. The record was uncertain and marked by projects that came to an early end. In most cases, the costs of using technology here were additions to the cost of regular schooling and, for that reason, difficult to sustain within tight budgets.

Third, despite a mixed record of success and failure, the idea of offering an alternative to schooling through technology continued to influence educators in many parts of the world. Latin American experience suggested that a model that rested on a powerful non-governmental organization movement and used radio to reach rural audiences was potent and effective so long as it was politically sustainable. In South Asia, where enrolment ratios lagged behind most of the world, there was a continuing interest in a non-formal alternative to school that might meet demands in remote areas at costs lower than those of schools. The Mexican Radioprimaria and Telesecundaria projects had demonstrated that, in a large country with a shortage of rural schools, broadcasting-based alternatives could be effective. In sub-Saharan Africa, at junior secondary but not at primary level, there was modest evidence of success for some students in correspondence study centres. While some of these programmes attracted adults – and in some cases were originally designed mainly for an adult audience – most of their students were in practice adolescents of secondary school age. In the next decade it was to become steadily clearer that these lessons were important for the expansion of junior-secondary education even if, at primary level, there was no substitute for school.

The fourth growth point was at the open universities, in particular where they were beginning to apply their methods to basic education and to teacher training as well as to degree programmes. ■

III. Social and technological developments and opportunities 1990–2000

To interpret the achievements and setbacks of the last decade, we look firstly at educational development generally and secondly at the way other social and economic changes have influenced the use of technologies in education. Then we look, in turn, at developments in computers, broadcasting and distance education over the past decade, examining the ways in which they have been used to support or provide basic education.

Global trends in education

Global trends in education are a necessary backdrop to this study. Much of the story is gloomy. The setbacks to education in sub-Saharan Africa and Latin America in the 1980s were still affecting education well into the 1990s while, towards the end of the decade, the Asian financial crisis was taking children out of schools just as it was taking people out of jobs. The most depressing figures come from sub-Saharan Africa where, 'since the Jomtien conference, a group of 16 countries in the region, accounting for half of all 6-11 year olds, have suffered a decline in net enrolment rates' (Watkins, 1999, p. 12). In much of the world, the pleas of the international conferences from Jomtien (1990) to Rio de Janeiro (1992), Cairo (1994), Beijing (1995) and Copenhagen (1995), have not resulted in the expansion of basic education that was looked for in 1990. Absolute levels of world illiteracy have changed little, with between 850 and 900 million adults unable to read and write. While gross enrolment ratios at primary level in developing countries as a whole have been between 90 and 95 per cent for girls and 100 and 105 per cent for boys, they remain below 65 and 80 per cent respectively in the least developed countries.

But a world summary should also take account of the real advances that have been made. Illiteracy, for example, has fallen dramatically in Europe, East Asia and Oceania since 1980. Despite the static ratios, Ministries of Education have, within the severe constraints on their work, managed to increase the numbers of students at most levels of education in most parts of the world. Even in the least developed countries, in 1996 there were 171 children in school for every 100 who were there in 1980 and 134 in 1990 (*UNESCO Statistical Yearbook . . .*, 1998). Education has expanded, even while lagging behind the Jomtien targets.

The figures suggest, too, that there may be one more trend that, while as yet least pronounced in basic education, may have profound implications for it in the future. In many parts of the world, including the least developed countries, female enrolment has been growing more rapidly than male at all levels, but especially at tertiary and secondary levels (see Table 3). The figures start from a lower base but show a consistent pattern. In sub-Saharan Africa, for example, female enrolments in tertiary education increased by over 250 per cent between 1980 and 1996 (against an increase of 80 per cent for male students); there is a similar pattern in south Asia – a common feature of two regions facing the severest educational difficulties.

Given what we know about the effects of female education, this shift deserves attention alongside the gloomy overall record. It may affect basic education in several ways: by increasing enrolment as the process feeds back from tertiary and secondary levels; by providing role models that support education for women and girls; by expanding the number of potential women entrants to the teaching force and raising their educational background; and by influencing family attitudes as better-educated mothers insists on better education for their daughters.

Trends affecting choice of technology

Particular trends within the past decade are creating a new, more complex communications environment. Major trends include the general development towards digitization and digital technologies, the fragmentation and deregulation of the communication sector, new participatory methodologies in development communications and the new mainstream status of open and distance learning

This new environment is making an impact on the ways technology is used in basic education and has opened up both opportunities and disparities within basic education.

The development towards digitization

The exponential expansion in new information and communication technologies is one result of the general process towards digitisation (the digitisation of images, sounds and data; digital data compression and new developments in electronic components). What is emerging is the capacity for the convergence of telecommunications, computer and audio-visual technologies 'previously separated by techniques, legislation and modes of distribution' (UNESCO, 1997*b*).

The convergence between previously distinct forms of communication has organizational and technical consequences. At the functional level, the once distinct communication media – radio broadcasting, telecommunications and computer technology sectors – have the potential to offer a more hybrid

range of services. Radio broadcasting services, for example, will be able to transmit signals other than information or entertainment programmes; the telephone industry will be able to transmit entertainment in addition to conventional services of dialogue and data transmission. At the technical level, old distinctions within the transmission infrastructure (terrestrial broadcasting, cable and satellite) could become obsolete. Where information is processed in digital form, distribution systems then become multi-purpose. This will undoubtedly have a significant impact on isolated communities and will open up the potential for new and more regular basic education opportunities.

The use of new information and communication technologies, and especially of the Internet, has expanded dramatically within the decade. Increasingly, as new technologies are becoming integrated into educational settings, there are new learning opportunities for learners and intermediaries (teachers, health and agricultural extension workers); there is the potential for communicating across geographical distances and time differences with ease, for accessing new pools of information and resources, and for participating in new learning networks and partnerships.

In communications, as in every other sector, these developments have been unbalanced. 'Overshadowing the utilization of the new information and communication technologies in education are worldwide disparities in access to these technologies' (UNESCO, 1998, p. 79). Most developing countries lack the basic infrastructure and training needed for gaining access. This 'digital divide' compounds existing inequalities between people within and between countries; the disparities in access are not random but correlate strongly with income, education, ethnic origin, location and gender (Novak and Hoffman, 1998; NTIA, 1998). But access alone will not be enough to create a level playing field:

> Knowledge is the new asset: more than half of the GDP in the major OECD countries is now knowledge-based. With such importance placed on these technologies, the new rules of globalization – liberalization, privatization and tighter intellectual property rights – are shaping their control and use, (and) have set off a race to lay claim to knowledge. The global gap between haves and have-nots, between know and know-nots, is widening. Tightened intellectual property rights keep developing countries out of the knowledge sector. Patent laws do not recognize traditional knowledge and systems of ownership (UNDP, 1999, p. 57).

Learners from developing countries therefore face additional risks: the concentration of the ownership of communications systems; the dominance of western educational models and market leaders; and exposure to what may be seen as new forms of political, cultural and linguistic colonialism. The English language dominates. It accounts for 85-90 per cent of Internet messages, 80 per cent of websites ('and in the common user interfaces – the graphics and instructions') and 80-85 per cent of all scientific and technical information in abstracted, published or computer-stored form (UNDP, 1999, p. 62; Kaplan, 1993). The consequences may be to downgrade other languages. But, at the same time, the use of English, already the key international language, means that those with some capacity in it have their access to learning widened by the new technologies.

The development of the Internet therefore poses difficult ethical challenges. These may bear particularly on aid agencies. There is a danger that funding to support Internet development may only nurture an illusion of egalitarianism while differences in access to computer communication in fact shore up existing inequalities. Agency investment in this sector has also been criticized as principally helping the communications industry penetrate new markets and set up new dependencies. Aid for Internet development might divert funds from more traditional forms of development; the balance between funding for books and teachers and funding for technology is not easy. At the same time there is an obvious downside to decisions against funding Internet growth.

One response to the demand for investment in communications technology for education has been the pooling of resources between bilateral and multilateral aid agencies in the form of large-scale, collaborative and sectorwide, capacity-building and training initiatives in telecommunications. Examples include the InfoDev programme (World Bank), the International Programme for the Development of Communications (UNESCO), the Intergovernmental Informatics Programme (UNESCO), BellaNet (CIDA, IDRC and UNDP) and the Telecentre Fund (ITU, UNESCO and IDRC). Emphasis has also been placed on innovative ways to develop rural communications, including the notion of developing public access points and resource centres such as community access centres, multi-purpose rural telecentres and public communications booths.

The ground statistics, however, remain salutary: in Africa as a whole, radio covers 75 per cent of the population, television 40 per cent and the Internet 0.1 per cent. Some 62 per cent of all telephones lines in the entire world are installed in just 23 countries (15 per cent of the world's population), one-quarter of all countries in the world have less than one telephone per 100 people, 84 per cent of mobile phone subscribers, 91 per cent of fax machines and 97 per cent of Internet host computers are in industrialized countries (Communication for Social Change, 1998); 63 per cent of users are male and 37 per cent are female, a ratio that has remained consistent over several years (Panos, op. cit.).

Media liberalization and fragmentation

The heyday of neo-liberalism means that much of the communication sector has been deregulated and privatized. The decade has seen the end of some state monopolies of media, a rise in commercial media, and a growth in satellite and com-

munity broadcasting. These changes have ushered in an increasingly fragmented media environment and, in some countries, regulatory and legislative bodies more favourable to pluralism. All these developments have influenced the use of communications technology for basic education.

One development is that, in some developing countries, there have been new opportunities for commercial and small community radio stations to develop educational programming. For example, in some countries of French-speaking West Africa – Benin, Burkina Faso, Guinea, Mali and Senegal – the move away from an exclusively urban-concentrated, government monopoly has resulted in a new wave of community radio programmes for non-formal and adult education, targeted to particular communities and often in a range of African languages.

Another development is that audio and video technologies have become cheaper, smaller, more reliable and easier to use. This has made them usable in a wide variety of contexts and by a broader, less professional range of people. Needs-based assessment, discussed in the following section, has given rise to much wider use of audio and video equipment for recording interviews. The media have thus become more accessible to more organizations and individuals working in basic education. Part of this trend can also be seen in the emerging and innovative private sector in rural communication – video rental shops, video recording services for weddings, photocopying, local and long distance telephone shops, fax services, photo-taking, film processing, newspaper and magazine kiosks, bookstores and pre-recorded audio-cassette outlets.

One downside of the privatization process is that many educational bodies that once had free access to satellites or airtime on national government stations no longer do so.

Participatory methodologies in development communication

Since the Jomtien conference, most energy and most attention has been given to the expansion of schooling through government action. But this is not the whole story; non-governmental organizations in particular have played a number of roles in the expansion of education and in rethinking approaches to expansion and change.

Although it is difficult to quantify, it seems likely that non-governmental organizations have increased their involvement in basic education, alongside governments. Their work has benefited from their inherent advantages: modest scale, an ability to respond quickly to emergency situations; local knowledge and continuous presence in particular regions. All these have enabled them to make small-scale interventions and target specific, often excluded, populations such women farmers. One consequence of this is a new pattern of co-operation between government agencies and non-governmental organizations in basic education.

Many non-governmental organizations have brought to their work, and to these cooperative developments, a commitment to a participatory style of working, arguing that:

> Self-determination is an important characteristic of development. People's participation in their own empowerment is critical to foster a sense of dignity and self-reliance. Small and short-term projects may work better than long-term and big projects. Also projects that begin small and then expand carefully have better chances of success. (Singhal, 1996, p. 10)

This emphasis on the participation of rural and urban communities in decision-making has led to a proliferation of grassroots initiatives, and community-based and non-formal education programmes, and has influenced the choice and use of technologies within them. Participatory approaches fit more easily with small-scale, locally developed projects than with those that are centrally planned and rely on broadcasting on a large scale. There is, therefore, a tension between the demand for a participatory approach and attempts to use mass media on the large scale which their technology allows and from which their economic benefits flow.

While much non-governmental organization attention has gone to general programmes of basic education, many have also given particular attention to the needs of marginalized basic education groups – girls in some societies, special needs, war children, displaced communities, travellers, street children, adolescents, remote, excluded, religious and ethnic communities. Here, too, in contexts where conventional approaches to basic education have been least successful, the more imaginative projects have benefited from non-governmental organizations' freedom of activity and commitment to participatory methodologies.

Mainstream status of open and distance learning

During the 1990s, open and distance learning moved firmly away from its status as the poor relation and began to be regarded as a legitimate part of mainstream education to be used separately or in combination with face-to-face education. There are now closer links, at all levels, between conventional education and open and distance learning. Another drive towards legitimacy has been the professionalization of open and distance learning – the proliferation of specialist international, regional, and national agencies, organizations, interest groups, professional journals and conferences. As noted above (p. 7), two intergovernmental agencies, the Commonwealth of Learning (COL) and the Consortium international francophone de formation à distance (CIFFAD) have come of age and are now putting open and distance learning squarely on to government agendas. As Nielsen (1990, p. 21) predicted a decade back, they have 'moved from early mobilization to a phase of consolidation during which research, publication and international networking are becoming more prominent'.

Technologies and their applications

Our context, therefore, is one in which technological change is making it easier for the world to share information. In principle, this should provide opportunities to build on earlier experience of using technology to support basic education and to harness new techniques to its expansion and improvement. At the same time, appropriate use of the technologies is likely to be shaped by changes in the regulatory framework of telecommunications and by insights from new approaches to education that have gained prominence in the past decade.

There is a wealth of experience in using technologies to serve the needs of various audiences for basic education. Assessments are difficult as the documentation is scattered and good evaluations are rare. Before looking at the ways in which technologies have been used for different audiences, we examine here the current state of development of the technologies and identify various strategies that have been adopted for their use.

Although a theme of much recent discussion of informatics is the convergence of computing and broadcasting technologies, major differences remain between them, at least from the perspective of an educator. Both sets of technologies can be used either to make incremental changes to regular education or to provide access to resources that are not conventionally available to the classroom or to the individual learner. But the ways in which they are used, the challenges they offer to the educator and their different cost structures mean that it makes sense initially to consider them separately. We do so in the following two sections.

Computers

New information and communication technologies have attracted much recent attention among educators. Computers have been used in an attempt to change, strengthen and improve basic education in a variety of different ways and for a variety of different purposes. We start by looking at the rationales for using computers in education and then at strategies for making them available to learners.

Rationales for the use of computers

It is worth distinguishing between various different rationales for using computers in education so that policy decisions can sensibly reflect educational purpose. An analysis by the Commonwealth Secretariat, which drew on reviews of Commonwealth-wide practice, usefully distinguished four rationales for introducing computers to education; the development of Internet communications means that we now need to add a fifth.

Rationale 1: To build a resource of people who are highly skilled in the use of information technology. Where governments see information technology as a means of strengthening the economy, and want to develop a workforce with vocational skills for computer-related activities, computer-education programmes have been set up to develop a cadre of people with specialist skills.

Rationale 2: To equip all students for a future in which technological awareness and basic computer skills will increasingly be important for greater numbers of citizens. Countries have adopted this approach as they see that, whether or not the country is likely to be a producer of computer hardware or software, their citizens need to be in a strong position to take advantage of technological developments as they arise.

Rationale 3: To use the technology to enhance the existing curriculum and to improve the way in which it is developed. Computer-assisted learning programs, in which the computer takes over some of the activity of the teacher, fall within this rationale.

Rationale 4: To promote change in education by moving towards a more relevant curriculum and a new definition of the teacher's role. Some computer projects have been designed to shift the curriculum in the direction of practical learning of information-handling and communication skills rather than concentration on memory.

Rationale 5: To allow learners to seek information from databases, especially through the Internet, and use computer technology to communicate with other schools, colleges and learning communities. This rationale opens up new learner-initiated opportunities. This fifth rationale has been developed in the last five years.

(First four rationales adapted from Commonwealth Secretariat, 1991, pp. 8–12)

Of course the rationales overlap and national policies may embrace more than one but their curricular and cost implications are different.

The *first* rationale leads to investment in courses at the upper end of secondary education, in vocational training and in tertiary education. Whole-hearted adoption of the *second* rationale, concerning the education of all future citizens, suggests that computer-related education should be at the upper end of the universal stage of education. It is likely, too, that educational content will rely on generic software – allowing children to develop basic skills in wordprocessing or the use of data-bases and spreadsheets for example – rather than the use of subject-specific computer-aided learning. The *third* rationale has been the subject of the most severe criticism; early computer-aided learning proved to have high unit costs and, in many cases, simply offered an expensive way of offering drill and practice, with keyboard and mouse instead of pen and paper. The *fourth* and *fifth* rationales both suggest that, if computers are to be used in school, it is necessary to think through their consequences for the curriculum; changes in the curriculum will not occur through technology alone. The *fifth* rationale presents new opportunities for reshaping the curriculum but demands not only that schools should have

access to computers, but also have, and can pay for, access to the Internet.

No matter which rationale dominates, the use of computers in the classroom presents significant demands to ministries of education. Computer equipment – hardware – needs to be provided and accompanied by appropriate software. Staff using computers need training. Where computers are used mainly, or even partly, for access to the Internet, then reliable telephone access and an agreement with an Internet service provider are also required. We look at the costs involved below and turn next to the strategic issues involved in getting access to computer technologies for schools, and in some cases for getting access to the Internet.

Strategies for getting access

The use of information and communication technologies in education has been constrained by economics. At present, few low-or middle-income countries have been able to develop nationwide programmes for the use of computers in the classroom. Where there are programmes to develop educational capacity in information and communication technology, they tend either to concentrate on tertiary education or to be limited to a small number of, usually, urban, schools in a pilot project. These initiatives may form the first stages in an overall government strategy or be piecemeal developments dictated by budgetary limitations, political interest and serendipity.

Throughout the world, there is a clear pecking order when integrating communication technologies into the formal educational system – tertiary downwards and with primary education low on the list. This situation is changing mainly in Organisation for Economic Co-operation and Development (OECD) countries and newly industrialized countries (NIC) for various reasons: national communications policies; increased governmental funding; the integration of the technologies into all levels of national curricula; generally far cheaper hardware and software and increased private ownership. These governments are now funding nationwide initiatives to build up hardware, software and accompanying skills at all educational levels, including the lower secondary, primary and even nursery levels.

As a result, various different approaches have been adopted to enable schools to get access to computer hardware and software. Five approaches can be identified:

1. direct provision of computer hardware and software to existing schools,

2. building new customised schools or computer suite annexes,

3. bringing resources to schools via mobile units,

4. providing access for children via a variety of community-based resource centres, e.g. libraries, technology access community centres, non-profit organizations, and

5. mediated access – where someone with access to a computer and Internet helps children who do not.

Examples of these appear in Table 4. The first three strategies bring computers to individual primary schools. The fourth takes children out of school to computers off-site. In the fifth, the child does not have actual hands-on access to computers but benefits, directly or indirectly, from someone who does.

Strategies 1 and 2 put computers into individual primary schools enabling pupils to have permanent and regular access to them. But heavy demands accompany computer supply. In some cases, mainly in industrialized countries and where it is difficult to adapt existing buildings, strategy two has been favoured with the building of new annexes within schools.

Where it is not possible to equip every school, Strategy 3 involves the development of mobile units equipped with satellite and computer equipment. Units can then visit schools on a regular basis, thus offering limited access to a number of schools within a whole region and on regular basis. They are also a means for bringing technology to marginalized learners such as girls in segregated schools and unemployed youth with no access to formal schooling.

Strategy 4 involves making use of computers somewhere outside the school. A number of countries have developed telecentres, or public access points to computer facilities. These have parallels to the 'early days of telephones. In those days, only the elite had their own telephones, so society evolved the concept of public telephones, which anyone could use, paying only the cost of their actual use' (Fontaine and Foote, 1999). Similarly, telecentres are public places where people can come to use computers. Telecentres exist in a diversity of forms. Some are commercial while others are not-for-profit; some are free, while others charge. They can operate on an appointment or drop-in basis. Some offer training in software applications and provide induction to new users while others operate on a solely self-access basis for experienced users (wanting e-mail, on-line distance-education courses, Internet access and computer games). Some are highly equipped, staffed telecentres offering a wide range of other technological facilities such as reprographics, television/video, fax, telephones. Others are unstaffed kiosks. In some, the telecentre is part of a wider community education centre catering for different target groups, including school children, and offering classes and meeting rooms. Telecentres exist in range of locations including libraries, bus stops, cafés, shopping malls and voluntary sector premises.

Strategy 5 provides more restricted access to computer facilities. It assumes that, even without direct access, the schoolchild can benefit, directly or indirectly, from someone or

some institution that does have access to information and communication resources and, in particular, access to the Internet. This type of strategy is a new development, set to expand, and we are beginning to see innovative initiatives, large and small.

We can see examples of the five options operating in low- and middle-income developing countries but usually with restricted coverage. Strategies 3, 4 and 5 hold particular significance to developing countries for overcoming access problems created by economic, infrastructural and geographical challenges. The pooling of resources, through community networks, resource centres, and telecentres has been seen as an important way forward and an 'eminently sensible social and political approach' providing the road to wider and more equitable technological access (*CTC Review*, 1998).

In high-income countries, the first four strategies commonly operate at primary and junior secondary levels. Provision of computers to individual schools is widespread and it is increasingly the norm to find upwards of one computer per classroom in state primary schools. At the top end, we can see primary schools with classroom computers as well as dedicated computer suites with one computer per two children. Strategies 3 and 4 are often an extension of well-established regional library service systems. Increasingly, well-supported national library services have expanded from books to include the lending of commercial or educational CD-ROMs and video- and audiocassettes. In addition to computerized self-access centres for adults, many libraries have a dedicated children's section with computers and software, to be used on a school visit, as an after-school club and on a drop-in basis. Many children also benefit from privately owned computers to which they have access at home. In combination these strategies create a range of educational opportunities for school children.

These initiatives are led by an increasingly wide number of drivers often working in collaboration – governments, multi- and bilateral donor agencies, non-governmental organizations, trusts, the communications industry, companies via tax benefits, computer recycling and donation schemes. Most of the initiatives, particularly the high-tech ones, are in a pilot stage, especially among least developed countries, and have, understandably, tended to prioritize learning opportunities for teachers, extension workers and people operating small businesses rather than for young learners.

Alongside acclaim for the educational strengths of information and communication technology there is a widespread concern that access to it tends to entrench existing inequalities not only between but within countries. Within low- and middle-income developing countries, for example, a very clear divide in access to computers exists between private and public schools, urban and rural areas. Similar disparities are reported from OECD and NIC countries despite the much higher level of resources they can devote to the technologies.

The Internet for professional support

Improved telecommunications may have implications far beyond formal schooling of the kind which has dominated our discussion so far. We look below at the significance of improved communications in health and medicine, with potential benefits for health education. Telecommunications have, for example, the potential to help countries with limited medical expertise and resources. Telemedicine and telehealth are health delivery systems that increase the medical and health resources available to medical practitioners for diagnosis and treatment between two or more locations using technology-assisted communications. The technology can vary between basic telephony, digital land line, cellular/wireless, satellite and broadband networks such as ATM.

Telemedicine services include access to remote expert systems (teleconsultations) and remote sensing (telecardiology, telepathology and teleradiology). It is suitable for long-distance, emergency patient treatment in areas without a sophisticated health service such as at sea and in remote or war-torn areas. The consultations, for example, can take place in real time by radio, telephone or videoconferencing or off-line via e-mail exchanges. Telehealth, more the domain of health workers, is to do with preventative health care or the provision of health services to those who are at a distance from the service providers but who are not necessarily ill. This includes access to remote national or international telehealth resources concerning the prevention and identification of serious diseases documentation centres, databanks, information networks, electronic conferences, on-line medical journals and courses. Databank examples include INFOLEP, MEDLINE, AVLINE, BIOETHICLINE and TOXLINE. Documentation centres include CANCERLIT and web versions of leading medical journals such as *Lancet*.

Broadcasting

Both radio and television have long been used in education, to raise the quality of education within school and to extend teaching to audiences outside. Work of this kind continues. Many countries, of all income categories, continue to offer schools' broadcasts. Radio is widely used for public and adult education, often as an auxiliary to the work of other extension agencies.

Developments in broadcasting have been influenced by the social and technological changes identified above. The shift of emphasis away from public-service broadcasting to a deregulated sector, increasingly dominated by small stations and transmitters, has been accompanied by technical changes. Many of the newer stations are broadcasting in FM only; the move away from medium-wave, AM, frequencies are reducing national coverage. It is possible that direct satellite broadcasting may, again, bring extremely wide broadcast coverage. At present, however, direct broadcasting by satellite exists on a trial basis only, and requires relatively expensive and specialist receivers.

With these caveats, radio and television broadcasting remain an important means for supporting existing formal education. Three approaches have been followed in using broadcasting to support basic education: *first*, direct class teaching which substitutes for teachers on a temporary basis; *second*, school broadcasting and third, *general children's programming* on mainstream national and commercial radio and television stations). The first two are used directly within schools while the third operates outside in the more general public domain. The strategies are set out in Table 5. One variant of the first approach – interactive radio instruction – has attracted much international interest, and is discussed below. It is distinguished by three main features. It is designed for direct teaching, rather than enrichment; broadcasts demand frequent responses by children as they listen; projects have generally devoted significant energies and investment in curriculum development so that their development costs have been higher than those of conventional radio.

Direct class teaching: interactive radio instruction

The first approach has been dominated by a series of Interactive Radio Instruction (IRI) projects. These bring ready-made 20–30 minute direct teaching and learning exercises to the classroom on a daily basis. The radio lessons, developed around specific learning objectives at particular levels of maths, science, health and languages in national curricula, are intended to improve the quality of classroom teaching and to act as a regular, structured aid to poorly trained classroom teachers in under-resourced schools. Children interact with the radio presenter by answering questions, singing or performing practical tasks in carefully timed pauses in the audio script. Teachers can prepare or integrate the lesson in their own way or where available, according to suggested extension activities in printed teachers' notes.

Successive evaluations have demonstrated the educational effectiveness of IRI: the children consistently perform as well as or better than control groups in tests; it can narrow gaps in achievement between rural and urban children and between boys and girls; where teaching quality is low, it promotes greater standardization of teaching in schools; the methods and models in the programmes can contribute to a teacher's professional development.

We look at the extensive case-study evidence on interactive radio below.

School broadcasting

The second approach is school broadcasting. Unlike IRI, school broadcasting is not intended to bear the main burden of direct classroom instruction. Instead, the aim is to provide teachers and learners with complementary resources and learning experiences not locally available. Teachers can choose to slot them into their class work. These programmes, geared to national curricula, are available in a range of subjects and often with back-up resources (print, cassettes or CD-ROMs). Typical strategies include story-telling, dramatizations and interviews. They can be used according to broadcasting schedules or, where technology permits, the teacher can get them recorded for later use at more convenient times. In the latter case, broadcasting stations are used to disseminate educational materials. Schools' broadcasting materials give greater control to the teachers than IRI, particularly when in cassette form, and help teachers draw on a wider range of resources and use a multimedia, multi-channel teaching approach. However, it is a strategy that depends very strongly on the ability of the teacher to integrate the materials into their classroom. The lesson here, as with IRI, is that educational broadcasting cannot afford to skimp on teacher and producer training.

We can see radio and television schools broadcasting in a range of countries and in a variety of organizational patterns. Some, in high-income countries, are based within large broadcasting corporations, have extensive programming (BBC, Table 5, Education Radio and Television, the NHK Japanese Broadcasting Corporation) and can broadcast over several national radio and television channels, sometimes (e.g. NHK) on dedicated educational channels. Others are units based within the Ministry of Education, and part of collaboration between the Ministry of Information (where the broadcasters are located), Curriculum Development Centres and a book production and materials resources unit. The latter is typical of lower-income developing countries. They tend to have a far smaller output that is restricted to certain slots within national or local broadcasting schedules. Regional or community radio stations can often reach only modest numbers of schools but may be able to extend their influence if they can supply programmes in cassette form or arrange to share material with other radio stations. Within industrialized countries, school broadcasters can expect schools to be equipped with recording facilities and therefore freer of broadcasting schedules than in poorer countries where recording equipment cannot be assumed.

Non-formal children's programming

The third approach – non-formal children's programming – consists of radio and television programmes on community, national and international stations aimed at children in or out of school at the primary and junior secondary level. These may provide general and informal educational opportunities and exist in a variety of radio and television forms, including popular culture quizzes, story-telling and educational cartoons.

Mainstream children's programming has been gaining increasing attention in the shift towards sophisticated, intergenerational and multi-channel communication strategies and growing recognition as an undervalued educational resource. An emphasis on the need for links between formal and non-formal education, the recognition that learning is an intergenerational

phenomenon and that children play a crucial role in teaching each other have all led to an increased concern with informal and non-formal opportunities for learning both in and out of school. Mainstream children's programming has a role to play here. We can see this development most clearly in recent types of health campaigning which are no longer conceived as one-off projects but highly planned long-term campaigns based on extensive formative research. Generally, these combine popular, prime-time radio and television programmes with a wide range of supporting activities directed towards different target groups the community. Increasingly schools are taken into account in these campaigns.

One major stumbling block here is that children's programming is particularly vulnerable where market forces rule: advertisers, marketers and managers see less profit in children's programming than for other target groups; children's programming (e.g. the United States' *Sesame Street* and the United Kingdom's *Tele Tubbyland*) is neither an easy nor a cheap option compared to other programming. Where it does exist, rampant commercialism has entered children's programming. It is therefore not surprising that in many countries, particularly low income, there is very little home-grown children's programming, educational or otherwise, and instead a predominance of imported foreign-origin programmes, often cartoons.

A variety of strategies have been adopted to stimulate the development of children's programming. *First*, a small number of countries have developed and followed well-articulated national policies for the development of television for children backed by government support in the form of public-service broadcasting on government stations or quota demands on commercial broadcasters. A survey of nine Asian countries, for example, found that China, Viet Nam and Japan had developed policies of this kind (Goonasekera, 1998).

Second, where children's broadcasting depends on imported children's programmes, then international agencies have sometimes played a role in funding the making of good programmes or funding their distribution. An international consortium of 70 animation studios, for example, was funded by UNICEF to produce broadcasts spots for 2,200 broadcasters in 160 countries based on different articles in the Convention on the Rights of the Child. These are intended for both children and adults.

A *third* strategy is to produce programmes that can be used in a range of ways. For example, popular health and children's programmes can be broadcast at prime family times but can re-broadcast as schools' broadcasting and exploited in more child-appropriate extension activities.

A *fourth* strategy is the using of commercial children's and family radio and television programmes as educational resources in themselves and the basis for children's media education.

New technologies and distance education

Programmes of distance education themselves use a variety of different technologies so that they may embrace, even rely upon, broadcasting as well as print and associated face-to-face study. At some levels of education, they are beginning also to use computer communication.

As noted in our retrospective view (Chapter II), distance-education programmes have been set up to offer an alternative, out-of-school form of primary schooling for both children and adults. They are, however, the exception and have not proved transferable across cultures: the radiophonic schools of Latin America, with considerable achievements to their credit a generation back, have not proved a replicable model for other parts of the world. There is wider use of distance education for those who have reached the top end of primary schools. The open schools of India and Indonesia, for example, offer an alternative form of junior secondary schooling and may be a growth point for the future. Their use of technology tends to be simple, relying heavily on print with only a modest use of broadcasting or cassette technology.

The other major use of distance education is to support the work of intermediaries, a blanket term to include both primary-school teachers, and extension agents and health workers. There is widespread, successful and continuing use of distance education for teacher training, using a range of technologies and reaching both large numbers and significant proportions of the population.

Much distance education has used modest and relatively simple technologies: radio and print have been the staples. There are now the beginnings of the use of the Internet both to distribute teaching materials to students and as a means of providing a tutorial service but these are mainly confined, so far, to higher education. Within French-speaking Africa, in particular computer and satellite-based technologies are beginning to be used for the in-service education of teachers and school administrators, with a number of projects initiated by CIFFAD. We may expect new forms of distribution to be of growing importance, especially for professional upgrading programmes where they may be of particular value for isolated professionals in small states and states with low densities of population.

Summary

To summarize, while there are major national and geographical differences in the pace of educational change, there are a number of common features marking the adoption and application of communication technologies to education.

Despite severe checks in many countries, and in some cases, especially in sub-Saharan Africa, an actual decline in

enrolments, the past decade has been marked by educational expansion, within which enrolments have been growing faster for girls than for boys. Expanding demands for education have been accompanied by developments in communications technology that have prompted interest in the use of technologies both to extend education and to raise its quality. At the same time, political changes have led to an increasing acceptance of a private-sector role both in education and in the management and control of public communications.

These trends can be exemplified by the arguments for, and development of, the use of computers in education. A variety of strategies for enabling schools to use computers and get access to educational resources through the Internet have been adopted and a range of experimental projects set up in both developing and industrialized countries. At the same time broadcasting – including direct teaching, enrichment programmes for school, and informal programmes for use outside school – has continued to play an important, if less attention-grabbing, role in the education of children and adults. New and old technologies alike have been used within programmes of open and distance learning, addressed to individual learners and to groups of professionals, including above all teachers, seeking professional upgrading.

In the next chapter we look in more detail at recent international experience before moving to an assessment of its significance in Chapter V. ■

IV. Audiences and programmes

With this brief summary we can now review some of the distinctive ways in which technologies have been used in the past decade to serve the needs of three different basic education audiences – *children and adolescents*, *general adult population* and what we are calling *intermediaries* (teachers, extension agents and health workers). Our aim here is not to provide exhaustive or definitive lists of projects using different technologies but to identify some illuminating experience and if possible capture the main trends in a fast-changing scene.

The use of technologies for children *in school*, mainly using broadcasts and computer-based technologies, are for the most part designed to raise quality or to support curricular change. *Out-of-school* programmes are addressed to various different audiences including the geographically remote, marginalized communities and minorities seeking supplementary schooling. These two areas will be discussed separately.

Children and adolescents in school

The disparities between and within countries demonstrably affect the resources available for children in school. While, as noted above, some well-endowed schools in rich countries will have suites of computers in most classrooms, there remain many schools within developing countries that lack much simpler technologies: the basic tools for measuring or calculating, enough pens, pencils and rulers, or blackboards or textbooks. We need to avoid losing sight of these disparities which exist within, as well as between, countries.

The disparities and the level of available resources are likely to affect and inform policy on the choice of technologies. We know that multi-media teaching can improve the quality of the learning experience, particularly where teachers are knowingly exploiting the strengths of individual media and using combinations judiciously. They are used to raise quality, support curricular change, extend the range of courses available and introduce new learning experiences. Both school broadcasts and computers have been used to raise the quality of classroom teaching and to broaden the curriculum. But there is often a distinction between the way in which the two sets of technologies have been used. Within developing countries, broadcasts have often been seen as a universal service, aimed at all children in a particular subject at a particular level, even if they have not achieved that universal coverage. The relatively modest cost of radios, and the simplicity of maintaining them, makes this possible. In contrast, most computer use in basic education has been on an experimental and pilot basis, aimed

at strengthening education in a small group of schools, with results that may in due course be applied more generally.

The major purpose of introducing, using and developing new technologies in school has been to raise quality at a time of educational expansion. The capacity of the technologies to share and distribute information has prompted their use in addressing particular educational problems of expansion and quality. Their use at the upper end of basic education provides an example. Spurred in part by the Jomtien conference, enrolments at primary level have expanded and have in their turn led to new demands further up the education system and the age group. Much larger numbers of children complete primary education, see that there are then few jobs available to them, and want to move on to junior secondary education. One consequence is an unsatisfied demand for teachers with the specialist knowledge and skills to teach at junior secondary level. Many teachers have moved up from primary to junior-secondary teaching and, in some cases, have been able to use resources through communication technology to help them in their new task. At the same time there are the beginnings of the use of the same materials both in school and out and the development of new structures for adolescents who cannot get into school which we consider below. The choice of technologies is heavily influenced by economics but also varies with the level of education. Radio has probably been more significant for the education of younger children; most interactive radio instruction, for example, has been aimed at primary schools. At junior secondary level there is more experience of the use of computer technologies and of school broadcasting. We look, in turn, at some examples of the major technologies being used.

Computers

As we have seen, computers have been used in the classroom for a variety of different reasons. While most recent attention has focused on the use of computers to get access to the Internet, other uses have, until quite recently, dominated school activity. We look below at some examples of computer use for curriculum change, for getting access to Internet resources, for school linking and for sharing resources, sometimes through the setting up of virtual courses. The experience described is biased towards the North rather than the South, reflecting economic realities.

Curriculum development and enrichment. Many of the early computer developments in schools reflected a desire to increase understanding about computers among the workforce of the future rather than to change the curriculum more generally or to offer a new means of communication.

One significant exception that serves to illustrate the curricular opportunities is a project in Costa Rica using the *LOGO* programming language. The Costa Rican *Computers in Education* programme was launched in 1988 with the aim of raising the quality of education in primary schools. The programme specifically aimed to use a constructivist approach, to encourage collaboration among the children involved and to raise cognitive skills. Advisers, principals and teachers were trained on the *LOGO* software and the principles behind its use. The programme was designed to reach one-third of all primary school children in the country with some 80 minutes per week access to computers. Although gains in student learning were not assessed, there appears to be positive evidence of the impact of the programme 'with positive effects on enrollments and computer interactions, [and a] tendency for students and teachers to move towards more egalitarian relationships. Under these more self-directed circumstances, teachers reportedly see capabilities in their students that were not observed prior to the introduction of technology in the schools' (Inés et al., 1998, pp. 28–9).

The Costa Rican experience is of particular interest as its aim was not to strengthen understanding of, or facility with, computers but to use them in order to reach more general educational ends.

Access to internet resources. Industrialized, middle-income and even some least-developed countries have begun to find ways of providing schools with Internet links. Some are a long way down the road. In Slovenia, for example, more than 80 per cent of primary schools and 93 per cent of secondary schools have access to the Internet. Examples in developing countries include SchoolNet South Africa programme, a Uganda SchoolNet Pilot and the Enlaces project in Chile. The Enlaces project plans to connect 8,250 primary schools (50 per cent of the total in Chile) and 100 per cent of the 1,700 secondary schools by 2000. All these initiatives have required the deployment of hardware and arrangements for it to be serviced, acquiring software and making the necessary arrangements to train the teachers.

Once connected, children are using the web in a variety of ways. Websites for primary school learners and teachers offer a range of Internet-based educational services, such as discussion groups, and curriculum resources to download and use in the classroom. Many are dedicated to particular subject areas such as *The Globe Programme* (environment), *The Wild Ones* (conservation), *TERC* (mathematics and science). There are also examples of website design projects in which children themselves create resources to use and show, (e.g. *DRIK Picture Library*, Bangladesh).

A variety of on-line resources and courses have been developed that target adolescents in school, at the top end of the primary cycle or in junior secondary school. Some are ready-made materials that are posted on websites for downloading. Others involve opportunities for dialogue and collaboration between geographically separated learners in different teacher-learner and learner-learner combinations. The latter are referred to in a variety of ways – global classrooms, learning networks, virtual

communities and e-mail classrooms. There are also examples of dedicated websites for in-and out-of-school youth. UNICEF's Voices of Youth (www.unicef.org/voy) offers a global e-mail discussion and opportunities for collaborative projects.

It is sometimes possible to provide access to the Internet indirectly. The Kothmale Community Radio in Sir Lanka, for example, uses radio as a gateway to the Internet for its rural listeners. Listeners, including primary school children and teachers, send requests (by post or on foot) to the broadcasters for specific information, about particular subjects. The broadcasters search for this on the Internet, download it and make the information available to their audience in a range of ways: constructing a broadcast around the information, sending the information by post, or placing the information in the radio station or in an open-access resource centre. (In the particular case of Kothmale radio, the station also operates as a community centre with a cybercafe offering free access to the Internet.) This mediated access has several advantages: it can make the Internet's information resources available to rural and underserved communities; community re-broadcasting can relay the information in local languages as opposed, for example, to the dominant English language of the Internet; and the information can be pre-sifted, culturally mediated and presented to the audience in ways that are appropriate to local social practices.

A different example of this mediated access is the growth of adopt-a-school projects. Schools, companies and individuals with Internet connections adopt under-resourced and unconnected primary schools in poor countries and solicit resources and funds on their behalf by setting up a dedicated website, with photos and needs-lists. Examples include adopt-a-rural-library schemes and, where language permits, send-a-comic and send-a-book campaigns.

School linking. One burgeoning use of the Internet is school linking – sometimes known as twinning – which involves the establishment of long- or short-term Internet links between individual schools for the purpose of communication between pupils, teachers, head teachers, managers and carers. Linking is occurring at regional, national and international levels in north-north, south-south and north-south configurations. At the moment, most linking occurs at secondary and junior secondary level but as computer provision is increasingly taken up at a primary level, links are beginning to be established between primary schools. Table 6 illustrates some of the ways in which schools have been linked through the Internet.

For pupils, school linking opens up innovative and enriching learning possibilities: new learning communities, classroom pen-pals, information-sharing skills, resource exchange and development, collaborative writing and web-page development projects, and global virtual classrooms. The global context can act as a powerful site for the 'recognition of, and support for, cultural difference' and for the assertion or protection of differences on the part of both parties in the exchange (Giddens, 1990, p. 7). In this, school linking appears to hold particular significance amongst minority and isolated communities such as setting up links within the Jewish Diaspora, between Afro-Americans and Africans, or among isolated Inuit and Native American communities.

There appears to be considerable potential for expanding school linking in its different forms and particularly in promoting south-south links. They seem to be a successful way of building on and consolidating established links. The National Schools Network in South Africa, for example, was an extension of successful regional schools networks, a school-driven, grassroots networking organization.

Sharing resources. The Internet provides schools with the opportunity to offer more open learning opportunities through virtual courses. Virtual school projects, for example, commonly offer a range of Internet-based courses at junior secondary level, although these differ in the scale, structure and purpose. In some cases the virtual technologies are making it possible for schools to teach both on and off the school premises, replicating the mode of teaching of dual-mode institutions at tertiary level. Some allow students to study some courses on a face-to-face basis and others on an open-learning basis. Electronic materials can in some cases be slotted into a face-to-face course as an additional resource. In other cases a full school programme is provided on either a face-to-face basis or on a distance-education basis for out-of-school learners, but both under the supervision of the school. In a third model, some schools have begun to offer on-line private tuition for home-based education, outside regular school provision and with the aid of parents. In practice the distinctions can become blurred; for example, when schools attempt to capitalize on virtual courses used in school by also offering them on a commercial basis to other learners.

Participation in some virtual projects provides schools with the means of extending their range of available courses without the need to expand enrolment or recruit specialist teaching staff. They are particularly useful as a means for increasing the access to a broader range of specialist subject courses in small and remote communities and without the need for learners to leave their home community. In some cases, groups of schools have worked together in this way in order to share their resources.

The Virtual High School (VHS), for example, is a recent co-operative venture between thirty-five high schools from twelve states in the United States in which they pool on-line courses and teaching-time. During the 1998/99 academic year, the schools offered forty NetCourses to students in the schools. Courses include computer programming, music appreciation and composition, microbiology, stellar astronomy and statistics. Virtual High School teachers complete a graduate-level NetCourse to learn how to develop and deliver courses over the Internet with a view to them offering and hosting new

courses. In exchange for teaching a NetCourse, schools can enrol students in any NetCourse being offered by other participating schools. In terms of technology, VHS uses 'interactive databases that teachers use to design their NetCourses' – (vhs.concord.org) with students accessing 'their VHS NetCourses using graphical web browsers like Netscape navigator or Microsoft Explorer'.

Another approach is to enable a central agency to develop materials for a group of schools. During 1995/96, the New Direction in Distance learning (NDDL) project of the Open Learning Agency's School Programme in the Canadian province of British Columbia delivered interactive instructional courses in mathematics, science, languages, humanities and applied skills to thirty-five learning sites, mostly in small high schools. The project was used to increase access to educational programmes in small and remote communities as well as to provide access to distributed learning models for urban schools and their students. Others were located in community learning centres so that the programme could also have implications for out-of-school adolescents.

By using a variety of network-based and more traditional distance-education tools, each course involves learners in both independent and group learning activities. Electronic communication occurs between geographically separated learners in using a range of technologies including computer conferencing, audiographic conferencing and web-based delivery. The choice of technology was influenced by the subject matter of the lesson.

> For mathematics, NDDL uses application-sharing whiteboards to teach mathematics when it is important for students to be able to see the instructor manipulate equations in real-time using hand-written figures and mathematical symbols. A whiteboard is an electronic screen that resembles the classroom whiteboard. Learners at any site can see on their screen what someone at another site writes, and they can also write on, change and augment what has been written by others, hence the shared application feature. NDDL learners use small scanner (Visioneer Paperport) to digitise their homework assignments, then they attach file to e-mail, which is send to the instructor. The instructor uses graphic software to annotate and correct the assignments, which are then returned via e-mail to the learners, eliminating the expense and bother of paper transportation. (Haughey and Anderson, 1998, p. 56)

A total of 450 students completed courses during 1995/96. The programme was jointly funded by British Columbia Ministry of Education and the participating schools. In 1996/97, the fees were Can$1,000 per school district and $500 per NDDL school or community site. In addition, participating schools, parents or communities were expected to pay a tuition fee of $375 per student per course.

> The schools must also provide all the communications tools for student use. These include a local area network (LAN) connected to the Internet, graphics tablets, audio-teleconferencing equipment and various network and stand-alone software. Schools must also assign a site-based facilitator (either a teacher or paraprofessional) for one eighth of a full-time position for each 25 students enrolled. NDDL supports teachers with a 3-day in-service course before commencing teaching duties and is currently digitising this training programme using videos and CD-ROM technologies so that new instructors, facilitators and learners can take initial training at their convenience any time of the year. (Haughey and Anderson, 1998, p. 58)

The programme also supports students in job-seeking by providing on-line career counselling, job and work experience data-bases in the environmental and entrepreneurial fields.

Conclusion. The evidence available so far leads to three conclusions. First, computers have been introduced to enhance conventional teaching, not replace it, so their costs are additional to existing educational costs. The example just quoted illustrates both the need to work on an adequate scale in order to justify software development and that the costs for sophisticated applications and materials development are likely to be higher than many schools can afford. Second, many projects have under-estimated the costs of curriculum development and teacher training. These are likely to amount to around 50 per cent of the total costs of computer-related education. Third, differential access to computers within countries, let alone between countries, looks likely to remain. It presents the dual challenge that significant investment will be needed to overcome the differential and there are also significant opportunity costs involved in making that investment.

Educational technologies in the classroom

Within schools in high-income countries, a range of educational technologies are taken for granted – audio and video-cassette equipment, hand-held still and video cameras, overhead projectors and calculators. These either belong to the school or are on loan from different sources: libraries, local or national educational institutions. Multi-media teaching is encouraged not only by the availability of the technologies, but also by its inclusion within teacher-training courses and by the availability of professional support. In many low- and middle-income countries, by contrast, the dearth of educational technologies is matched by minimal, if any, corresponding teacher training.

International experience makes possible three generalizations. First, where teachers and managers have developed an understanding of multi-media and multi-channel teaching within their own training, they are more likely to adopt innovative ways of securing and using them. Second, planned strategies are required to increase access to educational technologies in schools, particularly low-tech, multi-media resources. Strategies might include government or donor-funded donation initiatives, mobile units, loan systems from libraries and audio-visual resource centres. National and regional audio-

visual centres and broadcasting stations in particular emerge as key drivers for producing and introducing audio-visual resources within basic education. Third, we need to understand that infrequent use of technologies within schools may not reflect a lack of training but may be because teachers see little pedagogical value in using them, a factor which techno-enthusiasts overlook.

Broadcasting

We made a distinction earlier between three main types of broadcasting used for primary and junior secondary school children – direct teaching, school broadcasting designed as enrichment and general children's programming. In practice, as we have seen, there can be a blurring of edges between them. Together, however, they can create a loose but formidable mosaic of learning opportunities for this group of learners.

Interactive radio is the best documented. It has been pioneered and developed mainly by the United States Agency for International Development (USAID) from the 1970s up to the present day in over twenty Latin American, African and Asian countries. Some of the experience is set out in Table 7. These are mostly individual country projects but some operate at the inter-country level such as in the five African countries with Portuguese as an official language (PALOP). With assistance from UNESCO, the Netherlands government and USAID, these countries are involved, in the joint development of IRI curriculum materials in mathematics and Portuguese as a second language.

During the twenty-five years of IRI projects, a significant research base has grown (e.g. Moulton, 1994; Dock and Helwig, 1999) out of project evaluations and these can help us gain insight into conditions for success and sustainability for radio teaching projects. (One caution, however, is that most of the evaluations are in-house and there has been little outside critical analysis of IRI.) As already noted, there is consistent evidence of learning gains among children who have followed IRI lessons.

But some problems remain. One is that of scale and cost. The achievements of interactive radio have to be set against the relatively high cost of the curriculum development on which they are based. In a significant number of cases, IRI has proved not to be sustainable beyond a pilot stage because Ministries of Education could not meet the costs. Operation at a pilot scale is likely to keep unit costs relatively high. There may be conflict between the demands of scale – seeking to maximize audience and keep materials in use as long as possible – and the needs to be responsive to local needs and shifting needs in learning. Materials with long-production lead times (and from the cost point of view a long shelf-life) cannot easily be responsive in these ways. Then, broadcasting is particularly susceptible to the promise that all that is lacking in an impoverished and limited education system is an adequate means for depositing ready-made education; that adaptations of projects from one culture to another are straightforward. In practice IRI cannot be expected – nor was designed – to transform education systems.

Successive evaluations of educational broadcasting generally show that it is likely to succeed if it grows out of prevailing pedagogical practices, and community, professional and national networks through a process of continuous research and dialogue. IRI is therefore likely to have limited success if it is seen as being imposed externally. In South Africa, for example, the original plans for an IRI project were rejected on grounds that their apparently behaviourist pedagogy was dangerously close to prescriptive, teacher-centred aspects of apartheid education. Only when it was reshaped on constructivist premises was it acceptable. IRI continues to be faced by a concern that it may reduce, even usurp, a teacher's control and responsibilities. In addressing that concern, too, it needs to explore how to broaden the concept of interactivity away from a simulated conversation and overcome the top-down, one-way nature of radio.

During the 1990s IRI has developed initiatives in heath education and early childhood development that attempt to answer some of these questions. Using a 'decentralized implementation methodology', preventive health and education programmes are marketed and disseminated on cassette to local radios and local municipalities and, through decentralized training, adapted culturally for different language groups. However, this sort of decentralized system involves higher costs, is more time-consuming and labour intensive.

While we have much less documentation on other uses of radio, there is some evidence that fills out this picture of radio's strength and weakness in formal education. Flavell and Micallef (1995), for example, working in Mozambique, attempted to measure the relative effectiveness of a radio-only approach and a radio-plus approach (teaching materials and teaching assistance) in terms of improvement in English language skills among students at a secondary level. Following large-scale longitudinal sampling over a nine-month period in seven Mozambican state schools, they concluded that general exposure to radio is beneficial but markedly so when radio is used in conjunction with good quality local print materials and where local teachers are well trained in the use of radio and audio-cassettes in class. Used in this more integrated way, radio can be exploited in a far greater range of educational strategies and with greater effect than a radio-only approach. Studies from the BBC English project, called Radio English Direct, which is taking place in a number of African countries, are also likely to prove useful. Radio programmes and materials are being developed within particular countries that reflect teachers' and students' concerns, and existing educational conditions and curricula. Part of the project has been the development of a radio awareness element within the teacher-training curriculum. More studies are required to measure the effectiveness of radio in formal education.

An innovative new direction in schools broadcasting is child- or teacher-initiated schools broadcasting at the local level. As already mentioned the Kothmale radio station in Sri Lanka serves remote rural communities and receives from children or their teachers' requests for further information about school topics for which no local resources exist. The producers search the Internet for resources, download them and then construct programmes around the information or release it in printed form back to the school or at the station' public access centre. This directly responsive relationship between school and broadcasters overcomes, to a large degree, the one-way, top-down nature of much broadcasting and perhaps points to a future area of development.

There are also examples of television school broadcasting based, as in rich countries, within large broadcasting corporations and as part of television channels (BBC Education Radio TV, NHK Japanese Broadcasting Corporation, the United Kingdom's Channel Four Educational Broadcasting). In developing countries these tend to the product of the Ministry of Education and Ministry of Information or Curriculum Development Centres.

We distinguished above between formal and non-formal children's programming. International experience provides a number of examples of projects that use a non-formal approach and may allow use either in school or outside. Some programmes are designed with the content of the school curriculum in mind. Colombia's *Ricon del Cuento* programme, for example, is a forty-seven-part television series for 4-to-8-year-olds, designed to promote a love of reading. It has been broadcast on public television and also distributed to 1,500 schools in Colombia on cassettes. The British Broadcasting Corporation's hugely successful factual documentary, *Walking with Dinosaurs*, is broadcast at peak family viewing times in the evenings but has generated a range of learning resources in and out of school such as books bought commercially, and on-line resources for teachers and young learners. In South Africa, in a move further away from the conventional curriculum, the South Africa Broadcasting Corporation produce Lifeskills print packages for schools, based on the characters and stories in its prime time *Soul City* television and radio series, and produced in nine languages. These schools' activities are just one element within a broader campaign that creates a whole mosaic of mutually reinforcing educational opportunities.

There has also been a growth in children-driven or child-centred programmes. This trend is a particularly noticeable in programmes with a conflict-resolution curriculum. Examples include the *Children in Conflict* radio programmes (with ten series in nine languages produced by the BBC World Service) which centre on interviews with children in war-torn parts of the world. A national-level example is children's television in the former Yugoslav Republic of Macedonia, a drama series for 8–12 year olds following the lives of five children, two from the former Yugoslav Republic of Macedonia, one Albanian, one Turk and one Gypsy.

The evidence suggests that there is a renaissance in the use of radio and television broadcasting as teaching tools for both formal and non-formal purposes. The widespread ownership of both makes this an obvious development. At present there is more emphasis on radio in developing countries but some are arguing that television for learning will become a foremost tool in the twenty-first century.

A critical mass of TV viable countries now exists for educational purposes, to justify unprecedented levels of international co-ordination in such areas as experience exchange, training, resource development, and national and regional capacity building (Palmer, 1999, p. 1).

Out-of-school children and adolescents

Expansion of secondary schooling is constrained by a shortage of qualified teachers, particularly in rural areas, and a shortage of school buildings. Inevitably, secondary experience has lagged behind primary. Coverage in urban areas is much higher than elsewhere but still remains insufficient while adolescents in low-density rural areas present a particular problem: schooling is often unfeasible due to low student numbers, the difficulty of attracting and retaining teachers, and the difficulty of offering a range of specialist courses. Gender, ethnic background, class and caste, as well as location, affect children's chances of getting to secondary school.

Various technology-enhanced initiatives have been used to address needs of the out-of-school children and adolescents. These can be grouped into three categories: first, those that offer direct teaching in alternative secondary systems; second, smaller-scale, non-formal, outreach learning opportunities; and third, resource-based self-access learning opportunities.

Alternative secondary systems

Within this category we can find a range of technology-enhanced course-based alternatives to the regular secondary-school system – computer-based teaching, television-based direct teaching, radio-based distance education and the open school movement.

In rich countries *computer-based* virtual classrooms have been developed for out-of-school adolescents. The majority of these, as we have seen earlier, are focused on individual subject areas and used by in-school learners as additional resources. The John D. Bracco School in Alberta, Canada, has taken this a step further and is operating as a dual-mode school: in parallel to its mainstream schooling curriculum, it offers a full alternative junior high school programme – LearnNet – for adolescents in remote areas or parents who wish to educate their children at home. LearnNet gives guidance from professional educators to home-schooled students and their parents through a

computer conferencing system, although students may occasionally come to the school to socialize, to meet their teachers and to attend classes. The Rocky View Virtual School offered a full course load to over 185 students in Grades 9-12 in 1998/99 and expanded to include Grades 7 and 8 in 1999/00. Course are offered in a wide range of subjects in three different streams – the academic route required for university entrance, the non-academic route required for college entrance and the lower academic route for students looking towards an apprenticeship after graduation.

Television-based schools are exemplified by Mexico's Telesecundaria programme which has been providing direct television teaching to increasing numbers of rurally based learners. Centrally produced television programmes covering the same secondary school curriculum as that offered in ordinary schools are beamed via satellite throughout the country on a scheduled daily basis to Telesecundaria schools in two shifts (8am to 2pm and 2pm to 8pm). Each hour focuses on a different subject area and typically follows the same routine – fifteen minutes of television, switch-off, and then book-led and teacher-led activities. Different levels in the same subject are staggered to begin at exactly the point at which the preceding level switches off. The child is exposed to a variety of teachers on television but has one home teacher at the school for all disciplines in each grade. Some 60 per cent of Telesecundaria teachers are fully qualified while 40 per cent are university graduates with no previous teacher training. They receive induction training and then follow-up in-service training through televised programmes broadcast in the afternoons or on Saturdays.

Following the introduction of satellite transmission, the numbers of learners grew from 512,700 in 1993 to 817,200 by the end of 1997/98, with a projected enrolment of 1,100,000 by 2004. By the end of 1997/98 there were 13,054 schools and 38,698 teachers (Castro et al., 1999, p. 29). In terms of effectiveness, Telesecundaria is encouraging: drop-out rates are slightly lower than those of general secondary school and significantly better than technical schools. Interim achievement rates show that students 'start significantly behind other students but catch up completely in math and cut the deficit in half in language' (Castro et al., 1999, p. 32). Costs include teaching and administrative costs, physical facilities, televised programmes and books; while they are more expensive that urban secondary schools, they cost less than what would be required to establish a general secondary school in a rural area. '60 students would require 12 teachers, for a 5:1 ratio, as well as a full laboratory and administrative personnel' (Castro et al., 1999, p. 31).

Its success is attributed to a variety of factors: it brought schooling to areas where there had been none before rather than replacing existing schools; it attracts committed teachers who have elected to live in rural areas; over thirty years, the programmes have evolved from talking-head format to a more varied and contextualized teaching style involving more participants. Perhaps most important is its perceived status and the esteem for the producers. 'It constitutes one of the very few programs in which the poor receive a better-conceived and better-managed program than urban middle and upper socio-economic classes' (Castro et al., 1999, p. 32).

Difficulties include persuading teachers to remain in rural areas, high costs of replacement books and theft or maintenance problems with antennas, the costs of replacing long shelf-life programmes with those with more principled pedagogy and the rigidity of scheduling. In terms of the last, there are plans to switch to an Internet-based system that would give the teachers and learners the flexibility to view programmes at convenient times.

Radio-based distance education has also been used for basic education. Radio has advantages over television, in terms of access as well as cost, for countries with a low population density. Mongolia provides an example. The change to an open market economy created new challenges for the Mongolian education system in order to cater for new demands of basic education, retraining, continuing education and literacy training for both young people and adults. With over a third of the population living a nomadic life with an economy based on animal husbandry, radio-centred distance education has become widely used in Mongolia for this and other levels. Learning for Life, a UNESCO and Mongolian government programme launched in 1997, is to target marginalized youth throughout the country over a four-year period. This amounts to 37,000 selected families who, through radio programmes, self-learning booklets, learning centres, teacher-training sessions, acquire competencies in micro-enterprises and marketing.

Open Schools represent a different approach to out of school education. In response to an unmet demand for places at secondary level, the central governments of India, Indonesia and the Republic of Korea have created alternative systems for young learners unable to get into mainstream schools. This Asian model of open schools, though differing in certain particulars, is distinctive because it retains close connections with the regular secondary school system. Students learn from self-instructional materials used in conjunction with different combinations of low-tech cassettes and broadcasts and differing types of student's support.

The National Open School, India oversees the development of self-instructional print and sometimes audiocassette materials by other educational institutions including mainstream schools, the National Council for Educational Research and Training (NCERT) and the Indira Gandhi National Open University. They offer four different types of programmes in English and Hindi: secondary, senior-secondary (Grades 10-12), bridge courses (around Grade 8) and vocational courses (free-standing or combined with academic courses).

A student in the secondary level can choose home science and business studies, in addition to mathematics, science, English, social studies, or bakery and confectionery. At the senior-secondary level, a student may choose subjects, such as political science, chemistry, or furniture and cabinet making (Mukhopadhyay, 1995, p. 94)

There are no formal entry requirements for the programmes (except at senior-secondary level), and the range of courses and the freedom to select is often better than in many schools. The courses are distributed to students who attend classes or Personal Contact Programmes at study centres generally within a regular school. Gaba (1997, p. 46) reported that in 1997, there were about 670 study centres through India, that 50–70 per cent of students attended study centres and for about 30 days during their programme of study. Enrolment at the National Open School grew from 34,800 in 1991/2 to 130,000 in 1998/9 with 61 per cent of students following secondary and 37 per cent senior-secondary courses. When compared to the 64 million in formal secondary school, this enrolment seems insubstantial. Nevertheless, the chairman, speaking in 1995, predicted that open-school methods would be used to reach 40 million students in sixteen languages within ten years. The Open School's income is derived from student fees and the sale of books and materials. In 1997/98 male secondary students paid 800 rupees ($22) and female 600 rupees ($17) for five classes. Reduced fees are charged to handicapped students, ex-serviceman and members of scheduled castes and scheduled tribes. The cost per student is 637 rupees ($44) as compared with a cost of 1,019 rupees ($71) for regular schools.

The Open Junior High Schools in Indonesia have similar objectives of serving the disadvantaged, who are economically and educationally deprived. The open school system was developed in 1984 alongside the expansion of regular secondary school and is considered part of it as the children follow the same curriculum and examinations and attend open-school centres often attached to regular schools or in a community building near their home. Centrally produced self-instructional materials are designed to promote individual learning. These are also backed up by twice-daily radio and television broadcasts and local student and teacher support groups: the students meet for three hours daily, four to five times a week. Untrained local teachers' aides are available at meetings (and mark students' assignments) and the students attend a weekly three-hour session with subject specialists at the base school. This provides fifteen to eighteen hours of supervised study per week contrasted with the twenty-seven contact hours in regular schools. In 1995 the open schools and others developed along similar lines were available in 59 provinces throughout the country with a total of about 50,000 students. By 1996/7 there were 172,000 students in 956 locations with plans to expand to 410,500 students in 3,270 locations by the end of the decade (Sadiman and Rahardjo, 1997, p. 287) although the Asian financial crisis intervened in the meantime.

The Republic of Korea has established a system of Air and Correspondence High schools similar to Indonesia. Centrally produced self-instructional materials, designed around the first three years of high school, are distributed to the students once a month. These are used in combination with daily radio lessons (early in the morning and late in the evening) and attendance at the linked secondary school on alternate Sundays. This amounts to 1,224 study hours a year. In comparison to the 3.6 million in regular high school, 35,300 students (aged between 18 and 24) studied in this manner in 1992. Some 82 per cent of them also held down jobs at the same time. Examination pass rates were above 80 per cent while the drop-out rate has been in the range of 40 to 48 per cent.

In a variant of the open school system, Malawi, Zambia and Zimbabwe all developed study centre programmes which served as substitutes for secondary schools. Buildings were provided – or shared – where young people could follow correspondence lessons, some backed up with radio broadcasts and with some help from a tutor supervisor. The schemes always suffered from being seen as a second-rate alternative to regular schooling, by both parents and teachers. In both Malawi and Zambia a government distance-teaching institution produced learning materials for use in the centres. Both institutions suffered from, at best, benign neglect so that the impoverished system did not even work to the best of its capacity. Despite the difficulties, the centres did appear to be achieving results, in terms of junior secondary passes, at modest costs that compared tolerably well with those of the conventional system. But the perceived weaknesses of the systems mean that they appear to be in a state of decline. Malawi, for example, has decided to transform its centres into community schools, even at the risk, in the short run, of providing the centres with less in the way of open-learning materials.

Community-based approaches

Communication technologies have been used, particularly in industrialized countries, within the framework of community projects for young people. These have often been addressed to adolescents who are out of school and disaffected from it. Mobile units, sometimes bringing videos and films but increasingly offering access to the Internet, have been used for this purpose and have sometimes become a permanent and integral part of a national library system. Programmes of this kind allow access to self-study materials in a range of forms including print, cassettes, educational computer software and materials on the Internet. They may bring a double benefit, enabling those using them to widen their education generally while acquiring some computer skills.

Programmes that rely on advanced technologies in this way demand facilities seldom available within developing countries. The development of telecentres may, however, open some opportunities for similar programmes. There is, however, one further problem that inhibits the development of effective pro-

grammes – a dearth of self-study materials. Often there is little, either specific to a national context or of general relevance. There is a particular need for materials that are geared to prevailing technological constraints and that can be used on a flexible basis – low tech combinations of print, audio and video cassettes – but also have a potential application. More advanced technologies UNESCO's Learning in Portuguese project aimed at the PALOP African countries – Angola, Cape Verde, Guinea-Bissau, Mozambique and Sao Tome and Principe provides one example of a project that attempts to do this. Learners can use the computer-based package – CD-ROM, user's manual, teachers' notes and Internet-like pages included within the CD-ROM (and at the same time learn Internet skills without the expense of Internet connectivity).

Mass media health campaigning

Mass media have been used, sometimes in a campaign approach, to meet educational needs outside the formal curriculum. Health programmes offer a variety of examples, many of them concerned with the prevention of HIV/AIDS. The majority of health advocacy projects are large-scale, popular-culture, health advocacy campaigns targeted at adolescents, in or out of school. These use a range of media – film, radio, television and cassettes in a variety of formats – documentary, soap, music, talk shows. Different fulcrum interventions are used depending on the sexual mores of individual countries. Some are sophisticated campaigns that use popular-culture radio and television broadcasts, at a national or community level, and organize a range of well-planned and often synchronized outreach activities around them in a variety of community domains. Where sexual matters are considered taboo in the public domain and where there is no formal sex education in schools, many of the campaigns are targeted directly to youth out of school and are based around informal peer support networks. Others are intergenerational projects or ones that reach youth as a secondary target group.

Health education broadcasts have been developed and produced both by in-country broadcasters, often in partnerships with non-governmental organizations and donor partners, and by international broadcasters such as the BBC World Service. Its Sexwise project, for example, focused on sexual and reproductive health in Asia; it included 9 radio series with more than 130 programmes overall which were tailored to the needs of the countries where they were used. The programmes were translated into 9 different languages.

Some initiatives have sought to use communication technology to support peer education or youth-to-youth education. This is intended to provide a communication framework to enable young people to address issues that their culture does not allow these to be discussed at home or within formal education. One recent high-tech example was a video-conferencing experiment linking Australian medical students with Soweto high-school students in South Africa for a discussion about HIV and AIDs prevention. This youth-to-youth networking illustrated to the medical students the culturally embedded nature of health issues. For example, during the exchange it became apparent that sex education was virtually non-existent for the South African participants, either at home or at school, and that the use of impersonal communications technology – such as the Internet where it is available to the audience concerned – would be a valuable way to learn about HIV prevention (www.netschools.org/ health4youth/lancet).

Table 8 gives some examples of various approaches. It illustrates the range of approaches and the potential for expanding education for adolescents in a, literally, vital area.

Marginalized children and adolescents

In both developing and industrialized countries there are some groups of children and adolescents whose educational needs are not being met by the conventional education system. Within this group are young learners who are in danger of being marginalized because they live in difficult or remote circumstances or because their parents are occupational travellers. The most severely deprived groups are likely to be refugees, displaced war children and street children. Within many communities some children may seek supplementary – or even separate – education for ethnic, linguistic or cultural reasons. In principal, technologies may be of help in providing educational opportunities where specialized teachers and resources are scarce.

Computers

Different marginalized and minority groups have found that computers and digital communication networks can enable them to retain, assert and develop their cultural traditions. The Internet, specialist software and CD-ROMs are increasingly used in rich country contexts and in a range of different educational settings, including supplementary schooling for refugees, Hebrew and Muslim special schools, schools in remote areas and community centres. The Internet is typically used to establish new national or international learning networks between groups of children in school or community centres. Examples include Inuit schools in the Northwest Territories of the Arctic and Jewish schools throughout the diaspora. It is also used, by children or their teachers, to access new or specialist learning resources. The latter are frequently posted on dedicated websites that provide information, contacts, educational advice and ready-made materials for particular minority or marginalized groups. Examples include the WEB DuBois Center for Afro-Americans, the Artemis Gypsy and Traveller Education Database, The Kids' Hospital Network, the Efecot and Pavee Point websites for travellers and the website of the Office of the United Nations High Commissioner for Refugees. Other projects are feeding into the

creation of appropriate content: some fund the digitization of ethnic minority literature while others, like one initiated by the government of Tamil Nadu, promote keyboard standardization and software interfaces in different languages, such as Tamil.

Software for language development is a particular growth area. The Socrates Me Too programme, for example, is a collaboration between twelve European organizations and is developing customized language-teaching software in first and second languages for minority ethnic pupils (so far offering material in Italian, Chinese and Arabic) and websites to support school and community centres.

Providing education for travellers' children has produced innovative uses of technology. In the United States, for example, the Department of Education is providing some secondary-level learners with laptop computers that enable them to study online courses provided by a private education company. The FLEX project, involving twenty-three European–wide partners and with a budget of some 1.5 million euros (about $1,530,000), is exploring way of using the latest technologies to improve the education of travelling children (e.g. circus, fairground and bargee children). Travelling children are provided with laptop computers, CD-ROM learning resources, GSM modem and a digital video-broadcast receiver. The school-based teacher sends messages and structured 'learning blocks' via a video-mail message. The child communicates with a remote tutor by leaving voice mail messages on the FLEX website. Another European project, TOPILOT, combines learning resources on a CD-I (interactive Compact Disc) and other print-based materials with cheap narrow-band mobile data-communication (via GSM). The tutor can monitor their learners' progress through the CD-I material from a distance.

The examples here all concern marginalized children in rich countries. They have had to overcome the problems of geographical or cultural remoteness within a single country: even within national boundaries there can be differences between the information rich and the information poor. Remote communities are likely to have lower quality and less reliable communication links, sometimes at higher costs than those in urban centres.

Broadcasting and distance education

Radio plays a central role in bringing both formal and non-formal educational opportunities to marginalized communities. In formal distance education, there is a long-established tradition of radio-led courses for children in farming communities, including, for example, the School of the Air in the Australian outback and the Government Primary Correspondence School in Zimbabwe. The School of the Air is also beginning to integrate the Internet into the course. Over the course of two years, for example, the University of Ballarat is arranging Internet connections for 1,200 families so that they can have access to learning materials for remote children. OLSET in South Africa is providing radio-led IRI education courses (in English language and mathematics) to remote under-resourced schools of South Africa. This has in some cases been made possible by the use of Baygen wind-up and solar powered radios.

Radio has also been particularly useful as a means for extending education to home-based girls. It has made possible distance-education programmes for ethnic minority girls in the mountainous regions of the Lao People's Democratic Republic and has been used to reach travellers including, for example, the children of migrant fishermen in Nigeria. There is also a long tradition of developing radio education for refugees and for refugees living in camps. Afghanistan provided a current example.

Broadcasting – radio in particular – is also widely recognized as the prime means of fast-response communication in regions of conflict and is used extensively to provide non-formal educational programmes for children (often in programmes targeted to the whole family). The type of programmes vary. Some are designed to raise awareness of hazards: land mines and cholera for example. Others aimed at children are designed to be therapeutic, often involving music therapy. Radio Kwizera in the United Republic of Tanzania, for example, brings Rwandan refugees 40 hours of broadcasts a week in a range of languages in general health education, sanitation and children's issues. For their part, international radio broadcasters play a significant role in bringing multilingual information and music programmes to war-torn areas and displaced communities and, in some cases, make specifically educational programmes. At a cost of $650,000 per year, the BBC Afghan Education Drama Project, for example, has since 1993 broadcast health education and mines-awareness education. Broadcasts three times a week use a soap opera format and are either beamed directly from the international broadcaster or made available for re-broadcasting by other radio stations.

Underpinning these projects are radio donation schemes and school-in-a-box emergency packs. War Child, for example, is currently testing the validity of Baygen wind-up radios as a communication aid for families in isolated and war-torn communities and, if effective, will consider funding large-scale radio distribution projects in war-torn countries. Teachers' emergency packs are also deployed containing basic teaching equipment for children and teachers (textbooks, teacher's manual, pens and pencils), and sometimes radios and audiocassettes.

Radio and television broadcasting are also enlisted to promote wider aims of conflict resolution. The British Department for International Development (DFID), for example, funds a children's television series in the Former Yugoslav Republic of Macedonia that seeks to encourage understanding and the non-violent resolution of disputes.

Some distance-education programmes, of the kind discussed above, have developed programmes or approaches specifically

for marginalized young people. The Indian National Open School, for example, has, been seeking to extend its basic education programme to vulnerable groups such as rural and tribal women, school drop-outs, working children and drug addicts. This has included the development of new curricula and outreach work.

Outreach activities

Outreach educational activities are often the only means to reach young learners in some marginalized communities. Most are small-scale face-to-face teaching projects but some use different forms of technology. In war-torn areas, there are examples of mobile creative therapy units equipped with art and music therapy resources. The War Child Netherlands project in Albania brings music tapes, CDs and musical equipment to Albanian refugee children. The War Child Visual Impact project operating in the Western Sahara, Liberia, Kenya, Azerbaijan and Georgia brings art therapy to young refugees. Children, often recently orphaned, present their stories via single-use cameras that are then exhibited. War Child also produces music therapy resources donated and delivered to youth and social centres and orphanages.

Community resource centres, either permanent or mobile, play a key role in providing educational support for street children and drug abuser children in a variety of countries. In New York, for example, the Covenant House Community Resource Centers, established in 1993, offer support and educational resources to adolescents in crisis situations. In Mexico, the Juconi Foundation uses audiocassettes to support the face-to-face teaching of street living, street working and market children. Training videos in crafts such as woodwork and metal work are presented to marginalized street youth through mobile projection units (in Port-au-Prince, Haiti) or youth centres (Ciresari Centre, Romania).

Adult basic education

Programmes for adults include both equivalence programmes offering a second chance of getting formal educational qualifications and non-formal education, with a different kind of curriculum from that in the formal school system. Non-formal education is often poorly documented, under-researched and frequently neglected. It caters for a range of mainly poor, disadvantaged and marginalized adults with little or no past formal education. In developing countries, this includes farmers, remote communities and adults with limited literacy skills.

After Jomtien, schooling has continued to attract more attention and investment than adult basic education. Some have suggested that it got short-changed in the 'resulting dispersion of responsibilities for basic education' among governments, donor agencies, non-governmental organizations, the media and business (Limage, 1999, p. 76; UNESCO, 1996*a*; UNESCO, 1997*a*). It is an area that attracts debate about the ethical and economic case for significant public expenditure and involvement. Jones (UNESCO, 1997*a*, p. 31) is quoted as arguing that there is a solid economic case for investment in adult basic education. Wagner, however, found little evidence of economic benefit from literacy programmes (UNESCO, 1997*c*, p. 34) while earlier reviews found that the cost per successful student of adult literacy programmes was far greater than the cost of making a child literate through conventional primary education (cf. Perraton et al. 1983). Ministries of education have reflected one side of the debate with the lion's share of budgets going to provide basic education to children rather than to adults. The piecemeal nature of many non-formal projects, the shortage of evaluative data and the long shadow cast by failed projects have made it easy for governments to ignore the demands of adult basic education. Unlike primary education for children, there has always been a need to justify expenditure on adult education. Only rarely has there been a strongly stated political case for expenditure or economic evidence to back it.

We can identify two trends within adult basic education over the past decade that bear on its use of technologies. The first is a renaissance in the use of radio – national, local and community – and its increased use in non-formal education. The second is a new emphasis on a participatory methodology. Projects run by the British charity ActionAid, for example, are founded on a carefully constructed methodology known as REFLECT (Regenerated Freirean Literacy through Empowering Community Techniques). This draws on, among others, participatory rural approaches (Chambers, 1983, 1993), Freirean critical approaches to education (1972) and views of literacy as social practice (Street, 1993).

Both these developments have encouraged the use of outreach communication strategies. Community radio programming is often based on recordings and requests gathered in outreach work. In REFLECT projects, technologies are not necessarily built into a project plan but may emerge as a project is developed in consultation with participants. Where this does occur, it is more likely to include simple technology such as audio- and video-recorders in the hands of learners themselves and work with local radio broadcasters.

There is a wide range of projects: some are for individualized learning, others for group situations; some concentrate on discrete areas such as health or agriculture while others take a more integrated approach to the everyday needs of learners. Again, we are short of evaluative data.

Information and communication technologies

A handful of projects in low- and middle-income developing countries have begun to explore the use of communication

technologies to widen access to learning and information. The Kothmale Internet Community Radio project in Sri Lanka, discussed previously in relation to school children, has mainly been used for adults, enabling rural communities to seek information from the Internet.

Community radio broadcasters respond to requests from listeners for particular information that they search for on the Internet and then broadcast back in suitable form and language to their listeners in a daily two-hour radio programme. The radio station functions as a community resource centre, providing free community Internet access (at the station and two other community libraries) and as a community library with computer database, CD-ROMs, downloaded literature and print materials. Opened in 1999, the costs of the project will be covered by the government for two years after which the $1,000 per month will become the responsibility of the radio station.

The Grameen Telecom project in rural Bangladesh is one of a range of projects in developing countries with the aim of achieving telephone and Internet connectivity to rural communities. Women in villages are offered loans by the Grameen Bank (located in every Bangladeshi village) to buy cellular phones (the purchase price is $221, or $313 with an antenna) which they can then rent out to other villagers on a commercial basis. The owners repay the loan from income generated from rental (daily income ranges from $3.70–$9.00 per day).The use of the telephone is seen as a way of stimulating growth and development in villages while providing incidental learning opportunities to learners.

Other telephone projects include Inmarsat pilot projects with solar panel, battery-powered satellite community payphones. They are taking place in rural and remote locations in Africa, Latin America, South-East Asia, China and the Pacific Rim countries. There are also a variety of Village Internet projects such as the Wirana Wired Village Project in India and the Village Internet at El Limón in rural Dominican Republic.

Similarly, the development of multipurpose community telecentres will also facilitate telephone and Internet connectivity. Pilot projects, generally with United Nations funding, exist in Benin, Bhutan, Egypt, Ghana, Honduras, India, Mali, Mozambique, Philippines, South Africa, Suriname, Trinidad, Uganda, the United Republic of Tanzania and Viet Nam.

In industrialized countries, adult literacy programmes lag behind other educational levels in their incorporation of electronic technologies. Investment in the area is limited by the precarious nature of adult literacy programmes and their funding constraints. But there is also some resistance to the use of information and communication technologies for adult learners in the area. For adult literacy practitioners, however, a growing number of dedicated websites offer the usual fare: on-line publications, links to resources and networks. Examples include the Literacy OnLine (www.literacyonline.org), LiteracyLink for educators (www.pbs.org/adultlearning/literacy), Literacy Training Network (www.mlrc.stthomas.edu/ltn/resourcecenter/home).

In recent years in America, there has been a small but pioneering growth of on-line literacy projects for adult learners exploiting bulletin boards, information servers and virtual learning communities. One example is the SHELCOM (Shelter Communications Literacy Network) project for adults living in homeless shelters in Philadelphia, Pennsylvania. Modem links were set up between five separate shelter sites. Twice a week, for two hours each session, learners were paired across the city for e-mail communication and collaborative writing activities developed together and with the help of on-line instructors at the National Center on Adult Literacy. Qualitative evaluation (Scheffer, 1995) suggests that the motivating impact of the computers and computers had played a large part in the 75 per cent retention of learners. LitLearner, set up by the public broadcasting service and the University of Pennsylvania, is an 'online collection of learning activities and resources for adult learners' (www.litlink5.pbs/litlearner). It offers video and print materials and tools to 'set learning goals, manage your progress, and get feedback on your learning'.

Apart from the obvious differences of wealth, there are apparent differences of methodology between developing and industrialized countries here. Most of the developing-country examples are of attempts to improve access to information – rather than of structured programmes – while the rich-country examples are of programmes that have linked the use of technologies with some kind of individual support. Of course there are many programmes and commercial activities within industrialized countries that provide informal and unstructured access to information. The growth of the Internet is only the most recently dramatic example. It is the absence of structured, developing-country programmes that merits more attention.

Broadcasting

Broadcasting, with its capacity to reach large numbers of adults even in remote locations, has been widely used for adult education. Attempts have been made to provide learner support, based on existing social networks and linked with broadcasts. Participatory approaches have driven a shift towards public-interest broadcasting with programmes planned around identified audience needs and requests.

There is a long history of projects that seek to link group study and activity with broadcasts. *Radio listening groups* – also known as listening forums and clubs – make use of local educational broadcasts addressed to groups of learners who meet with a community teacher on a regular basis. Group discussions precede and follow the broadcasts, and are often accompanied by additional flipchart material demonstrated by the teacher. The broadcasts usually centre on health and agricul-

tural issues, and may include related literacy work. The community teacher provides feedback – and sometimes actual recordings – to the radio broadcasters who then incorporate them into their future broadcasts. Examples include the Radio Listening Clubs in Zimbabwe and Radio Listening Groups, Kenya.

Video forums are similar in set-up. Many non-governmental organizations in Peru are involved in the production of alternative videos for development work among a wide range of beneficiaries. The videos, which centre on journalist analyses of urban and rural issues from fifteen different, mainly Latin America countries, are produced by development video specialists working in dedicated audio-visual and teaching aid centres. The objectives of such centres (such as Video Centro, Videoteca Alternativa) are 'education, dissemination of innovations, social promotion and participation within marginalised urban sectors and in the campesino communities' (Charun, 1993). High production values and audience research have gone into preferred audiovisual formats; for example, it was found that documentaries and narrative reports are preferred over fiction. Most video forum work is done in Lima, the provinces and the southern part of the country, with the main beneficiaries being women and district community groups. Half-hour videos are shown one to two times a week, with an average of forty viewers per showing. The forum around the video lasts for about an hour.

Small-scale, *community radio stations* can directly interact with the audience they serve. In remote or isolated areas they can operate in a multifunctional way, providing the means for accessing a wide variety of vocational, business, health and agricultural information. Examples include Radio Dwensa in Mali, Radio Sagarmatha in Nepal and Radio Bobo, Burkina Faso. Within the Philippines, eleven community radio stations have been established under the auspices of the Tambuli Community Radio project in isolated and economically depressed areas of the country. The project started in 1991 and was externally funded by DANIDA until 1999. These low powered radio stations using 20 to 100 watt transmitters are collectively operated by community volunteers and transmit programmes planned by the people of the community. Village people are trained to produce their own simple programmes and they use them for entertainment, to discuss village issues and to feedback messages to municipal and local leaders. They are dedicated to development, education and people empowerment. The administration of the village radio has been devolved directly to the community and is undertaken by a village co-operative, church or school.

Health advocacy campaigns have used radio, with programmes emphasizing preventative health care and using as a format soap operas, songs and dramas. These national, local and community broadcasts are often linked to a variety of multi-media outreach activities.

The power of radio for education and information is very tangible in Mali. Most local and international non-governmental organizations, particularly those working on health issues like HIV/AIDs, have realized that radio is an important part of their outreach work. Plan International, UNICEF and others such as Malian Groupes Pivots, regularly sponsor airtime on local radios, knowing that in doing so they are reaching many thousands of people. A comprehensive Health Survey completed for USAID in 1996 found that in Mali radio was the principal source of AIDS information for men (75 per cent of the sample) and women (50 per cent) (Myers, 1997).

International agencies and development groups within industrialized countries have played a role in supporting broadcasting for adult basic education. The Centre for Communication Programs at Johns Hopkins University (United States) for example, has been involved with a number of increasingly sophisticated campaigns – the Promoting Family Planning through Mass Media in Nigeria and the Lilac Tent campaign in Bolivia which use combinations of television and radio, enter-educate songs and music videos. Television health dramas include *Womanwatch* television programmes (Philippines), *And the Nile Flows On* (Egypt), *Nazariya* (India), *Tasi* (Indonesia) and *Aahat* (Pakistan). International broadcasters including the BBC World Service, Voice of America, Deutsche Welle and Radio France Internationale are also sources of adult education programmes. Their programmes are either beamed direct from their own stations or distributed as cassettes for rebroadcasting.

As previously noted one wide-ranging review of experience in using mass media for public education in this way found that, paradoxically, while there is sufficient world experience to know how to run educational programmes of this kind effectively, the knowledge is seldom applied with the result that most programmes fail (Hornik, 1988). One of the difficulties, also noted in projects since his analysis, is to maintain interest in radio learning groups: few have found an organizational structure that is sustainable. Some projects have been over reliant on external funding and have not been able to survive its withdrawal. Thus, the rich and varied experience of broadcast-led projects has to be tempered by the knowledge that few of them have succeeded in developing a long-standing and sustainable support structure to underpin the work of broadcasters.

Distance education

There is a narrow dividing line between some of the broadcasting projects discussed above and programmes of distance education. Programmes of rural education, using distance-teaching methods, have been run by governments, universities and, above all, non-governmental organizations. Some have been aimed at individuals, others at groups on the lines discussed above. Examples include INADES-formation in ten African countries, the Gobi Desert Project, the Functional

Education Project for Rural Areas in Pakistan and the Women and Girls Literacy and Basic Skills Training Project in ethnic minority regions of the Lao People's Democratic Republic. A number of these projects use group meetings, backed with materials from outside, as a central part of the teaching system.

INADES-formation, operating 1962, has been providing education, including distance education, for farmers in ten African countries. It was established by the Roman Catholic Church and operates as an international non-governmental organization. The headquarters in Côte d'Ivoire has semi-independent branches in seven other French-speaking states and also in Kenya and the United Republic of Tanzania. It provides correspondence courses in farming and runs face-to-face training sessions; in recent years the emphasis of its work has been shifting from education to assist individual farmers towards education aimed at the development of a whole community. It receives 80 per cent of its revenue from funding sources abroad and its costs are relatively high for non-formal education, with a cost per seminar attender of about 18,790CFA francs ($38) per day. Nevertheless, it regularly reaches around 15,000 students per year and recruits 3,000 to 4,000 new enrolments each year. In the past three years, the majority of new learners were male, aged between 29–45, had only primary school education and were working on small-scale farms (INADES-formation 1998, p. 7). Much of its work is directed towards individuals – though they are brought together in seminars – and INADES-formation has had only limited success in linking distance study with group work.

The UNESCO/UNICEF Gobi Desert Project in Mongolia uses radio to deliver education to 15,000 nomadic women in livestock rearing techniques, family care, income generation and basic business skills. The radio programmes are related to the booklets and include literacy work. The programme includes visiting teachers, small information centres that serve as meeting places and learning groups.

An externally funded Functional Education Project for Rural Areas (FEPRA) at the Allama Iqbal Open University developed a methodology for group study, based on materials developed by the university and made available through cassettes and flipcharts. It demonstrated the effectiveness of its techniques but was conceived as a pilot project and took place in only one area of Pakistan. Replication to the rest of the country would have needed a structured system of co-operation with ministries that had cadres of rural extension agents and a willingness for them to work in an unprecedented way.

The record of achievement echoes Hornik's conclusion, quoted above. There is ample experience of using distance education for adult basic education, in various different formats, but it demands a commitment of continuing support and interest that it has seldom been possible to maintain. non-governmental organizations have made the running, carried out the demonstrations, but for the most part neither been able to develop programmes to a national scale nor to persuade governments to put in the resources to maintain and expand them.

Intermediaries: teachers

Broadcasting, the use of computers and distance education have all been used for the education of teachers, extension agents, health workers and other educational intermediaries including literacy workers. These methods make it possible to apply leverage to the solution of educational problems by strengthening the capacity of these intermediaries who play a key role in implementing government initiatives and as innovators of practice.

Teachers' education presents formidable challenges to governments and other agencies. To be effective and to keep up with the demands made upon them, they require quality training on a recurrent basis. However, as the single largest category of public-sector employees, their pay alone accounts for the majority of the recurrent educational budget.

Teacher education has problems of quantity and quality. In quantity, the supply of teachers and teacher education has often lagged behind the expansion of schooling. In Africa and South Asia, millions more teachers are needed. Andrews et al. (1990, p. 63) suggested that up to half the practising teachers in the developing world were unqualified in terms of their own country's formal standards for teachers' education; primary or junior-secondary school graduates are still being recruited to teach with no formal training. In such contexts, the traditional pre-service and in-service distinction is inappropriate; more useful is the distinction between initial training (delivered either pre- or in-service) and continuing professional education. Problems of teacher supply and training are compounded by shortages in certain areas: specialist junior-secondary teachers, particularly in science and mathematics; rurally based teachers living in cultures or communities that restrict mobility, women teachers (particularly where it makes the difference between girls attending school or not) and male teachers at primary-level schools in western Europe and the English-speaking Caribbean.

It is useful to distinguish between two different strategies for teacher education: providing formal courses, often for qualifications, and making resources available for teachers, but without the framework of a formal course. Both strategies have been widely used. Although we look at them separately below, they are increasingly interwoven to create richer, more flexible and multi-channel learning opportunities for teachers.

Course-based teacher education

Most course-based distance education is aimed directly at teachers rather than at teacher educators. This has the

advantage of bringing education more rapidly to the teacher than is possible through a cascade approach.

In wealthy countries, *communication technology* is increasingly being employed within print-led teacher distance education for a variety of purposes: on-line teaching, networking, course delivery, assignment delivery and marking. We are also beginning to see more on-line courses. In Iceland, the University College of Iceland is offering on-line teacher education courses through The Icelandic Education Network. TRENDS (Training educators through networks and distributed systems) is a collaboration between seven European Union countries which aims to develop an in-service, schools-based teacher-training system using multimedia and network technologies. In Denmark, some teacher education is conducted via computer-mediated conferencing, satellite-based teleconferencing, multimedia and computer-based training (Ingesman, 1997). The British Open University is remodelling a course leading to a postgraduate certificate in education so that it involves extensive online teaching and gives entrants to the teaching profession an opportunity to use computer conferencing for interaction with other trainee teachers.

The use of *interactive video technology* – sometimes referred to as two-way audio, one-way video or interactive narrowcasting – has been used extensively in the United States but is a recent development in teacher education in some developing countries (e.g. India and Morocco, Cape Verde). This teleconferencing network approach has been employed to address the difficulties of training remotely located teachers and as an alternative to a cascade approach. In India, for example, the Indira Gandhi National Open University and the Indian Space Research Organisation initiated a seven-day pilot training course for primary school teachers in twenty different district training institutes in Karnataka State in 1996 as part of a broader Special Orientation for Primary Teachers programme (Maheshwari and Raina, 1998). In all, 850 teachers and 60 locally based facilitators at 20 district centres took part in the project. Studio-based educators made live one-way video presentations about different teaching areas – aided by pre-recorded video-clips – to groups of teachers in the different sites. These teachers engaged in the particular subject area both before and after the telecast through print materials and activities produced centrally by the twenty-strong course team but mediated at the local level by trained facilitators. Direct questions to the educators could be made from the teachers through telephone and fax links. The approach used satellite transmission of the one-way video and two-way audio interaction, the production of video-clips, computer systems, cable television, telephones, and radio and television broadcasts.

During the seven-day course thirteen thematic areas were explored, covered in either morning or afternoon sessions. These included areas such as techniques for multigrade teaching, using the blackboard effectively, physical education, developing mathematics competencies and language teaching. Achievement tests, designed as part of the project evaluation, showed gains in competencies.

An international project, operating mainly in Latin America, has been piloted by UNESCO and the Iberoamerican Association of Educational Television for environmental education. It involves co-production between ninety-eight different institutions in six Spanish-speaking countries – Argentina, Chile, Colombia, Honduras, Mexico and Spain. Eight universities from six of the countries each produced video programmes and print materials that present the variety of experiences in the field of environmental education - teaching methodologies, innovative teaching and use of technologies – but firmly embedded in the specific socio-cultural contexts of each institution or country. It uses a different interpretation of interactive television:

> The project includes two steps designed to ensure interactivity. First, the videos are viewed and discussed by an interest group within each participating institution. The target audience consists of students of education, teachers and others interested in the topic. An expert in environmental education guides the discussion enhanced by written material, explaining the theoretical background of the proposal. Second, an international discussion on the proposal will take place. In the phase of this discussion the questions and suggestions which arose during the local discussion will be sent to the producers of the program. Then, each institution will be connected via e-mail to four other members, forming a sub-group of five. Within this group, each participant will have the opportunity to exchange ideas and experience with colleagues in other countries. (Kempf, 1995, p. 1)

An evaluation of the project is being prepared. If successful the model will demonstrate a way of achieving the necessary scale to justify the use of television while retaining some interactivity.

Most *distance education* for teachers, whether pre-service or in-service, is carried out through correspondence lessons 'seizing the advantages of a medium which could reach students anywhere – though some students more quickly than others – and could give them a text on which to rely' (Perraton, 1993, p. 78). In both industrialized and developing countries the print materials have sometimes been supported by radio and television broadcasts (often with cassette versions) and by tutorial support. Within industrialized countries there is an increasing use of computer technology used for additional on-line teaching, learning, networking, course delivery, assignment delivery and marking. In developing countries interactive technologies have played a minor role so far although this may change as the infrastructure of a country develops.

Particular combinations of media are often dictated by infrastructural and geographical realities. In Nepal, for example, the Radio Education Teacher Training Project used radio as the main medium for reaching primary-school teacher trainees because the mountainous terrain and lack of reliable transportation system made delivery of printed materials problem-

atic. In the South Pacific and West Indies, audio-conferencing is used to facilitate discussion between teacher and tutors on different islands over large distances. In China, the massive scale of teacher education requirements resulted in television- and radio-led training, offered through the China Central Radio and Television University among other institutions.

The providers of distance education for teachers vary in organizational structure: dedicated large-scale open universities (Allama Iqbal University in Pakistan, and Universitas Terbuka in Indonesia); mainstream universities with distance education units (University of Zambia, University and the Javeriana, Colombia); dedicated distance teacher education colleges (National Teachers' Institute in Nigeria); and one-off, time-limited projects for primary teachers such as the Mubende Integrated Teacher Education Project in Uganda (1991–95) and the Malawi Special Teacher Education Programme (1990–93).

Distance-education programmes have been run for various different purposes. Some focus on initial training for unqualified teachers delivered either pre-service (Christchurch College, New Zealand) or in-service (National Teachers' Institute, Nigeria). Others provide further professional development to up-grade experienced teacher (University of Nairobi, Kenya, and Insituto de Aperfeicoamento dos Professores, Mozambique). Some give teachers an updating in new curriculum (Allama Iqbal Open University, Pakistan) while others offer retraining in specific subject areas. The Southern African Commonwealth Accord in 1998 was an agreement between several universities to pool and co-develop in-service training teachers in science, mathematics and technology subjects. Some distance education is aimed at teacher trainers. In 1992, the Network for Teacher Upgrading, in Lao People's Democratic Republic, for example, started training 10 primary teacher educators in each of 8 regional centres by means of mixed-mode delivery – a combination of distance education modules and residential courses – in order to train 3,200 untrained primary teachers in remote areas by 1996.

We have considerable evidence on the methodology, costs and effects of distance education for teacher training (Perraton, 1993; Robinson, 1997). Many distance-education programmes have achieved high success rates, or successful completion rates. In particular, where teacher-education programmes led to a qualification that increased a trainee's status and pay, motivation helped towards success. There is some evidence of changes in classroom practice as a consequence of distance-education programmes. We assess the evidence in Chapter V. The main difficulty in executing programmes has been to organize classroom practice as an integral part of the programme and to supervise this practice. In some cases this has been made the responsibility of the staff of regular teachers' colleges. Occasionally in-school mentors have been trained to provide classroom guidance to trainee teachers. And, where the main aim of a programme has been to strengthen teachers' general education, a deliberate decision has been made to concentrate on these other aspects and not to monitor classroom practice.

Data concerning the costs and outcomes of some teacher education projects are shown in Table 12. They show that, by and large, distance-education programmes do succeed in getting trainee teachers to pass their examinations. Where we have data on teaching performance, teachers trained at a distance compare adequately with those trained conventionally. Most of the cost data are consistent indicating that, above a threshold in terms of numbers, teacher training at a distance costs less than conventional training.

Resource-based teacher education

Alongside formal courses of teacher education, there has been a growth in programmes to provide resources for teachers and self-access learning opportunities for them. *Information and communication technologies* are being increasingly used for these purposes. They have two potential benefits. They can make educational resources of all kinds more readily available and can serve as a challenge of communication among teachers. In doing so, they can help overcome the isolation faced by some teachers and by teachers' colleges. A variety of innovative communication-based projects have demonstrated some of the potential.

A number of projects have sought to use communication technology to create virtual communities of teachers, in the form of Internet interest-group sites or e-mail connected-networks of teachers.

There have been national and international moves to link teachers' colleges through information and communication technology. These projects assume that teachers are key agents for stimulating educational reform and that improved communications can help teachers initiate change within the education system from the grassroots level. Potential benefits are seen to include facilitating dialogue between practising teachers and college staff members, educational planners and policy-makers on issues related to learning and teaching.

Some experimental projects of this kind have been launched within developing countries. The United Nations has a set of Harnessing Information Technology for Development initiatives which includes a project on Creating Learning Networks for African Teachers project. It is intended to equip a maximum of four teacher-education colleges in each of twenty African countries with a computer and full access to the Internet in order to develop local, national and regional networks. The project, in its pilot stage, will also fund teacher education curriculum development in the area of mathematics and science, and the creation of twenty national educational websites.

In the pilot project in Zimbabwe, the participating colleges have developed their own websites, linked by a collaborative web-based platform, and all lecturers and trainee teachers have undergone an in-house computer literacy course. The project has had mixed results. While the percentage of computer liter-

ate lecturers increased to nearly 75 per cent, many lecturers found that, to use the system effectively, they needed more training than had been anticipated. Lecturers did not always feel confident in their use of computers and felt uncomfortable demonstrating to students. At the same time, as access to the Internet was available from only one computer, practical constraints tended to be demotivating. Colleges are now considering networking computers within the college and increasing the number of computers with Internet connectivity. Lack of funding has limited the follow-up to this pilot project in Zimbabwe but other projects have started elsewhere in Africa. In Mozambique, for example, The WorldLinks for Development aims to connect all secondary, technical and teacher-training colleges to the Internet. Underpinning the project are computer literacy training workshops and pedagogical training modules extended first to a cadre of teacher educators and eventually to every teacher within each institution.

The evidence seems to suggest that there should be significant practical benefits in using advanced communication technologies within teachers' colleges but that the practical problems of doing so, and of integrating them with the curriculum, are far from being overcome.

A range of non-formal organizations is also driving the development of virtual communities for teachers, especially in industrialized countries. Independent professional associations for teachers are increasingly on-line. TeacherNetUK (www.teachernetuk.org), for example, aims to support teachers' professional development by selecting appropriate existing web projects, facilitating links to national and international teacher networks and developing on-line discussion groups for debate, dissemination of information and news. Teachers can develop an online profile of their interests, needs and achievements, and then TeacherNetUK attempts to match the individual with accredited professional development programmes. Similar websites exist in many industrialized countries around the world. In Africa, the website Forum for African Women Educationalists (www.fawe.org) posts articles on gender issues in education for children and teachers, has 'Networks for change' and is developing links to 'chapters' in all individual African countries.

Other types of virtual dialogue for teachers (and other intermediaries) are on-line experts and mentors. Teacher-learners can seek information and advice from organizations that offer ask-an-expert about particular subject areas, e.g. health (www.goaskalice.columbia.edu/index.html) and weather topics (www.kark.com/kark5a.html). Mentoring schemes offer one-to-one guidance to individual teachers by well-established members of the teaching community. In an effort to increase the retention of new teachers, the United States National Science Teachers Association is providing first-year primary-school teachers with experienced teachers as mentors (www.live.nsta.org/report/article2.htm). In Australia, the faculty of education at the University of Wollongong is linking teachers directly to lecturers through e-mail networks and provides online support to teachers in school. Mighty Mentors (www.mightymentors.com) allows mentors and those they are advising to search for each other based on the levels at which they are teaching, their subject interest and their location.

There is rapid growth in on-line teacher education resources mostly in North America, Australasia and western Europe. These are as yet thin on the ground in developing countries, but their future development may help to redress the imbalance between the information rich and the information poor, and generate home-grown, culturally appropriate website resources. Resources vary from small-scale websites (often for teachers and students) with downloadable materials in particular subject areas to larger-scale CyberLibraries consisting of a broad range of subject-oriented resources with state-of-the-art literature about integrating technology and good practice guidelines, curriculum resources and projects, links to lesson plans and classroom activities. Examples of the former include NASA's Classroom of the Future Program (www.cotf.edu) which provides teachers with literature about mathematics, science and technology education. Examples of the latter include TTS Internet Links and resources for Primary Teachers (www.tts.group.co), the Teaneck Public Schools CyberLibrary (www.berge.org/edpartners/teacneck/tps/mscl, the SLS CyberLibrary (www.leonline.com'sls/teaching), K–12 world CyberLibrary (www.jdltech.com/walkthrough.index).

The use of CD-ROMs provides an alternative way of distributing information for those who have computers but no Internet access. Given the necessary agreement on intellectual property, CD-ROM distribution can provide access to educational literature which is not otherwise accessible to many teacher educators. UNESCO, for example, has developed Education CD-ROMs, available in three languages, each with the equivalent of 20,000 printed pages of teacher-education articles and references.

Low-tech approaches have also been followed in offering resources to teachers. In order to develop better English language skills among teachers, the national Self-access Project for Teachers' Colleges in Malaysia aimed to establish self-access English language learning materials – mainly print materials, audio-cassettes and some videos – in all twenty-eight teachers' colleges in Malaysia. This included developing resource centre management in addition to learner induction and monitoring. Self-access materials development projects such as these seem likely to become a growth area in the future and underpin the trend towards the development of decentralized community resource centres, used by a variety of target groups, including teachers. In richer countries, well-established library systems often provide both the community resource centre and some teacher education opportunities. For example, the Herefordshire schools library service, like other libraries in the national library service of the United Kingdom, offers an INSET programme designed to enhance the teachers' or school

librarians' existing library skills and to keep staff up-to-date with new resources – books, audio-cassettes, videos and CD-ROMs – that reflect national priorities in education and the national curriculum.

Educational broadcasting for teacher education exists but is thin on the ground. One example is that of Bombay Television Center which telecasts a 20-minute programme for primary-school teachers every week aimed at improving knowledge and skills. National television in India also broadcasts 45-minute programmes – *Hints for Teachers* – once a week during school hours on Saturdays in different languages to raise awareness about innovations in teaching.

Conclusion

Two broad conclusions can be drawn from this varied experience. First, the application of communication technologies of all kinds to teacher education offers a way both of overcoming the isolation that is inherent in their employment and of raising their skills as teachers. There are demonstrable successes in broadcasting and in the use of distance education, and important potential in the use of computer-based technologies. While the cost of some technological developments may be high, investment for teacher support and training allows a multiplier effect.

It may, therefore, be possible to look to the development of computer-based communication to support teachers long before it becomes realistic to deploy computers in many classrooms. Second, much teacher education demands a sensitivity to what the teacher is doing in the classroom, something that often needs to be demonstrated, seen and practised rather than mediated and learnt about through print or broadcast or computer. But the evidence of success of, for example, distance education for teachers, suggests that the availability of technologies makes it possible to rethink the structure of teacher education. 'The strongest case for using distance education in the education of teachers may, in fact, be that it will centralize and industrialize those parts of teacher education for which this is appropriate, and so allow time and resources to be devoted, in greater measure, to interaction and reflection' (Perraton, 2000, p. 83).

Intermediaries: health workers

The use of technology in training for health workers reflects trends in health sector policies and demands within the profession. Primary health care planning is increasingly being decentralized to district level with a new emphasis on training health workers from within the community. This in turn has encouraged health planners to collect local information in order to develop appropriate strategies and allocate resources. Pressure to involve communities in health planning also requires health workers to develop and strengthen their capacities to use participatory approaches. There are, therefore increased demands for good communication systems, and for in-service training and updating for health workers. Methods need to be found that will not take health workers out of the field and will reach workers in remote and isolated areas; distance education in various forms has been employed for these purposes. A range of technologies have been used for the training and support of health workers (see Table 9).

ICT in health education and access to health resources

Within industrialized countries, the medical profession has made considerable use of information and communication technology to provide access to current medical knowledge and, through telemedicine projects, to provide access to information and advice to remote doctors and other health professionals. Most of this work is at tertiary level, but some of the techniques may in due course lend themselves to the training of health workers operating at basic level. MERMAID (Medical Emergency Aid through Telematics) is a European Commission project which illustrates the potential of the technologies. It aims to deliver a 24-hour multilingual telemedicine system of surveillance and emergency services and establish a telematic network connecting major private and public emergency centres around the world. The system will enable the transfer of medical expertise via satellite and ground based ISDN and other networks where necessary, responding to the needs of those dealing with medical emergencies on ships, for example, and those of distant and isolated populations or areas where there are no fully experienced doctors.

Similarly, within the developing world, there are the beginnings of programmes to use communication technologies to extend the reach of health information. In Ghana, for example, there are proposals for a telehealth project at the Martin Luther King Memorial Clinic in Accra, which would complement the existing health delivery systems and serve poor, disadvantaged and marginalised people living in rural areas. If funding is secured, it will involve the installation of computer communication equipment in some rural clinics and laboratories, the training of health personnel in the use of the technologies and the provision of some mobile clinics for rural areas. Similarly the Northwest China Telehealth Service will use networked information to help overcome the problems of inaccessible, remote, poorly equipped and impoverished areas in China. 'Medical schools and hospitals in Zinjiang, Qinghai, Gansu, Ningxia and Shaanxi Province will be linked to medical centres elsewhere in China and in the United States. Together, they will form a network to provide continuing medical education, telemedicine, and library services. Users in Northwest China, depending on their capabilities, will access these services by telephone, fax, e-mail or the World wide Web' – www.bridge.org/xian.html. In the Western Pacific, the still-image telephone has been used to provide long distance medical consulting and continuing med-

ical education to isolated health-care workers. Still-image telephone is a still-frame video-conferencing system which, used with a video cameras and a television monitor, can digitise and transmit freeze-frame colour pictures over ordinary telephone line. It is also possible to link it to satellite telephone system.

In Australia, the Cairns Rural Health Training Unit provides training for Aboriginal and Torres Strait Islander Health workers by means of audiographic learning . This is an application which uses a combination of computer, modem and a speakerphone. Participants in different sites can interact by phone or on screen. Data (text and pictures) can be sent down the modem line before a session is delivered live. During the conference, the graphics device allows anyone in the conference to handwrite, type text or draw graphics which are seen in all locations.

The potential of information and communication technologies for the education and training of health workers, and for providing them with good and up-to-date information is clear. As yet, however, the evidence is of potential rather than achievement.

Broadcasting

We have already discussed the trend toward sophisticated multi-faceted health campaigns which pivot around popular culture radio and television broadcasts. Most are directed at general listeners but, to maximise impact and ensure consistency, often build in a range of spin-off activities and resources for particular audiences, schools, teachers and health workers. The Radio Communication Project in Nepal, for example, using a combination of soap opera radio broadcasting and distance learning, was aimed at general listeners but included materials for updating resources and information for health workers. A combination of radio and postal material aimed to improve communication between husbands and wives, and between service providers and clients as part of a family planning service. Health workers were provided with upgrading information on family planning and reproductive health, and encouraged to improve their interpersonal communication and counselling skills.

Distance education

Most health distance education in developing countries is conducted by means of correspondence courses, and is offered at various levels (certificates, diplomas and degrees) and in a range of subjects areas. Programmes offering in-service training for rural health workers have been run in many parts of the world.

The African Medical Research Foundation (AMREF) has been providing courses that exemplify this approach since the 1980s. The Foundation's headquarters are in Kenya and it has country or field offices in Rwanda, Somalia, South Africa, the United Republic of Tanzania and Uganda. Its courses are directed to a range of health workers: community nurses, clinical officers and public health technicians. From a pilot target of 100 students, the Foundation had reached over 6,000 by 1995. It runs two programmes. In the first, it offers ten distance-education courses – print with audio and radio – in areas such as communicable diseases and immunization. The second uses radio programmes directed at health workers in areas such as dental health, diabetes, HIV/AIDS.

The Distance Education Programme (DEP) run by the Ministry of Health in Uganda provides continuing education to health workers – in government and non-governmental organization hospitals, dispensaries, health centres and sub-dispensaries – through self-directed materials, correspondence course and radio programmes. Other methods include workshops, seminars and short courses. Since its inception in 1986, it has reached over 5,970 learners. One problem associated with it is low completion rates that appears to be the fact that the courses are not certificated or recognized for promotion purposes.

In the Solomon Islands, the scarcity of training programmes available for remote health workers has led to the local adaptation of AMREF and Fiji School of Nursing materials, and the addition of locally produced handbooks and videos. Students are supported by means of assignments, two-way radio contact and newsletters, and are funded to travel to provincial centres for occasional seminars and meetings with tutors. The attachment programme provides students from remote areas with the opportunity to practise clinical and interview skills.

Mixed-mode delivery – the combination of face-to-face learning with distance education within the same course – is proving useful as a means of ensuring that health training on centrally produced courses is culturally appropriate. In Australia, at Yooroang Garang, the Centre for Indigenous Health Studies of the University of Sydney, attempts are made to address the need for developing culturally appropriate health strategies by incorporating community-based and independent learning packages within diploma programmes. These emphasize students' learning in, with and from their local communities in relation to health issues. They contain a variety of learning materials such as readings, audio cassettes, board games and written exercises in workbook form, as well as practical tasks that involve co-operative work in the student's own community. They also use community-based tutors employed through an existing Aboriginal Tutorial Assistance Scheme.

Self-instructional materials are also proving a useful way to train remote health workers. The World Health Organization, for example, produces *Clinical Skills: A Self-Instructional Course,* designed to teach health workers to assess and treat cases of diarrhoea, and to educate families about prevention and home treatment of diarrhoea. The package includes print and audiocassette materials. One problem with a print-based approach is

that some health worker or auxiliary trainees may have low literacy skills, especially in a second language. Translation into local languages may not be practical. Pennells (1996) used another solution. In a small research project in the Maldives, he found that community health workers had difficulty in using their manual – *Where There is No Doctor*, a village health care handbook for Africa produced by Teaching Aids at Low Cost. This manual was considered central to community health workers during initial training and subsequently used as a reference book in their working life. In order to help trainees once they were back in the field and to maintain their training, he adapted the existing manual into a self-study package by adding an audio component and supplementary audio-vision frames and notes. The wrap-around materials integrated referencing and indexing skills, English language skills, and practice in a range of literacy and numeracy skills such as following instructions, working with fractions and calculating dosages from information provided.

There is, apparently, less reported experience on the use of mass media approaches to the training of health personnel than there is of teacher education. At the same time, there are often similarities between the educational needs and social circumstances of primary-school teachers, primary health-care workers and agricultural extension agents to whom we turn next.

Agricultural extension agents

Well-trained agricultural extension workers are key players in rural development. 'Studies have shown that the improvement in farmers' knowledge, skills, attitude, efficiency and productivity are positively correlated to the training level and quality of extension staff' (Qamar, 1998).

As for health workers, distance education seems a natural choice for the in-service training of the scattered cadres of extension agents. The need for continuing education, on a regular basis, is particularly important where, as in Africa, and in Asia and the Pacific, the majority of agricultural extension personnel are educated only to secondary level. It becomes even more important where, as in Africa, there is a projected 50 per cent shortfall in trained staff numbers and insufficient institutional capacity to cover estimated training needs (Qamar, 1998, pp. 4–5). Table 10 sets out a number of approaches to he training of extension staff.

Information and communication technologies

As in the area of health, the most significant application of communication technologies may lie not within formal courses for extension agents but through the development and use of information services. As extension agents develop improved ways of getting answers to farmers' problems, so the quality of their work is likely to improve. (It may be, too, that encouraging access to information available though the Internet will counterbalance the, much-criticised, top-down approach of some conventional extension work.)

A growing number of on-line agricultural data-bases are internationally available on subscription. For example, the Electronic Reference Library (ERL) provides access to the four major agricultural databases – AGRICOLA, AGRIS, CAB Abstracts, TROPAG and Rural. After a two-month trial period, the Department of Research in Botswana subscribed on a permanent basis in 1998. The Food and Agriculture Organization of the United Nations (FAO) also has an on-line and multilingual database of statistics and data in a range of agricultural areas. The CTA website, for example, (www.agricta.org/index.htm) is dedicated to advancing agricultural and rural development in African, Caribbean and Pacific countries by promoting the transfer, exchange and utilization of information. It provides a data-base with publications, networking advice, information to producers of audio-visual material, audio download sites for re-broadcasting, training databases and a CD-ROM Programme. As noted previously, where Internet access is costly or impractical, CD-ROMs offer a partial alternative – good for research literature or information about plant pathology, useless for information about current market prices. Within industrialized countries, country-specific websites, often aimed at computer-literate farmers themselves, have been developed and act as a clearinghouse to other nationwide agricultural sites. www.aiua.org/ pages/agnet.htm is an American example.

Computer-aided data collection using laptop or hand-held computers is becoming widely used in Europe, Australasia and North America for data collection in health and agriculture as well as for population surveys and censuses. Their use in developing countries is limited as yet but may well become employed in needs-based, data-dependent areas such as agricultural extension to make the flow of information more efficient. There have been recent experiments with computer-aided personal interviewing (CAPI) in Madagascar for example (www.maroint.com/dhs/publicat/nltr/laptop).

Broadcasting

Broadcasting is used by agricultural extension agencies as a means of disseminating information to farming communities rather than as a vehicle for training their own staff. Farm radio programmes have long been a staple activity of many agricultural extension services, often run in co-operation between Ministry of Agriculture extension services and national broadcasting authorities. A number of studies have shown that radio is likely to be the primary source of new agricultural information to farmers. It tends to be trusted and unit costs per farmer are often modest. But, while extension agents have long worked with radio programmes, it appears to have been little used for the training of extension agents.

New technologies are beginning to play a role in staff training. There have been experiments with interactive television – one-way video, two-way audio teleconferencing – for in-service training of extension staff. The Jhabua Development Communications Project in India organized in collaboration with the Indian Space Research Organization, has recently experimented with satellite television broadcasting to extension staff from various departments of the state governments.

A small number of international projects have provided broadcasts in agriculture. The Developing Countries Farm Radio Network, based in Canada, disseminates radio scripts (in English, French and Spanish) in a variety of agricultural subject areas. These provide programme planners and scriptwriters with examples of different approaches that can also be adapted by agricultural extension workers to suit local conditions be and translated into local dialects and languages. International broadcasters such as the BBC World Service also produce a range of agriculturally orientated radio programmes, often for specific developing country regions, which are available for re-broadcasting. CTA provides an audio download website – the Rural Radio Database – for broadcasters to listen to and download suitable ready-made radio materials.

Distance education

A number of distance-education courses for agricultural extension workers – and indeed farmers – have been produced by open or dual-mode universities. Most of these are print-led (but often with accompanying cassette and tutorial support) and several are aimed at workers educated to secondary equivalent level. Print-based courses have, for example, been produced by the South African Extension Unit in the United Republic of Tanzania and the Open Polytechnic of New Zealand. Tamil Nadu Agricultural University in India has developed broadcast-led courses. As with health worker training, the literacy demands of such courses, often in second languages, can prove difficult for learners previously educated only to secondary level and now returning to study, after a break of several years. Culturally appropriate literacy support and quality tutorial support at a local level is desirable but not always available.

Wye College, part of the University of London, offers an internationally available print-led distance education course aimed mainly at developing countries. It is tutored from the United Kingdom but also, wherever possible, supported locally. Although offering postgraduate certificates and diplomas, in practice the course has been taken by underqualified but experienced extension staff, offering a route to formal qualifications not otherwise available to them.

Summary

The various communication technologies have been used in-school and outside to raise the quality of education, to change the curriculum and to meet the needs of scattered communities. Much attention has recently been directed to the use of computers in schools for a variety of educational purposes, with an increasing emphasis on using Internet materials and on electronic school-linking projects. Where computer-based technologies have been applied outside school, they have been used more often as a means of getting access to sources of information than as a means of teaching or a subject of the curriculum. Radio, some television and distance education have continued to play a role in providing based education out of school for some deprived groups of young people and adults. Programmes of teacher education, using distance-teaching methods, have demonstrated the leverage on the educational service that can be provided in this way. There are the small beginnings, but not much more, of training health workers and agricultural extension agents in the same way. ■

V. Assessment of experience

We examined the different needs of varied educational audiences in the previous chapter. We now seek to assess this experience, for the range of technologies examined, looking in turn at outcomes, costs, conditions for success and funding arrangements. Two themes run through the discussion of these areas. First, we are short of hard data. This is true, especially in relation to costs and outcomes, alike for rich, middle-income and poor countries. Investment in some technologies, and near-abandonment of others, seems to have followed fashion at least as much as a rational process of resource allocation on the basis of knowledge about costs and effects. Second, while that much is common, the application of technologies differs widely from country to country. In this overview, and in the following chapter on possible lines of development, we need constantly to keep in mind available national resources and to shade any policy recommendation by reference to national wealth or poverty.

Outcomes

We can expect outcomes to be of three kinds. Using new technologies in education may widen access and therefore move towards increased equity, or raise quality, or change the curriculum. Assessment of outcomes is complicated because each kind of change is likely to be marked by a different indicator. Thus, while we are critical of the scarcity of studies that demonstrate improvements in quality following the introduction of new teaching technologies, we may be falling into a category error in seeking them. If computers in the classroom change the nature of what children do, shift the process of their learning and mean they learn more of one skill and less of another, then comparative studies of learning gain or examination passes are of limited value.

Access and equity

Quantitative assessment is difficult and needs to be cautious. As Chapter IV has shown, there is a wealth of experience of the use of varied technologies in order to extend education. In principle communication technologies make it possible to reach out to audiences who cannot be brought into a school or adult learning centre. The potential for using technologies to widen access to education remains important today as it did over the past century. But in practice this experience tends to be piecemeal, under-reported and difficult to evaluate, and often on a modest scale. Furthermore, the dramatic stories about widening access tend to be low technology: BRAC and Escuela Nueva, for example, are essentially adaptations of conventional education rather than major uses of new technology.

Projects using print and broadcasting have some solid achievements in widening access, especially at the level of junior secondary education. The well-established Telesecundaria project in Mexico was reaching over 750,000 students in 1997/98 in 12,000 centres, over 15 per cent of the total junior-secondary population (cf. Murphy, 1995, p. 62; International Bureau of Education, 1998). It was, therefore, providing an alternative system of education to children in rural areas where there were too few conventional junior-secondary schools.

The evidence on using similar methods in Africa and Asia is more equivocal. Study centres in Africa, which have historically enrolled significant proportions of the junior-secondary age-group, seem to be in decline. Malawi, for example, has decided to transform its distance-education based study centres into community schools. The Asian open schools propose to reach extremely large rural audiences. One Indian forecast suggested the system might reach 40 million students in ten years while Indonesia hoped to enrol 2 million by 2008-09 (Mukhopadhyay, 1995, p. 104; Sadiman Seligman and Rahardjo, 1995, pp. 77–9). Existing numbers, as shown in Table 11, are more modest and it remains to be seen whether expansion at the level forecast is a realistic objective.

As already noted, the use of technologies will not, of itself, increase equity. (Many projects, discussed in Chapter IV, have other aims.) There is a danger that the use of computer-based technologies may widen the gap between countries, and between richer and poorer citizens or regions within the same country. Metropolitan schools with computers – and children whose families have computers at home – are likely to be at an advantage as contrasted with the rural and poor. There, may, too be a widening of gender differences if boys successfully elbow girls away from computers. Where, as in Mexico and in the newer Asian open schools, technology is being used to widen access, it does so at the risk of creating two classes of schools – conventional for the more fortunate and more urban, and non-conventional, principally for the rural poor.

In summary, then, there is some evidence of the success of using distance-education methods to widen access at junior secondary level. With the partial exception of the Latin American radio schools in their heyday (see below), we have not found comparable evidence at primary level.

Raising quality

Technologies have been used in two main ways to raise the quality of basic education, through the use of broadcasts in classrooms and through teacher education. (We treat the use of computers in classroom below, considering their significance as a means of changing the curriculum.) While conventional school broadcasting remain under-researched, the various Interactive Radio Instruction projects have been researched and solid evidence has confirmed their effectiveness. Projects have raised the quality of learning, as measured by tests of

learning gain. There is some evidence to suggest that children's attendance at school is improved through their participation in interactive radio (Leigh and Cash, 1999, pp. 27–30). We consider in the section on Costs, below, the extent to which these gains are at a sustainable cost.

There is solid evidence, too, of the effectiveness of distance-teaching approaches, using a variety of technologies, for teacher education. We saw in Chapter II, that a decade ago there was already wide experience of the use of distance education. Although we have relatively few studies that investigate the effectiveness of technology-based training on subsequent classroom performance, the limited data available are positive. Evidence on the costs and outcomes of some teacher education projects are given in Table 12. They show that, by and large, distance-education programmes do succeed in getting trainee teachers to pass their examinations. Where we have evidence on teaching performance, teachers trained at a distance compare adequately with those trained conventionally. Most of the cost evidence is consistent that, above a threshold in terms of numbers, teacher training at a distance costs less than conventional training.

Curricular change

Various technologies have been used to advance curricular change. This was one of the aims of many broadcasting projects and has been the motive for some computer-based initiatives. The evidence appears to show that the introduction of computer-related education can bring benefits to learners and may increase learning. We have, however, little comparative data that would enable us to choose between, say, various types of computer use or an expanded programme of broadcasting in terms of their comparative effects on student learning. The crude and simple answer must be that increasing expenditure on education is likely to improve its quality but we are some way from having a metric that will provide a simple economic measure for choosing one technology rather than another.

There is anecdotal evidence of shifts in classroom practice following the use of computers, much of it from industrialized countries. An important comparative review of computers in schools in Chile and Costa Rica found evidence of educational gains following from the carefully planned use of LOGO in the classroom. This project was, however, exceptional in that the 'programme, which was launched in 1987, was designed as a total system underpinned by constructivist pedagogy and the *Logo* programming language. Its goal has been to contribute to the transformation of Costa Rican education through changes in learning and teaching that are brought about by the use of computers, the training if teachers, and the excitement generated by children's self-directed learning, knowledge creation and problem solving' (Inés et al., 1998, p. 27). We have a less clear view of the outcomes of the many computer projects introduced to enhance learning about computers or to facilitate communication and access to databases.

To sum up, communication technologies can be used within the context of curricular change; it is unreasonable to expect them to change the curriculum unless their introduction and use is seen as part of such a strategy.

Costs

In planning for the use of technologies to support basic education, we need to ask fundamental questions about their costs and how these compare with the costs of conventional education. Unfortunately there are no simple answers to the planner's questions: how much will it cost? and will it cost more or less?

The cost of conventional basic education sets the context for any analysis of the costs of alternatives or additions to it. By far the greatest proportion of expenditure on conventional education is for staffing, with teachers' salaries accounting for around 90 per cent of the total recurrent cost of basic education in many developing countries. Capital and other fixed costs are often a small proportion of the total, as are school supplies such as text books. In contrast the use of technology usually demands significant investment over and above the cost of employing teachers – for items such as the production and transmission of broadcasts, for computer hardware and software, and for the development and management of distance-education programmes.

There are three consequences. First, as technology requires different kinds of expenditure, so we cannot simply compare the cost of classroom teaching with technology-based teaching. We need to know something about scale – such as the number of students listening to a broadcast – before we can calculate a cost per student or cost per learning hour. Second, as many uses of technology demand centralized and up-front investment in the production of teaching materials, so their costs may be acceptable only if there is a large audience. A radio programme or piece of computer software that costs $50,000 to produce is likely to be uneconomic for an audience of 10 but may be economic, with a cost per student that seems reasonable, for an audience of 100,000. Third, technology can reduce educational costs only where it substitutes for teachers. If it is used in the classroom, to support or enhance their work with no reduction in the quantity or quality of the teaching force (as reflected in their pay), its economic effect is to increase educational costs. We generally find technology-driven reductions in cost only in programmes of out-of-school education where technology has replaced the teacher or made it possible to employ less qualified monitors, rather than teachers with lower wages.

In practice, technologies seldom stand alone. Computers in school require support from teachers and technicians; most interactive radio projects assume there is a teacher in the

classroom; effective distance education is likely to demand student-support systems along with teaching provided at a distance. Technology-based school projects require in-service training for the teachers involved. These human elements do not allow for the economies of scale that mark the use of communication technology considered by itself.

Costs achieved in practice

Available data make it possible to draw some conclusions about the level and behaviour of costs for various different applications of technology in support of basic education and then to consider, technology by technology, how their costs will compare. We look in turn at the use of radio and computer technologies in school, and out-of-school education for adults and adolescents, and at the use of technologies, including distance education, for teacher education.

As we saw in Chapter III, the two main ways in which technology has been used to raise quality in school are the use of broadcasting and of computers. While school broadcasting is long-established, we have few recent cost studies of regular programmes of either radio or television. Interactive radio instruction is better documented and we have some studies of the costs of computers in school. Some figures, drawn from records of actual expenditure rather than from budgets, are shown in Table 13.

The latest figures for interactive radio instruction are higher than earlier calculations. In a review of all the evidence Adkins (1999) concluded that the cost per student per annum was likely to be around $8.25 with 100,000 students and falls to $3.12 at 1,000,000 students. There are, therefore, significant potential economies of scale but ones which are open only to relatively large countries.

Earlier figures showing significantly lower costs are probably an under-estimate. While these figures are modest, they have to be seen in the context of educational expenditure for non-salary items and, as noted in Chapter III above, have proved unsustainable in a number of cases.

A small number of studies have been made of the use of computers in schools in developing countries. (There is a remarkable apparent shortage of studies in industrialized countries.) A study of their introduction to primary schools in Chile – a middle-income country – showed that this would require between 10 and 37 per cent of the total primary education budget, varying with the size of the school, with actual expenditure between US$22 and $83 per student. In Costa Rica, where computers have been used in both primary and secondary schools, found that the cost per student at secondary level was US$38, or about 13 per cent of the expenditure per student per annum. This allowed students a maximum of two hours per week of work on the computer. These figures are relatively higher than the actual level of expenditure in industrialized countries: figures in England for 1998 showed annual expenditure per student in primary school at £11 sterling ($18) and at secondary level £38 sterling ($63). These figures were 0.6 per cent and 1.6 per cent respectively of total expenditure per student. (United Kingdom Department for Education and Employment, 1999; Audit Commission, 1999). Annual costs per student of $70 were reported in the United States, with slightly higher figures in France. The American figures represented 1.3 per cent of total expenditure on schools (Orivel, 2000). This level of cost strengthens the argument, made above, that in many countries it is probably unrealistic to consider deploying computers in primary schools. At secondary level, where there may be strong curricular arguments for some investment, this is likely to make for significant increases in total educational expenditure if it is to allow students more than rare and occasional access to computers. The few available figures suggest that many countries may want to deploy computers in school libraries, in teacher-training institutions and perhaps in telecentres, but stop short of seeking to do so in every classroom.

In Chapter IV we examined a number of approaches to the education of adults and adolescents. As these are out-of-school programmes, they do not demand school buildings or the employment of teachers at conventional staffing ratios, and we might therefore expect to find costs that compare favourably with an in-school alternative. Some data sets are given in Table 14. They show that, in their heyday, the Latin American radio schools, using radio, print and limited support by monitors or animateurs, were operating at a cost comparable to that of conventional schools. These are unusual figures, not replicated in other parts of the world, and apparently achieved partly by the large scale on which they were working and partly by the heavy input of, uncosted, support from the Roman Catholic church. A radio campaign for farmers in Zambia was operating on a large enough scale to have unit costs that compared favourably with face-to-face alternatives but, as with non-formal costs generally, did not compare favourably in terms of cost per learning hour with those of primary schooling. The same conclusion can be drawn from a functional education project for adults in Pakistan. The long-established Telesecundaria project in Mexico shows that, when operating on a large enough scale, a television based alternative school project can have costs that compare reasonably well with those of conventional schooling. (Similar results are reported for Telecurso in Brazil (Castro et al 1999).)

The general conclusion is that primary education, at least in many LDCs, has such modest unit costs that with the rarest exceptions, technology-based out-of-school projects cannot match them. At junior-secondary level, where the costs of conventional education are significantly higher than at primary level, out-of-school costs compare more favourably. Telesecundaria and Telecurso in Brazil show that, despite the heavy investment in television programmes and the employment of staff to support learners in a technology-based rural school

system, the scale on which large-country projects can operate means that their costs can compare favourably with those of regular school education. (It is less surprising that open-school costs in India and Indonesia are lower than those of conventional schools as they have more limited systems of student support and are technologically simpler.)

We have more figures on the costs of using distance education for teacher training (Table 12). In considering them, we need to bear in mind that the cost of teacher education is generally much higher than that of secondary education, sometimes nearer the level of university education. We have evidence from a range of teacher-education projects, many of them using print-based distance education, with varying amounts of student support and supervised classroom practice. Distance education in these circumstances allows savings on staff costs, on accommodation and sometimes on student stipends. It is not surprising, therefore, that distance education for teacher training often achieves costs between one-third and two-thirds of those of conventional teacher training.

Technology choice and costs

While we have limited data on the comparative costs of different technologies, with much of the information coming from industrialized country applications, we can say something about the orders of magnitude likely to be involved and the location of costs. The information is summarized in Table 15. We can conclude, first, that costs increase with sophistication. Television generally costs more than radio, computers more than television.

There is a distinction between the infrastructural demands made by modest technologies and those made by advanced technologies. Print, radio and even computers depend upon industries and services that are readily available for non-educational use. If we move towards new technologies, not yet fully established in the market place, such as direct-broadcasting satellites, we are likely to need investment in specialist equipment where cost has not yet fallen in response to large-scale demand. Scale then assumes great importance: a technology that is appropriate for China may make little sense for Costa Rica. It may be that the scale demanded by satellite technologies will drive education towards international co-operation.

It is also important to consider where costs will fall. The sharpest contrast is between radio – where the user has to meet the cost only of a set and batteries – and a computer with access to the Internet. Here, central costs may be minimal but a school may need to meet the costs of acquiring the computer, staff training, software licenses, maintenance, charges for an Internet service provider and telephone line costs.

Allocation decisions also require us to consider how costs are likely to change in the future. We can assume that the costs of electronic equipment will continue to fall. Communication costs, until recently a function of distance, are now both falling absolutely and becoming independent of distance. We can, therefore, assume that some of the costs of using technology in education will continue to fall.

But there are two major constraints to this process. First, staff training, and technical support for teachers and the equipment they use, are critical for the successful use of any technology. There is no reason to think that these costs will decline. Indeed, the growing complexity of the technologies may mean that they are likely to increase. Second, one of the effects of computer-based technologies is to shift the location of expenditure and sometimes to increase it absolutely. Printing gives an example. Where text books are printed centrally, for a large market, and distributed through Ministries of Education, production, reproduction and distribution costs are likely to be met centrally even if a textbook charge claws back some of the cost from an individual school or student. In contrast, where teaching material is available from the Internet, the cost of computer time, telephone charges, print, collating and paper all fall on the receiving institution or individual. As conventional printing still allows some economies of scale, the absolute cost of making print material available to any one school is likely to be increased. As schools vary in their wealth, decentralizing expenditure in this way is likely to decrease rather than increase equity between them.

Conditions for success

We can distinguish between conditions that apply to the uses of technology generally and those that apply to a particular set of technologies.

Experience from a range of programmes and projects makes it possible to identify some conditions that apply regardless of the technology chosen, some of them, indeed, characteristics of successful educational innovation generally. The first condition, however, bears directly on the choice of technology. From television to computers, a consistent lesson is that education needs to build on the general state of development of technology in the society or community rather than lead it. Educational projects which have been at the leading edge of technology run into difficulties and are rarely sustained in the long-term. It is cheaper, and easier, to introduce a form of technology into education, and keep it working, where education is riding on the back of large-scale developments by governments or the private sector. Television works for education when it follows rather then precedes television for entertainment; computers in schools can be maintained once commercial and private use has expanded to the point where there is an established service industry.

Then, a whole set of conditions have to do not with the technologies but with the support structures that go with them,

essentially to do with people rather than with technology. The effective deployment of technology – from the simplest use of cassette tapes to computer-based learning – demands that there are arrangements on the ground that will ensure the effective use of the technologies and of teaching materials made available through them. Producing and delivering materials does not by itself ensure that they are used effectively. Success is likely to depend on training, on devoting adequate human resources to the development of materials, and on the process and location of innovation.

Technological innovations make two kinds of demand for training. As they demand new skills from existing teachers, they make an immediate demand for training and updating of the large number of teachers who will be involved in their use, and the smaller number who will move into new jobs as media producers, managers or software designers. Recent experience in the north suggests that effective computer-education projects, for example, demand as great an expenditure on training and software as on hardware. The second demand is for changes to the curriculum of pre-service teacher training. If information and communication technology is coming rapidly into the classroom today, its use needs to form part of the curriculum of the education of the teachers of tomorrow.

A recurring theme of project and innovation literature is the need to devote enough – which often means more than originally planned – resources to the development of teaching materials such as broadcast scripts, distance-education materials or computer software. From the Indian SITE project on, it has seemed easier to accept large budgets for capital expenditure on hardware than to devote the resources needed for the production of quality software. Success demands adequate investment in software. (This has implications for staffing. It may mean that the ablest teachers are asked to develop teaching materials when they are also wanted for many other activities. If technological projects are seen as marginal, it is difficulty to recruit or get the secondment of the ablest staff.)

Materials development is almost certain to raise questions of language. Language policy can foster national unity and identification or re-emphasize division. The pressure to maximize audiences and so reduce unit costs means that teaching materials are likely to be developed in an international language. Instructions on using technology, on-screen or off-screen, are even more likely to be in an international language. Most often it will be English and those with inadequate English may be doubly excluded if new-style, technology-based, education demands a higher level of capacity in English than they command, or than was necessary for more conventional education.

Success may depend on the location of responsibility for an innovation. Technological innovators face a dilemma. On the one hand, if an innovation, whether in school or out of school, is to be sustainable it needs to be accepted by the educational establishment and gain a sense of ownership among teachers, administrators and budget holders. (Some of the defunct interactive radio instruction projects, for example, fell because they were seen as being externally imposed.) But, on the other hand, conventional decision-making systems and ways of allocating budgets may restrict innovation. Regular schemes of service and conventional approaches to time allocation in terms of student-contact hours, for example, do not fit easily with the processes of developing teaching materials whether for computers, broadcasts or distance education. Successful technological innovation needs both adequate integration with the rest of education and a greater degree of freedom than is necessary for the day-to-day running of the more established parts of the education service.

The freedom to innovate needs to be accompanied by a sensitivity to those who will be affected by the innovation. Again, projects that are imposed, without consultation with beneficiaries and users, have been among the first to fail.

Finally, technologies are seldom neutral in their effect; a sensitive process of consultation needs to take account of the possible effects of a technological innovation on issues of gender and of language. There are many examples - from the need for measures to prevent boys, in some northern cultures, getting more than their fair share of limited time on the keyboard to the planning of radio programmes of rural adult education at a time convenient for men but when women are cooking.

Computers

As suggested above, decisions about the use of information and communication technologies in education need to start with the curriculum and with decisions about the curricular purpose of a proposed technological change. Quite different approaches to investment in hardware, software and training are needed, say, for increasing computer awareness among all children at school or for permitting access by health auxiliaries to information on the Internet.

The early experiments with computers in schools were led by enthusiasts, usually in a handful of schools, and using the computer in a restricted range of subjects, sometimes, indeed, limited to 'computer studies' or 'information technology'. But projects of this kind may be a poor foundation on which to build, limited as they tend to be to a handful of favoured schools and leaving large areas of the curriculum and the country untouched. A condition for national programmes is therefore likely to be a phased plan for introducing information technology into education that takes account of the availability of technical support – even in remote places – and considers the most appropriate use of resources if, say, schools can afford only one or at most two computers. At this level, the highest priority may be to use the computers to help overcome teachers' isolation and to increase their familiarity with the technologies rather than directly in the classroom. The plan will need to take account of the significant recurrent costs of regular computer

use: for technical maintenance, for updating software and for the replacement of computers as planned obsolescence makes them decreasingly useful. Where they are used for school linking, or for access to the Internet, then costs for line charges and for an Internet service provider need to be added on.

A national (or local or school) plan for computers will also demand decisions on the purchase or development of computer software. If use is to be limited to generic software – such as spreadsheet or wordprocessing programs or occasional educational programs like LOGO – then programs will be available for purchase on the open market. They will demand adequate facility in (usually) English and will assume that students will develop the globalized skills demanded by universal software. It may be unrealistic to worry about their cultural appropriateness. If it is intended to use teaching programs, for computer-aided learning or simulations, for example, the choice is more complex. Again, it may be possible to import software, at present mainly developed in the industrialized north, regardless of its cultural appropriateness. Or, if the market and language group is big enough, it may be possible to embark on the local or national development of software. We have not been able to identify cases in which this has proved economically viable.

Training has proved to be a major constraint on the effective classroom use of computers. (Teachers may need training to keep up with students from affluent families who have become familiar with computers at home.) With limited availability of hardware and software, it may be unreasonable to expect teachers across all disciplines to acquire computer skills and go on to the harder questions about how to integrate them into the curriculum. But there is a case for introducing topics of this kind into teacher education so that the next generation of teachers has that kind of capacity and flexibility.

Broadcasts

If broadcasting is to be effective, it demands access to airtime on a frequency that is available to listeners and at a time that is convenient to them. (FM broadcasting or direct broadcasting by satellite will be useful only if schools or learners have the necessary radio sets; terrestrial television may not reach all parts of large, rural, countries.)

Even though the costs of broadcasting may look modest when compared with those of computer-based education, they demand significant resources and there is therefore likely to be pressure to maximize the audience in order to reduce the unit cost. One way of doing this is to develop broadcasts that will meet the needs of more than one audience – formal education in school and informal outside. Another is to repeat broadcasts so that the initial production costs are spread over a longer period and a larger audience. The early studies of interactive radio suggested that programmes might be used for up to ten years. In practice, as teachers have become familiar, or over-familiar, with existing radio lessons they have pressed for change and become unwilling simply to repeat, with a new class, old materials.

Distance education

The effectiveness of distance education seems to turn on four factors. The first is good management and administration. Projects that have been based in a small, non-specialist institution (e.g. a teacher's college offering a single programme of teacher education) have tended to be vulnerable. The most promising way forward may be to work with an open university or dedicated distance-teaching institution whose responsibilities include education at lower levels.

Second, effectiveness depends on the development of good materials and, above all, on student support. (Students will often manage with mediocre materials but will be discouraged to the point of giving up if they are not supported in their work by some kind of tutoring system.) Success may therefore depend on judicious expenditure on that part of a distance-education system where economies of scale are not possible.

Third, evidence shows that motivation is all important. As already noted, programmes of teacher education using distance teaching have achieved impressive results and high successful completion rates, even with not very well-educated students, materials of mediocre quality and imperfect student-support systems, when students can expect promotion and more pay on completing their course. In contrast, adults and adolescents in programmes that are something like an alternative school, and without that promised reward, have much poorer success records.

Fourth, for teacher education, it is imperative to develop links between what is done through distance education and the practical work of the teacher in the classroom. Unless the logistics of this kind of link are effective, distance-education programmes are likely to have only modest effects at best.

Funding arrangements

New technologies, and attempts to meet the needs of new audiences, may prompt a search for funding that differs from that conventionally applied to education. For many years, where broadcasting was used to support education – either for audiences within or outside school – transmission costs and sometimes production costs have been met by the broadcasting agency. With the trend towards deregulation of broadcasting, the advance of the private sector and the development of new technologies, such as direct broadcasting by satellite, new patterns of funding may be necessary.

This change is one of a number that pose a dilemma: while new technologies may make it possible to expand and strengthen

education, in the interests of equity, they may do so by demanding resources that are not available, prompting a search for funding options that prove to be irreconcilable with that pursuit of equity.

Three features mark current arrangements to fund the expanding use of technologies in education.

First, innovation has often been heavily dependent on funding from external funding agencies, including both donors and the development banks. External funding has tended to be available for hardware rather than software and for initial capital investment rather than for running costs. Externally funded projects have, over the years and for most technologies, faced problems of sustainability where governments have been unable or unwilling to take over responsibility for recurrent costs once external funds are withdrawn.

Second, the heavy demands of schooling mean that Ministries of Education have often expected adults and adolescents, studying outside school, to meet the costs of their education. (Literacy campaigns and extension work are an exception and have been funded differently from other programmes for the education of adults.) Thus, adolescent studying at the Indian National Open School, for example, are expected to pay fees which are not charged to students at regular schools. The policy may be defended on the grounds that adults and adolescents are earning and can contribute to the costs of their own education, or criticized on the grounds that the most deprived audiences are required to pay for something that more favoured groups get free.

Third, some technological development is facilitated or accompanied by a move to decentralize funding and to tap new resources, sometimes from the community. As noted above, the distribution of teaching materials through computer networks transfers the costs of reproduction and distribution from the teaching agency to the learner. At a much more modest scale, the Grameen Bank loans for the purchase of cellular telephones are expanding a communication structure that then becomes potentially available for education, without central investment by government or the private sector.

We argue in the next chapter for the development of national and educational policies for communications. These policies will need to take account of appropriate funding structures. ■

VI. Proposed lines of development for 2000–2010

To identify growth points for the future we need to start not with the uncertainties of technological forecasting but with the realities of educational needs. If technologies are to help towards quality education for all, then we need to consider their relevance to the problems of quantity and access, and to issues of quality, and to relevance of the curriculum to society's present and future needs. Pedagogy precedes technology.

One common strand running through any analysis of the new technologies is the gap between the information-rich and the information-poor. The gap exists within countries, especially between town and country, and between countries and regions. A priority for development in the new century is therefore to find strategies to bridge this gap. It will be ironical, if not tragic, if the benefits of reducing the costs of communication flow only to the rich and not the poor. Already there is a danger that the rich can communicate by e-mail and seek information from the Internet at negligible cost while the poor, with poorer access, still have to meet the greater costs of conventional post, fax and book supply. Resolving the problem will not be easy but neglecting to address it may be catastrophic. The experience reviewed in this paper suggests two ways ahead which might form part of a strategy: to explore the possibilities of using shared computer facilities and to consider critically the level in the education system at which investment in the new technologies should be made. At the same time, narrowing the information gap is not the same issue as providing good basic education for all. We argue below that we may most effectively try to bridge the gap at other levels of education than the most basic.

As in previous chapters we can examine the role of technology in relation to the characteristics of learners – from children to adults and intermediaries – and to the wealth of their society. We move now from the youngest and poorest to the oldest and richest.

The technologies examined in this paper are of limited relevance to children in the poorest schools where a trained teacher, a few books and a blackboard rightly take precedence over more advanced technologies. And, while there has long been an expectation that it might be possible to offer a technology-based, non-formal, alternative to primary schooling, there is little record of success to guide us here. But there are two important exceptions to this hesitation about technology. First, many of the poorest and most remote schools also have the least qualified and experienced teachers. Teacher-education programmes, using whatever combinations of technology are available, are an effective way of raising school quality. Expenditure on technology for teachers, with its multiplier effect, is likely to be easier to justify than expenditure on technology in schools. Second, the power of radio to raise the quality of teaching has been amply demonstrated as have its relatively modest unit costs. The new century could raise educational quality by an imaginative rediscovery of radio.

With the approach of universal primary education, many countries will continue to face problems of access and quality, and problems arising from the shortage of suitably trained teachers, at junior-secondary level. Broadcasting projects and the important work of open schools in reaching out-of-school audiences of primary-school leavers have demonstrated that technologies can assist in the expansion of junior-secondary schooling. There is scope for programmes that hold down costs by using the same materials, and in part the same organizational structure, for audiences outside as well as within school.

It is more difficult to forecast, or to suggest guidance for, the development of computer-related activities within school. Forecasting is made particularly difficult because of the pace of technological change: 'computer education' may today be about access to information on the Internet while a few years ago it was about writing programs in basic.

As suggested in Chapter III, the introduction of computers into the classroom can offer new opportunities for communication and for access to information. At the same time it may make heavy curricular demands, asking that aspects of information technology should be included in the regular curriculum and should, in consequence, displace something else. These are accompanied by demands for relevant teacher education and for significant continuing investment in hardware and software.

In industrialized countries the policy issues that arise are likely then to be tactical rather than strategic, about the student: computer ratio, about the balance between using computers as a means of communication or as a way of developing skills needed by students as part of a general education and about control of access to any information on the Internet.

Within middle-income and developing countries there is a tier of strategic questions about the minimum level of investment that is necessary for defined curricular purposes and about the most effective way of deploying computers if, say, there are to be only one or two in any school. Among the approaches that have been suggested are the introduction of computers on a phased and regional basis and their restriction to the upper levels of the education system. If schools have only a single computer, with limited Internet access or dependence on CD-ROMs, it is probably most appropriate to put the computer into the library where there is one and perhaps to concentrate on its use to overcome teacher isolation and for teacher in-service education. A further possibility is to encourage the use of

computers within teachers' colleges and to explore whether it is possible to get shared use of, say, computer facilities provided to a telecentre or teachers' college.

Technology provides two kinds of opportunity for the education of adults.

First, as we have seen, there is a strong educational and economic case for the development of technology-based programmes to raise the effectiveness of intermediaries, including teachers, extension agents and health workers. (An oddity here is the limited use made of technology to update and inform agricultural extension agents, the largest cadre of adult educators – on a broad definition of the term – in many countries.) Wherever attention is moving from pre-service to in-service teacher education, we see a major role for the use of communication media. Examples to guide us include the use of the Internet within teacher-training colleges, the many programmes of distance education for teachers and the experiments, in India and elsewhere, in using teleconferencing for teacher education.

Second, there is scope for an expansion of non-formal education, despite all the setbacks, and to apply the lessons learned and illustrated in this study. The careful and planned use of mass media for large-scale programmes of public education (perhaps most important for education about AIDS) justifies investment both because of potential direct benefit to the learners and because of the negative impact on the formal education system of their absence.

New technologies and new organizational structures (e.g. telecentres) may have a role to play here. Indeed, as information on the Internet becomes more universally available, technology-based non-formal education may become ever more important.

Leapfrogging

We touched in the previous chapter on the danger of a widening gap between the information-rich and information-poor. In contrast it is sometimes argued that developing countries have the opportunity to leapfrog the industrialized, using technologies so that they develop a stronger system of education without going through the same slow stages of development that have been followed in the industrialized world.

The argument is not new. It was suggested at the time that the large-scale instructional television projects of the 1970s would allow developing countries to leapfrog industrialized ones and so accelerate their educational development. Television did not bring this result: a generation later we cannot point to any education system that was transformed as a result of investment in television rather than in teachers and blackboards, and in the slow process of raising teacher and school quality. More recently there have been some examples of leapfrogging in communications technology. India and Thailand, for example, have used satellite broadcasting where industrialized-country broadcasting has till recently been dominated by terrestrial systems. Cellular telephones have spread rapidly in Ghana so that a cellular network is in place while the terrestrial one is still limited in its coverage.

Can we expect educational leapfrogging, in which a technology-dominated system of education can be established more rapidly and more economically than conventional approaches to strengthen education? Four conditions seem to be necessary for this to happen.

The first is that telecommunications should be capable of delivering the greater part of the curriculum; if they are only used for, say, a tenth of the time or the content then they do not allow for the significant reductions in expenditure on conventional education that would be necessary to make savings in unit costs. This condition may be met in higher education, where technology-based teaching has in a limited number of cases proved to be a viable and effective alternative. (The National Technological University, operating at postgraduate level in and beyond the United States, is the dominant example.) It may be met in large-scale, broadcast-based projects at junior secondary level, like Telesecundaria in Mexico, but it seems unlikely that it can be met at primary level. For both social and educational reasons, parents, teachers and politicians all expect that young children need to study, in a classroom and with a teacher, and do not believe that the technologies can provide an adequate substitute for this.

The second condition is that an adequate communications infrastructure is in place. Effective radio, for example, demands that schools should be able to afford radios, have access to mains electricity or to batteries and funds to pay for them, and to a service industry that will repair and replace radios when they break. A web-based computer education service demands reliable electricity and telephone lines and, again, a support service to maintain equipment.

The third condition is that there is the capacity to train teachers, or mentors or classroom assistants if they are to substitute for teachers. Several different elements make up this capacity: a teaching force whose background education is adequate for them to learn and apply new teaching skills; enough time for them to study on top of their day job of teaching; and a national or local structure to provide in-service teaching even for the most remote teacher.

The fourth condition is economic. If technology-based teaching is to yield any economies, then the cost per learning hour achieved through the use of technology must fall below that of conventional education. Data from France and the United States suggest that computer-based teaching there has costs of

between $1 and $2 per student hour, which would compare favourably with the cost per hour of conventional teaching which is in the range $4 to $12 (Orivel, 2000). But a large proportion of the costs for computer-based teaching are a function of the costs of the technology. These costs are likely to be as high in developing as in industrialized countries, or even higher. In contrast conventional costs per student reflect local wage rates for teachers and may be as low as $0.10 per hour within LDCs, a fraction of the cost to be expected for technology-based teaching. Orivel has suggested that it is only when countries are achieving a GNP per capita of $7,300 that they may reach a breakeven point in which computer-based costs match those of conventional education. Even here, if technology is to produce savings, it must substitute for teachers. For most LDCs technology can only increase the cost of basic schooling, not reduce it.

If we focus on the needs of primary education in most developing countries, it is clear that none of the conditions for educational leapfrogging are likely to be met. Crucially, there are strict economic constraints on the deployment of technologies unless these are to replace teachers, to minimize costly interaction with a tutor, and to reach such large audiences that they achieve economies of scale. This is not to argue against the use of any of the new technologies in education. Rather it is to suggest that their use should be focused on tasks for which they have genuine strengths and in which the conditions for success can be met. Basic education will not be transformed through a leapfrogging process; it may be dramatically and effectively strengthened through the judicious and selective use of communication technologies for those aspects of education where it has particular strengths and advantages.

Underpinning: the need for policy

There are ways in which the application of technology to basic education can help widen access, raise quality and in some circumstances contain costs. But the picture of technological development over the past decade is of piecemeal and haphazard development, with some successes, some failures, and many initiatives undertaken without evaluation and within a policy vacuum. It is possible that much has been spent on technology with little return: we hardly know.

We can therefore conclude that sound development needs to take place within a national communication policy, one aspect of which will be a policy for the educational use of communications.

In arguing this, it is assumed that a national communication policy will consider political, economic, technical and legal or regulatory issues. It will need to define the roles of the private and public sector in relation to the whole range of information and communication technologies. One key issue here may be a strategy to allow educational institutions access to telecommunications on favourable terms, possibly through the use of governments' regulatory powers in the telecommunications sector. A communications policy will need to consider the following among other areas:

- policy on tariffs and on any common carrier requirements;
- investment policy, in relation both to the public sector and to the encouragement of particular areas of private-sector investment;
- government purchasing policy, and policy for the use of communication technologies for government's internal communication;
- technical standards including frequency allocation;
- the national development of capacity and expertise;
- issues of equity and access;
- intellectual property, seeking an appropriate balance between 'the right of creators to benefit from the use of their work and the needs of users to access those works and use them freely' (UNESCO, 1997, p. 88).

Assuming work on this kind of policy framework is under way, we can then identify a range of issues to be addressed within a policy on communication for education.

Issues of language will be on this agenda. The dominance of English as the language of the Internet is double-edged for all non-mother tongue English speakers. On the one hand it discriminates against other languages; on the other, the acquisition of English as an international language brings a new range of benefits. Cultural issues are closely linked with linguistic ones. Print, broadcasting and computer technologies all allow the development of local, national or regional teaching materials. Many countries are likely to seek to determine a policy on local materials development rather than leave this to the operation of market forces on the publishing industry.

Then an educational policy will have to take account of two sets of demands and opportunities presented by the telematics revolution. As noted above, the new technologies allow schools and colleges to reshape the curriculum, and to get access to new resources. At the same time, the technologies may become part of the curriculum; the education and training service will need to develop adequate national capacity to meet the demands of the economy and of civil society. Education about information and communication technology, education through the technologies, and education and training to provide skills in them will all influence the curriculum.

There are several different challenges in developing policy here.

One is to make hard-headed choices about the scale and level of investment in the new technologies at a particular level of education. Where it is not seen as possible, or desirable, to have a major programme of supplying computers to schools, and of providing the necessary training and support, a policy will need to be developed for any phased activity, or for the shared use of the technologies. It is likely to take account of the possible development of telecentres and other ways of sharing technical facilities, and of low-cost options for access to the Internet.

In considering the level at which new technologies are to be used in education, we come back to the gap between the information-rich and information-poor. Clearly, measures to bridge that gap are likely to form part of a communications policy. But this may not be part of the agenda of basic education: it may make far more sense for that concern to influence national policies for further education and training than for basic education.

One further difficulty here is that there is a shortage of good information on which to base policy and relatively few evaluations of the effects of changing the technologies used in education. We are short of the kind of cost data discussed in Chapter V and have a particular need for studies that would set out the costs achieved in using various communication technologies within developing countries. Yet another difficulty, in a policy that seeks to match technologies to educational needs, is the shortage of disinterested advice: much of it comes either from the telecommunication industry or from one part of the industry, with an understandable bias towards a particular technology.

Many of these issues go far beyond questions of basic education. But, unless they are resolved, with a particular sensitivity to the needs of the information-poor, basic education will suffer.

Software, training and evaluation

Whatever policy is adopted, three themes have run through the experience reviewed in this paper: the costs and difficulties of developing or acquiring software for any technological medium, the need for staff training as those working in education grapple with changing technologies and the need to evaluate our practice. All three demand resources. Inadequate attention to any of the three is likely to reduce effectiveness and waste resources.

Conclusion

At the risk of being over prescriptive we can sum up the conclusions of this paper in eight points.

1. There is no alternative to primary school. Technology-based alternatives have not thrived.

2. Computers have been used in primary schools but in a modest way, sometimes mainly for games. Their more significant use is at levels above that of basic education.

3. Radio, not limited to interactive radio instruction, can enrich basic education and do so at costs much more modest than those of television or computers.

4. The scale of the demand for junior-secondary education, and the increased capacity and maturity of students who have completed primary schooling, suggests that there may be an important role for the application of technologies to raise quality and widen access at this level.

5. There are models for out-of-school equivalence at this level, and the potential for developing and making available teaching materials that can be used both in-school and out-of-school.

6. The record of using mass media for public, adult and non-formal education, in areas such as health, citizenship, family planning and agriculture, is patchy, but the technologies available are widely understood, and the social and educational needs so great that there is a case for continuing investment and activity here by governments and non-governmental organizations alike.

7. If the development of new technologies is not to widen gaps between north and south or between the information-rich and the information-poor, national policies are necessary that will explore ways of making cost-effective use for them in vocational education and training, and possibly at the higher levels of formal education.

8. The use of communication technologies for intermediaries – teachers and extension agents – can have a multiplier effect and is likely to have cost advantages over conventional ways of supporting and updating them. They have the potential to reduce the isolation of remote, rural, teachers and so raise the quality of their work.

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Tables

Table 1. Some uses of information and communication technology

Type of use	Current activity
Computers in schools to support teaching	On modest scale in many countries, mainly at secondary level
Computers for school linking	Vigorous recent developments supported by the World Bank, CoL, etc.
School broadcasting	Widespread
Interactive radio instruction	USAID projects in a range of countries
Open learning, open schools, supervised study centres	On significant scale in small number of countries (Mexico, India, Indonesia, Malawi)
Distance education for teacher training	Widespread use, many countries; seldom fully integrated into teacher-education structure
Computers for teacher training	Some projects under way (e.g. UNESCO backed Internet linking of colleges in Zimbabwe)
Technology-based non-formal education	Widespread, uncoordinated activity by various ministries (e.g. health and agriculture) and non-governmental organizations

Table 2. Some distance-education and technology projects in Africa and Latin America

Country and institution	Date established	Basic education functions
AFRICA		
Botswana: Department of Nonformal Education	1973	Adult basic and nonformal education
Côte d'Ivoire (and 9 other countries): INADES-formation	1962	Basic education in farming and rural development
Kenya: University of Nairobi Department of Education and Extension Studies	1985	In-service education of primary-school teachers
– Ministry of Education/Voice of Kenya	1980	Interactive radio project for English teaching
– Ministry of Community Development	1978	Distance-teaching training of literacy workers
– Aga Khan Foundation	1983	Experimental computer education project
Lesotho Distance Teaching Centre	1974	Basic education for herdboys Support for national programmes of teacher education
– Ministry of Education/School radio		Interactive radio project for English teaching
Malawi: College of Distance Education	1965	Primary and junior secondary programmes Teacher training
Mali: Institut Pédagogique National	1962	In-service education of teachers
Nigeria: National Teachers' Institute	1976	Large-scale in-service education of teachers to upgrade whole-national teaching force
Somalia	1993	Teacher training for teachers in nomadic communities
Sudan: Open Learning Unit	1984	Basic education principally for refugees
United Republic of Tanzania: Co-operative Education Centre	1964	Basic education for co-operative movement
– Teacher education project	1978	Training of primary school teachers
Zambia: Cooperative College	1980	Basic education for co-operative movement through radio campaigns
– National Correspondence Institute	1964	Out-of-school junior secondary education
Zimbabwe: ZINTEC	1981	Distance-education programme for primary school teachers
LATIN AMERICA		
Bolivia	1986	Interactive Radio Instruction project in maths, health, child development
Brazil: Minerva Project	1973	Radio-based secondary equivalence courses for adults
Colombia: Acción Cultural Popular	1947	Basic education for rural adults and children
Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala	1988	Interactive Radio instruction in maths and Spanish
Dominican Republic: Radio Santa Maria	1972	Out-of-school basic education for young people
– RADECO	1981	Nonformal programme using Interactive Radio methods
Honduras: Acción Cultural	1974	Radio school programmes for rural families
– Popular Hondureña	1987	Interactive Radio Instruction in maths, Spanish, English
– Radio Learning Project		
Mexico: Radioprimaria	1970	Rural basic education by radio
– Telesecundaria	1965	Television-based rural education at junior secondary level
Venezuela: Instituto Radiofonico Fe y Alegria	1976	Primary and secondary equivalence courses for adults, using radio and print

Table 3. Educational enrolment trends 1980-96

		Primary		Secondary		Tertiary	
		M	F	M	F	M	F
All developing countries							
Gross enrolment ratio	1980	103.5	85.5	41.8	28.2	6.7	3.7
	1990	105.2	91.3	48.2	36.1	8.5	5.7
	1996	105.8	93.8	55.1	45.3	11.1	8.1
Growth over period %	1980-96	2.2	9.7	31.8	60.6	65.7	118.9
Sub-Saharan Africa							
Gross enrolment ratio	1980	87.4	68.9	21.8	12.5	2.6	0.7
	1990	79.5	65.9	24.7	18.6	4.1	1.9
	1996	81.3	67.2	27.9	22.4	4.7	2.5
Growth over period %	1980-96	-7.0	-2.5	28.0	79.2	80.8	257.1
South Asia							
Gross enrolment ratio	1980	90.4	60.0	36.3	18.2	6.2	2.3
	1990	102.4	76.8	49.4	29.9	7.4	3.7
	1996	105.8	83.0	53.4	36.0	8.6	4.9
Growth over period %	1980-96	17.0	38.3	47.1	97.8	38.7	113.0

Source: UNESCO Statistical Yearbook/Annuaire Statistique/Anuario estadístico 1998, 1998, Paris/Lanham, Maryland, UNESCO Publishing/Bernan Press.

Table 4. Ways to provide children with access to ICT

Strategies	Technology	Project examples
1. Computer provision direct to existing schools Government schemes International collaborative schemes Tax-relief schemes Recyling schemes	PCs, Macs, Laptops, hand-held computers	Botswana ICT School Project, Computers for schools, Detwiler Foundation, PEP Directory for Computer Recycling, DRAGnet, Computer Aid
2. Building customized new schools or computer-suite/labs/ school annexes	State-of-the-art computer technology	Accelerating the Use of Information Technology in Primary Schools project, Kong Hwa School, Malaysia Piggotts Primary School project, Antigua
3. Mobile units	Internet, CD-ROMs, books, videos with satellite and videoconferencing equipment	The Cyberbus across Africa, Internet Learning Trust, The Rolling Zone, Hertfordshire Library Service, UK
4. Community resource centres or kiosks providing access to (and sometimes training for technology outside school)	2 old computers in remote village schools	LEARN Foundation, Bangladesh
	Library with computers, access to Internet, educational CD-ROMs, books, video, audio-cassettes, self-access packages	School-local library links, visits and after-school clubs, e.g. UK library service
	Free Internet kiosk in streets of New Delhi	Children and the Internet experiment, New Delhi, NIIT.
	High-tech access centre: computers, DTP, telephones, fax, E-mail, WWW, video, audio reprographics + library services/resources	Technology Access Community Centres, e.g. Eygpt, UNDP
5. Mediated ICT use	Pupils without access to ICT make requests to mediators to download information from the Internet on their behalf (and send or broadcast back) + free radio-station cybercafé	Kothmale Internet Radio, Sri Lanka
	Adopt-a-school projects: creating webpage on school's behalf to elicit funds or resources	Supporting Children at Gurambira Primary School in Zimbabwe, Adopt a-Rural-School-Library, China

Table 5. Different broadcasting strategies for children in school

Broadcasting trategies	Technology use	Project examples
1. Interactive radio instruction	National and regional radio broadcasting (terrestrial and satellite) + radios receivers (mains, batteries, solar-powered or wind-up) + print materials	English in Action, OLSET, South Africa Portuguese, PALOP countries (Mozambique, Angola) Radio Math, CENEMAC, Venezuela English in Action, BRAC, Bangladesh
2. Schools Broadcasting Radio	National and community radio broadcasting (terrestrial and satellite) + radios (including solar & wind-up) + print materials	Al Manaahil, Jordan Drama Workshop, BBC Education Radio, UK Namibian Broadcasting Corporation Schools Broadcasting Unit, Gambia
Child- and teacher-initiated community radio broadcasts	Community radio broadcasts subjects and information requested by children or teachers, e.g. producers download information from Internet to broadcast or create print information for learners in own languages	Kothmale Radio, Sri Lanka
Television	National and regional TV broadcasting (terrestrial and satellite) + TV receivers + print materials	NHK School Broadcasts, Japan BBC Education TV, UK
3. Children's' programming on national and international radio and television stations	Radio & TV cartoons about children's rights and conflict resolution	Children in conflict, BBC World Service Cartoons for Children's Rights, UNICEF Common Ground Production, Macedonia
	TV series promoting literacy	Ricon del Cuento (Story telling corner), Colombia Sesame Street, USA
	TV Health campaigning + school health curricula (part of a wider multi-faceted strategy)	Soul City & Khululeka Series, South African Broadcasting Corporation

Table 6. Different types of school linking by Internet

Use of Internet: school linking	Technology use	Project examples
Promoting national learning networks for children	Computers +internet connectivity	Enlaces (Chile) Schoolnet South Africa Program Uganda Schoolnet Pilot Project Fjiordlands Irish Schools Project
Promoting international learning networks	Computers + internet connectivity	Education Partners Overseas Windows on the World Intercultural E-mail Classroom connections The Global Schoolhouse The Globe Program KidLink, KidProj Trinidad ICT School Project Botswana ICT School Project Twinning groups, Antenna, Netherlands
Linking within minority & isolated communities	Computers + internet connectivity	Ingalaaq, Leo Ussak Elementary School, Northwest Territories, Canadian Arctic Navajo Learning Network Project, USA
Webpage donation schemes on behalf of individual primary schools in developing counties	Webpage eliciting funds and resources from individuals, groups, schools, companies	Adopt a School Program, Peruvian Amazon Rainforest Send a comic campaign, Gurambira Primary School, Zimbabwe Adopt a rural school Library in China Riba Primary School Library Project

Table 7. Interactive radio instruction

Country and project	Dates	Subject, level, quantity	Scale	No. of students	Cost	Comment
Nicaragua: Radio mathematics project	1974-79	Mathematics in first four primary grades	Half-hour daily broadcasts	10,000 maximum[b]	Average cost 1975 $5.60 @ 50,000 students[c]	Closed as result of revolution
Thailand: Radio mathematics	1980-at least 84	Mathematics in first three primary grades	Half-hour daily broadcasts	n/a	n/a	Adaptation of Nicaragua materials, undertaken mainly by Thai staff
Kenya: Radio Language Arts	1980-85	English language in first three primary grades	Half-hour daily broadcasts	n/a	n/a	Project closed when USAID funding ended
Dominican Republic: RADECO	1982-at least 1989	Reading and mathematics for first three primary grades	One-hour daily broadcast	57 schools, 80 classrooms by 1989[d]	n/a	Project run for nonformal groups, with auxiliary, on radiophonic school model
Papua New Guinea: Radio Science	1987-at least 1994	Science for primary grades 4-6	60 20-minute lessons for each grade	9,000 in 1990 40,000 in 1992 75,000 in 1994[e]	n/a	Project survived USAID cuts 1989 and funding withdrawal 1990
Lesotho: English in action	1987-90	English for primary grade 1-3	391 half-hour daily broadcasts for 1-3 grades	200,900 in 1990 (80,500 in standard 1, 63,400 in s2, 57,000 in s3)	1990 $1.34 per student[f]	Materials adapted from Kenya and now part of regular curriculum, reported to be still operating 1997[g]
Honduras:Honduran Radio Learning Project	1987-	Maths primary grades 1-3 English, Spanish	465 lessons produced	100,000 grade 1, 50,000 grade 2, 30,000 grade 3 in maths 1990[h]	1990 $2.94 per student @ 200,000 enrolment[i] ($3.67)	Run in partnership with commercial publisher, not institutionalized[g]
Bolivia: Radio Mathematics, Radio Health, Early Childhood development	1986- 1992- 1994-	Mathematics: primary grades 2-5 Health Child development for careers	Daily Weekly	250,000 enrolled in 1994[j]	1990 $2.80 per student @ enrolment of 70,000, falling to $1.28 @ 300,000[k] ($3.49 to $1.60)	Run in association with church-based NGO
Ecuador	1988-91	Mathematics Early childhood education	n/a	300	n/a	Pilot in 21 schools, completed by 1991[l]
Guatemala, Costa Rica, El Salvador, Dominican Republic	1988-92	Maths, Spanish	n/a	n/a	n/a	Adaptation of Honduras material Costa Rica closed down; El Salvador continued
Costa Rica: Radio Environmental Education	1991-	Environmental education for primary grades 4 and 5	n/a	36,000 students in 1200 schools 1991[l]	n/a	Two pilot schemes run but not then implemented
South Africa: English in Action	1992-	English language, primary grades 1-2	130 30-minute cassettes; daily broadcasts	15,200 grade 1, 9,600 grade 2 in 1995	Cost in range 1994 Rand 3.13-8.16 per student[m] ($0.97 to $2.53)	Project criticized for behaviourist origins but then remodelled and continues with NORAD funding
Lusophhone Africa	1992-	Maths grades 3-4	n/a	n/a	n/a	Developed in Cape Verde for use also in Angola, Mozambique, São Tomé[g]
Venezuela	1996-	Maths	275 30-minute lessons	300,000 students in 12,000 classes	n/a	Funded with world Bank loan with some recurrent costs from state budgets[g]

Source: Perraton 2000: 48-51 Notes: Costs in italics are in constant 1998US$$.
a. Other projects, with less detail, are referred to in Bosch 1997 and Dock and Helwig 1999; b. Friend et al. 1980: 30; c. Jamison et al. 1978: 136; d. Radio Learning Project n.d.: 43 e. Olsson 1994: 16; f. Tilson 1991: 337 but including direct costs omitted from his figure; g. Bosch 1997: 9-10; h. Radio Learning Project n.d.: 48; i. Tilson 1991: 326; j. Fryer 1995: 20; k. Tilson 1991: 307-8; l. Anzalone 1991: 48; m. Cobbe 1995: 21; n. Helwig et al. 1999: 24-5

Table 8. Different health campaigning strategies for youth

Access trategies	Technology use	Project examples
Popular culture mass-media reproductive health education campaigns for youth	Radio, TV, film, video- & audio-cassettes + outreach activities National initiatives	Open Line (radio talk show), Philippines Radio Health (national radio), Côte d'Ivoire Kenya Youth Initiative Project (Youth variety show and radio drama), Kenya More Time (motion picture), Kenya The Music Project (songs & videos), Nigeria Good Times with DJ Berry (radio programme), Uganda Alang-Alang (television drama mini-series), Indonesia Angelica (Television serial drama), Ecuador Living Stories of Yemeni families (video documentary & TV spots), Yemen
	International initiatives	Aids Hot line, (telephone), Egypt Sexwise, BBC World Service
Outreach health activities for youth	Videos on Adolescent health, sexuality and development	FAD Video project, Philippines.
Mass-media, health advocacy reaching youth as a secondary audience or within inter-generational projects	TV, radio + literature + outreach activities	Family Planning IEC expansion project, Burkina Faso And the Nile Flows On, Egypt Nazariya, India Tasi, Tasi, Indonesia Aahat, Pakistan The Minya Initiative, Egypt Mass media campaign HIV/AIDS, Dem. Rep. of the Congo

Table 9. Intermediaries: health workers

Strategy	Technology use	Project Examples
ICT		
Telehealth – access to international databases	Internet connectivity	INFOLEP, MEDLINE, AVLINE, BIOETHICSLINE, CANCERLIT, CATLINE, POPLINE and TOXLINE, The Lancet Interactive, US National Library of Health
– national telehealth projects	Internet connectivity	Dr Martin Luther King Memorial Clinic, Accra, Ghana
– linked medical schools	Internet connectivity Telematic network, satellite and ground-based ISDN	NorthWest China Telehealth Service MERMAID multilingual, telemedicine
Still image telephone	Still-frame video conferencing with video cameras, TV monitor, telephony	Western Pacific Health Training
Audiographic conferencing	Computer modems, speaker-phone, graphics software	Aboriginal & Torres Strait Islander health workers, Cairns rural Health Training Unit, Australia
Videoconferencing	Satellite video-conferencing	Health for Youth – Australian medical students + South African high-school students
Broadcasting	Health advocacy radio campaigning for general public + health worker update material	Radio communication Project, Nepal
Distance Education Correspondence courses	Radio broadcast, audio-cassettes, practical demonstrations	African Medical and Research Foundation, Kenya Distance Education Programmed, Uganda National Distance Education Centre, Tanzania
	Print material, handbooks videos, two-way radio transmitters and newsletters	Solomon Islands Health Workers Project
Mixed-mode delivery	Face-to-face teaching + independent study (print, audio-cassettes, practical activities)	Centre for Indigenous Health Studies, University of Sydney
Self-instructional resources	Print + audio-cassette Health manual + wrap around study skills audio-visual materials	Clinical Skills: a self-instructional course, WHO Where There is No Doctor, adapted for Community Health Workers, The Atolls, Maldives

Table 10. Intermediaries: agricultural extension workers

Strategy	Technology use	Project Examples
ICT		
On-line resources for agricultural workers	Computer + Internet connectivity	AGRICOLO, AGRIS, CAB Abstracts, TROPAG CTA's CD-ROM Programme
On-line courses	Computer + Internet connectivity	Environmental Economics, University of Waterloo, Canada
Multi-purpose community telecentres (MCTs)	Telephony, Fax, photocopies, internet, E-mail, virtual office, distance education, tele-medicine, government and community info, tele-trading	UNESCO/ITU/CTSC pilot projects - Benin, Bhutan, Honduras, India, Mali, Suriname, Tanzania, Uganda, Mozambique, Vietnam
Broadcasting		
Interactive TV	One-way video, two-way audio-conferencing via satellite links + direct reception TV sets	Jhabua Development Communications Project, India
National audio-visual production centres	Radio, video, DTP, TV educational material + print and trainers	The Agricultural Information Centre, Kenya Centre for Learning Resources, Pune, India Centre for Audiovisual Teaching Aid services, Peru
International sources for radio scripts and broadcast programmes (for re-broadcasting)	Radio and Internet Audio- and video-cassettes Ready-made radio scripts for re-broadcasting, translation and adaptation	CTA's rural radio database for audio download Deutsche Welle, BBC World Service Developing Country Farm Radio Network
Distance Education		
National level	Printed text, tutorial support, audio-cassettes	Southern African Extension Unit, U. Rep. of Tanzania Basic Farming, The Open Polytechnic of New Zealand
	Radio & TV broadcasts, tutorials, print materials	Farm School on Air (Tamil Nadu Agricultural University, India)
International level	Print coursebooks, readers, audio and video cassettes, tutorial support (moving into web-based learning)	Wye College External Programme, University of London, UK

Table 11. Some out-of-school enrolment data

Institution	Year of most recent data	Enrolment (000s)	National secondary enrolment 1995 (000s)
Mexico: Telesecundaria	1998	757	7 589
Malawi: Study centres	1994	57	142
Zambia: Study centres	1990	11	290 [a]
Zimbabwe: Study centres	1992	23	661
India: National Open School	1998	130	66 634
Indonesia: National Open School	1996	172	12 224 [a]

Source: for Mexico: International Bureau of Education, *World Data on Education*, Geneva, 1998; Malawi: *Basic Education Statistics 1995*; Zambia: Siaciwena 1994; Zimbabwe: *Secretary for education and Culture Annual Report 1992*; India: *National Open School Profile 1999*; Indonesia: Sadiman and Rahardjo 1997.
a. 1994

Table 12: Costs and effects of some teacher education projects

Currency: constant 1998 US$

Country, project, date[a]	GNP per capita at time of study		Student numbers	Average cost	Educational and cost impact
	date current US$	1998 US$			
United Republic of Tanzania, TTD, 1979-84	1982 310	524	15,000 p.a. 45,000 total	1,863 per student p.a. 7,316 per graduate	Effects comparable to conventional education; cost about half conventional education
Brazil, Logos II, 1976-81	1978 1,650	4,125	24,400	211 per student p.a. 741 per graduate	80% pass rate; costs lower than alternative
Sri Lanka, 1984-88	1986 410	610	c5,000	116 per student p.a.	Cost 1/6–1/3 of alternative; more effective than alternative for some subjects but less effective for others
Indonesia, 1985-88	1986 530	788	c5,000	805 per student p.a.	Cost about 60% of equivalent; more effective than alternative in languages but less so in mathematics
Nepal, RETT Basic teacher training course, 1978-80	1979 130	292	3,000	196 per student p.a.	Cost slightly lower than alternative; completion rate 83%, pass rate 57%; no evidence that less effective than alternative
Nigeria, National Teachers Institute, 1978-89	1984 730	1,145	20,327	79 per student p.a.	Cost probably lower than regular colleges; completion rate estimated 42%, pass rate estimated 27%, both rates higher than those of regular colleges
Pakistan, Primary Teacher Orientation Course, 1976-86	1981 330	592	83,658 total enrolment 31,674 completed	107-149 per successful completer	Cost per AIOU graduate 45-70% of conventional university
Kenya, in-service teacher training, 1968-77	1972 180	661	790	806 per subject equivalent p.a.	Cost relatively high; favourable effect on access
Kenya, University of Nairobi BEd, 1986-90	1988 370	510	515	1,096 per student p.a.	Cost thought to be lower than cost of residential equivalent
Nigeria, COSIT University of Lagos, 1980-88	1984 730	1,145	2,000	345 per full-time student equivalent 1 304 per graduate	If opportunity costs are omitted then cost per graduate slightly lower than residential campus cost
Uganda, NITEP project, 1993-97[b]	1995 240	257	2,750	2,000 per successful student	Lower cost than equivalent

Source: Perraton, 1993, pp. 386-7 except where shown, with costs converted to 1998 US$

a. The end date in column one refers to the period reported, not necessarily the end date of the project or programme.
b. Wrightson, 1997, p. 5.

Table 13. Comparative costs of technology in school

Currency: constant 1998 US$

Country and date of project	Technology	Student numbers	Cost per student for technology	Cost as proportion of government primary school expenditure[a]
Various[a]	IRI	100,000	8	n/a
–	IRI	1,000,000	3	n/a
Chile 1995[b]	Computer-assisted instruction	100 per school	83	37%
		200 per school	60	26%
		1,000 per school	22	10%
Costa Rica 1997[c]	Computers in secondary education	typically 1,000 per school	38	13%[d]
United Kingdom 1998[e]	ICT	various	primary 18	0.6%
			secondary 63	1.6%
United States 1999[f]	ICT	n/a	70	1.3%[g]

Source: Perraton, 2000, p. 128, but see also:

a. Adkins, 1999, pp. 40-1
b. Potashnik, 1996, pp. 19-21
c. Wolff, 1999, pp. 29-30
d. This is the proportion of secondary school expenditure
e. DFEE, 1999; Audit Commission, 1999
f. Orivel 2000, based on Coley, Cradler and Engel, 1999
g. Proportion of total school expenditure

Table 14. Costs of some adult basic education projects

Currency: constant 1998 US$

Project	Scale and duration	Cost per learner	Cost comparison
Radio schools in Latin America (e.g Acción Cultural Popular, Colombia, Radio Santa Maria, Dominican Republic)	ACPO: 190,000 student; RSM 20,000 students One-year course offering equivalency to primary education	In range $50-$88 per student per annum	Cost at ACPO less than for primary schools. At RSM comparable with primary, lower than evening classes
Zambia radio education campaign on co-operative movement	4,730 participants Ten weeks of meetings, once weekly	$22 per student	Cost per learner lower than cost of training at farmer's centre, higher than primary school costs
Functional Education Project for Rural Areas, Pakistan	1,500 students Eight meetings at weekly intervals	About $46 per student	Cost probably low in comparison with alternatives, high as compared with primary schools
Telesecundaria Mexico	Running for 30 years in 1997-98, 817,200 students in 13,054 schools and with 38,698 teachers (16.6% of national secondary enrolment)	In range $441-589 per student[a]	Cost per learner has been relatively stable over a long period. Costs understood to be of similar order of magnitude to costs in conventional schools
National Open School, India	Year enrolment 130,000 (1998-99) 400,000 in full roll Weekly tutorials, one hour per subject	Cost per learner $10 (1997-98) Cost per graduate $92 (97-98) (graduation rate 43%)	Comparative cost per learners in formal schools is $27

Source: Perraton 2000; Castro *et al.*, 1999; Bradley and Yates forthcoming.

a. Figures from three studies in 1975, 1988, 1997. One further study in 1981 had figures of $927.

Table 15. Technology choice and costs

Project	Pre-requisites	Running costs	Location of expenditure
Radio	Broadcasting station with available airtime FM stations offering new opportunities	Typically 1/10 of television	Mainly central Reception costs for receivers and batteries
Television	National television service, audience big enough to justify production costs		
Cassettes	Modest studio facilities only	Distribution costs likely to make cost uncompetitive with radio when audience > 500	Mainly central
DBS	Access to transponder, uplinks and down link or specialist receiver	As for broadcasting apart from receiver cost	Mainly central
Distance education for teacher training	Organizational structure for materials development and student support	Typically below cost of conventional education	Central for materials. May be local for student support
Teleconference	High technology at centre, specialized equipment at satellites	Likely to exceed conventional teaching where tutors are employed at each site	Expenditure needed both centrally and at each satellite
Computers in schools	Provision of hardware and software to schools; maintenance; staff training	Probably exceeds cost of television	Cost may fall mainly on school
Computers in school with Internet access	As above, together with access to ISP and telephone lines	As above, but with line charges added	As above but communication costs likely to be met locally

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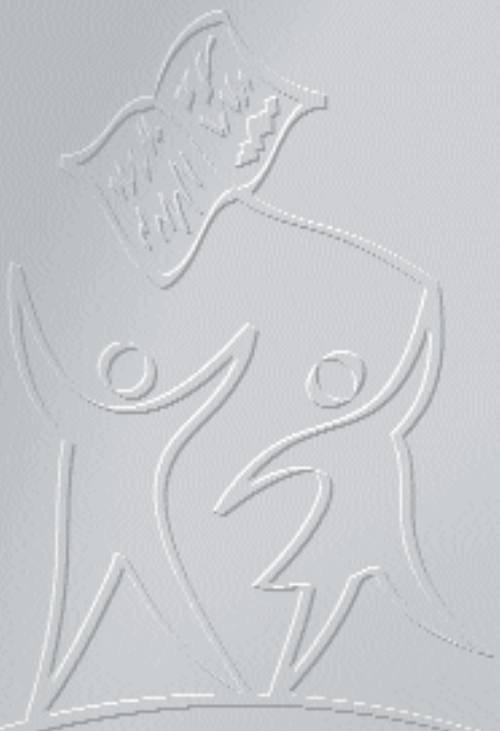

This study summarizes international experience in using communication technologies for basic education, both in school and, through distance education, out of school. It looks at outcomes, methods and costs. The new technologies are not a substitute for primary school. But the evidence shows the value of radio in education, the need to develop national policies for communications for education, and the particular value of the new technologies where they apply leverage by training and supporting teachers and extension agents.

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