CHAPTER THREE
Educational Technologies in South Africa

In this chapter we describe a range of technologies that can be used to support education, and give some indication of the availability of a selection of technologies in South Africa. Given the scope of this research we have focused primarily on radio, television, and computer technology infrastructure in the country. We have, however, drawn this information from fairly extensive research into a wider range of technologies and their educational applications. Much of the source information for this chapter has been included in appendices, six, eight, and eleven. In chapters five and seven, where various technology options are outlined for a dedicated educational broadcasting service, we have also described these technology models in some detail.

UNDERSTANDING MEDIA AND TECHNOLOGIES

In order to make choices about the educational use of technologies; it is worth differentiating between media and technologies, two concepts that are often used interchangeably. Such use masks important conceptual differences in the way the terms are used throughout this document. Tony Bates developed a useful grid to highlight the differences, and relationships, between media and technologies.[1] This table was amended by the TELI Research Team, and has been further amended for inclusion below. It is by no means a comprehensive map of the full range of media and technologies, but helps to illustrate the relationship between the two.

Medium	Technologies for Delivery	Educational Applications
Face-to-face contact	• Overhead projectors (manual or electronic) • Specialist technologies • All of the below	• Seminars, tutorials, classes, workshops, and lectures • Learner study groups or self-help groups • Conferences • One-to-one interaction, either between educator and learner, learner and learner, or learner and mentor (especially in workplace) • Drama-in-education or theatre-in-education sessions • Practical demonstration and activities
Text (including graphics)	Print	• Books, booklets, and pamphlets (either already published or written specifically for a course) • Study guides, written either as stand-alone material or as 'wrap-around' guides to already published material • Workbooks intended for use in conjunction with other media materials (for example, audio or video cassettes or computer-based learning) • Newspapers, journals, periodicals, newsletters, and magazines • Printed learner support materials (for example, self-tests, project guides, notes on accreditation requirements or other aspects of courses, bibliographies, and handwritten/typed materials or comments passing between learners and

[1] Adapted from Bates, A. (1984). *Broadcasting in Education: An Evaluation*. London: Constable, p. 248.

Medium	Technologies for Delivery	Educational Applications
		educators) • Maps, charts, photographs, and posters • Written/printed correspondence • Learner support material (for example self tests, project guides, notes on accreditation requirements, or other aspects of courses, bibliographies, and materials or comments passed between leaner and educator)
	Facsimile	• Written/printed correspondence • One-multi point distribution
	Computers (including a range of applications such as e-mail, electronic databases, Worldwide Web hypertext documents, FTP or ASCII documents, CD-ROM	• Electronic publishing • Study guides, written either as stand-alone material or a wrap around guides to already published materials • Instructional material intended for use in conjunction with other technologies (for example audio or video cassettes or printed materials) • Newspapers, journals, periodicals, newsletters, and magazines • Learner support material (for example self tests, project guides, notes on accreditation requirements, or other aspects of courses, bibliographies, and materials or comments passed between leaner and educator)
Audio	Audio Cassettes Audio Compact Disc	• Audio programmes (music, talk radio, documentary, literature review, lecture, panel discussion, news, current affairs, debate, drama etc) • Audio programmes as for above
	Radio broadcasts	• Radio programmes as above • Radio phone-ins, talk-back radio)
	Telephone	• Telephone tutoring • Information or enquiry service • Telephone conferences
	Computers with related applications (including CD-ROMs)	• Multimedia sound (audio files) • Voice communication
Video	Television Broadcasting (terrestrial, satellite or cable, digital or analogue transmission, including narrowcast educational television)	• Video programmes (music, talk shows, documentary, literature review, lecture, panel discussion, news, current affairs, debates, game shows, drama, films etc). • Lectures • Simulations of procedures and processes
	Video cassettes	• Video programmes as above • lectures
	Video discs	• Video programmes as above • Instructional material (for examples, art pictures or biological photographs)
	Video conferencing	• Video conferences (with two way audio and video or one way video and two way audio) • Point-to-multi-point classes with interactive video and audio
	Computers/Internet	• Videographics • See-You-See-Me Conferences
Integrated multimedia	*Stand-alone* Computer-based workstation, CD-ROM/ DVD, CDI, etc	• Presentation of information/knowledge • Simulations • Interactive exercises and assessment

Medium	Technologies for Delivery	Educational Applications
	Networked Linking Computer-based workstation, CD-ROM/DVD, or Set-Top Boxes to public (Internet) or private (Intranet, LAN, WAN) networks	• Presentation of material and/ or resources integrating all above media (text, audio and video) and possible applications • Simulations • Assignment submission, assessment and feedback • Conferencing data, audio, video

The above grid is complicated by rapid convergence in both form and functionality of many information, communications, and broadcasting technologies. This convergence, however, reinforces the importance of distinguishing between technology and medium, particularly when trying to understand potential educational roles for different technologies.[2] Communication technologies are the means of delivering media messages. Using a simplistic analogy, the technology might be considered to be the type of pipe used, while the medium (or media) is the form of the substance (or combination of substances) flowing down the pipe. Thus, a key criterion in assessing the potential educational value of a particular technology is to understand which medium – or combination of media – can travel down the 'pipe' under evaluation and in which directions it can travel. This understanding can then be related back to predetermined educational goals and objectives in order to determine whether or not a specific technology can be used to support or enhance an identified teaching and learning environment. Naturally, this process will need to take into account financial constraints and cost-effectiveness.

USING TECHNOLOGIES TO SUPPORT EDUCATION

All education and training involves processes of communication between an educational provider and learners, and it is essential to develop an understanding of the modes of communication most appropriate to a particular teaching and learning process. Those deciding to use technologies to support education need to understand the nature of the communication between educators and learners in order to seek ways to support and enhance these processes. Any teaching and learning process consists of combinations of different modes of communication, which in turn support the teaching and learning strategies and activities of a particular course. This communication can either be one-way or two-way, depending on need. Communication can take place in various ways:

- Face-to-face, for example, in classes, tutorials, or practical sessions;
- Via correspondence, whether it involves post, courier, fax, or electronic mail;
- Using printed media of various kinds, which can either be distributed via correspondence or in face-to-face sessions;
- Using audio such as radio, audio cassettes, telephone calls, or audio conferencing;
- Using video, for example, one-way broadcasting, video, or video- conferencing;
- Using computers and computer-based multimedia, whether they be stand- alone or part of a network.

Making decisions about technologies always requires a clear understanding of the varied teaching and learning environments it aims to support, as well as their potential functions. There are three broad applications for technologies:

[2] In chapter seven, we describe what is meant by convergence of technologies and focus the chapter on the implications of this for a dedicated educational broadcasting service.

1. *Technologies to Support the Educational Provider*
   Technologies have a crucial role to play in supporting the educational provider itself, particularly in its day-to-day management and administration. Regretfully, however, this important use is often neglected, both in policy statements and in the deliberations of people planning the use of technologies to support education and training.

   While some technologies, such as telephones and filing cabinets, have long been used for these purposes, there is a growing understanding that the rapid development of information and communications technologies provide significant opportunities for generating savings in this area of education and training and also for leading to more effective management and administration systems. For example, the growing use of databases and information warehouses, together with the explosion in the use of e-mail to facilitate quick, cheap communication are two relatively simple applications of such technologies that can prove very cost-effective.

2. *Technologies to Support Delivery of Resources*
   A crucial role that technologies can play in supporting education and training is to support the delivery of educational resources, particularly course materials. These technologies are made up predominantly of the wide range of information and communications technologies, from the printed book and other printed materials through television and radio to multimedia computers and the Internet.

   A defining characteristic of such applications of technologies is the implicit requirement that this will demand some investment in course materials design and development processes. Thus, the technologies covered by this group would not only support delivery of resources by making these available to students, but also support course materials design and development processes. For example, the technologies required for printing books – as well as the technology of the book itself – are necessary to make these resources available to students. Behind this, however, lies increasing use of computers – word processors, graphics programmes, desktop publishing – that support the development of the printed resource. Both the development and distribution of resources should, therefore, be considered when making investments in this area.

3. *Technologies to Support Teaching and Learning*
   Provision of course materials is an important part of the teaching and learning processes in all education and training, whether face-to-face or at a distance. In addition, however, there are many technologies that might support other teaching and learning processes. Some of these can be used generally in any education and training programme, such as white boards or overhead projectors, while others might be referred to as specialist technologies, such as woodwork equipment or language laboratories. Again, the technologies covered by this group ranges from the very simple, such as pen and paper, to the very sophisticated, such as computerized simulators.

   Convergence in the functionality of technologies is blurring the roles of technologies that directly support teaching and learning processes and those that support provision of course materials. For example, educators may use video conferencing both to deliver pre-designed resources and to support live discussion between geographically separate groups (or to deliver live lectures). Likewise, e-mail can be used to support communication amongst educators and learners, as well as to deliver pre-designed resources.

CHARACTERISTICS OF DIFFERENT MEDIA

In this section we explore some of the characteristics of specific media. Each medium has different strengths and can complement other media to exploit these strengths and overcome potential weaknesses. Below is an introductory explanation of the nature, characteristics, and potential educational applications of each medium. Following this, where appropriate we have described and contrasted the technology options for delivery focusing specifically on radio, television, and, to some extent, computers.

FACE-TO-FACE CONTACT

Face-to-face contact has long been the cornerstone of educational practices and mediated learning experiences (to the point that many people now unjustifiably use it as a yardstick for measuring educational quality). This type of contact allows for immediate interaction between educator and learner and between learner and learner. The educational purpose of a face-to-face contact session, the way in which it is designed, and the number of learners and educators involved, influence the nature of this interaction, as do the personalities of the individuals involved. Compare a lecture delivered by a single educator to a large audience with a facilitated group activity in which learners engage with each other in small groups. Each has very different purposes, and hence allows for very different educational experiences.

Face-to-face contact enables individual interaction between educators and groups of learners and, in some instances, between individual learner and educator. It also allows learners to be taken to different locations where the learning experience is designed around the immediate environment of the group. Field trips and excursions are examples of such educational applications. Its strength, when employed effectively, lies in the nature of human interaction. Social interaction, which is frequently beyond the scope of course material, is possible during contact sessions. Both social interactions and related learning experiences can be monitored while sessions are in progress, and instructional design adapted immediately where necessary. Potentially, both learners and educators can read how a situation is progressing, and choose to intervene during the session. Face-to-face contact allows educators to monitor moods, participation, attendance, and levels of engagement with relative ease.

Increasingly, however, extensive face-to-face contact is coming to be viewed as an unnecessary luxury due to its expense. This has been further influenced by the tendency of many educators to use face-to-face contact to communicate the curriculum to learners, a use for which it is ill suited both educationally and financially. Consequently, many traditional face-to-face institutions now seek to use distance education and resource-based learning methods to overcome some of the more inefficient uses of face-to-face contact. Many distance education methods seek to emulate or replicate this medium by using combinations of other media and a selection of technologies to replace some of the traditional functions of face-to-face contact.

TEXT

The term 'text' is commonly used to refer to scripted words and other related signs like numbers.[3] For the purpose of this discussion, however, text also includes graphics such as pictures, charts, diagrams, and maps. It is often debated whether text or face-to-face contact has been or is the dominant teaching medium, which has the greater influence, and, which is the most effective. Such debate erroneously protects one medium at the expense of the other, thereby ignoring the individual strengths and complementary nature of different media.

Various technologies can be used to facilitate textual media communication between learners and educators. For example, an educator may write a note on a chalkboard, course design teams may develop printed study guides for learners to read, learners may type or write assignments, and both educators and learners might participate in e-mail discussion lists. Text has many applications. To name but a few examples, it can serve as a record of activity, as a source for detailed explanation, as a reference for a summary of key concepts, or to support correspondence (including post, facsimile, courier, and electronic mail).

Text can precisely represent facts, abstract ideas, rules, principles, and detailed, lengthy or complex arguments. It is good for narrative or story-telling, and, in the hands of a skilled writer, can lend itself to interpretation and imagination.[4]

Technologies for Delivering Text

Text can be delivered by using print, facsimile or computer technologies (including e-mail, databases, web sites, or on CD-ROM).

Print[5]

Print could be said to be the foundation of all education. More than 85 percent of distance education programs use print either as the main delivery technology for courseware or in conjunction with other media and technologies. The importance and quality of print have increased as ready access to relatively low-cost desktop publishing and on-demand printing technology has eased the tasks of preparing, updating, and revising textual and graphic materials. As with computer technologies, printed materials can take a number of forms – newspaper supplements, one-page letters or circulars, posters, booklets, workbooks and textbooks – the full range of which has been presented in the table above. We describe some educational applications of newspapers, textbooks, and workbooks below. Many of the points made for print technologies describe educational concepts, rather than ideas specific to print only. For example, it is quite conceivable to have Matriculation revision guides that are available on the Worldwide Web (and not just in newspapers or booklets), or to have a wrap-around workbook that is contained on a CD-ROM rather than developed as a printed booklet. It is nevertheless useful to spell out these educational applications, as they serve to illustrate how a range of technologies can be used to do similar and complementary educational functions.

Special supplements or regular items in *national newspapers* – sometimes in conjunction with radio and other mass media – have often been used in large-scale education systems

[3] Bates, A. W. (1995). *Technology, Open Learning and Distance Education.* London: Routledge, p. 116.
[4] *ibid*, p.119.
[5] This description of the educational applications of print has drawn extensively from the Southern African Global Distance Education Network web site. http://www.saide.org.za/worldbank/Technology/print_recorded/tech_print.html

(and distance education programmes in particular) in such subjects as health care and rural development or in national in-service teacher training programs. Using newspaper distribution networks is often the most cost-effective way of getting educational material to large numbers of readers. Newspapers are also used as a vehicle for communication and contact between and among students, course developers, tutors, and instructors, while in-house student newspapers are sometimes used to provide general information on an institution's courses. In South Africa, educational newspaper supplements are common, with most large national and regional newspapers carrying an educational supplement on a regular basis.[6]

Most schools and tertiary education institutions make use of *textbooks*. These are written for classroom use, as well as for independent study and reference purposes. Some textbooks are written in a personal style, including self-assessment questions and review tests or questions at the end of each main section or chapter. Where textbooks are to be used for independent study, they often need to be complemented by a study guide or course guide with commentary and notes. Some online courses based on a 'wrap-around' model use standard textbooks or course readers (edited compilations of articles) as a basic resource, giving online guidance on which sections, chapters, or articles to read for later discussion through the conferencing system.

Modular units or workbooks are written for independent study by the course designers or instructors, and tailored to the course and students. They are generally written in a personal style, as if the writer was speaking directly to a student (a 'tutorial in print'), and are structured so that the student's reading corresponds to the agreed study schedule for the course (each unit might correspond to eight hours' work or a week's work, for example). A well-designed unit contains explicit study objectives, a clear table of contents, a glossary of any new or technical terms introduced, completed examples, and many in-text activities, such as exercises and self-assessment and review questions. Students may be encouraged to annotate units with their comments and answers to exercises and quizzes, and then compare their responses with model answers or instructor's comments at the end of the unit.

Computer Applications[7]

Most computer applications make extensive use of text. The written word is used for instructions, entering data and presenting most information. Two computer applications that are frequently used in tandem and are primarily text-based are *online services* and *databases*. Online services play an important part in education, including subject-related databases and library services, online access to information about courses, and links to administrative services such as registration and fee payment. Increasingly, however, personal computers with web browsers have become the most common mode for accessing online services.

Another is the hypertext protocols used for web-sites. *Hypertext* and the *Web Hypertext* is a protocol for linking parts of documents to other documents or to parts of other documents.

[6] Soul City and Yizo Yizo – recent South African educational broadcasting interventions – have used newspapers to distribute accompanying print materials. The Weekly Mail and Guardian includes a regular supplement called *The Teacher* for South African teachers. The Learning Channel Campus distributes Matriculation support and revision materials for school students via newspapers like the Star and the Sowetan, and makes duplicate consolidated newsprint packages for distribution through other networks. The Media in Education Trust has used similar methods, particularly for materials directed at teachers on Curriculum 2005.

[7] This description of the educational applications of computer based technologies has draw extensively from the Southern African Global Distance Education Network web site. http://www.saide.org.za/worldbank/Technology/

Clicking on a 'hot spot' in a hypertext document activates a hypertext link in the underlying software, taking the reader to the linked item. These items may be text, audio, graphics, or video documents – separate files coded in hypertext mark-up language (HTML). HTML files are read by a Web browser, a mouse-driven software interface. Writing text-based course materials in HTML is no more complex than using a word processor. The hyperlinking function allows a course developer to build interactivity into courseware, presenting students with options and paths to follow depending, for example, on their interests or on the answers they give to self-test questions.

Electronic mail also makes extensive use of text. It is a form of store-and-forward computer-based messaging that enables a user to send text messages from a personal computer over a data network (such as the Internet) to one or more recipients. Recipients collect messages from their 'mailbox' on a central server, using their own personal computer or workstation. Access to e-mail is becoming widespread in many countries, through institutional and corporate networks or Internet service providers. As network bandwidth and personal computer processing power increases, so does the ability to attach files to email messages, ranging from formatted documents to sound and graphics or even video files. E-mail can be used both for one-to-one and one-to-many communication (through e-mail distribution lists) and thus can support group interaction. For example, a tutor can use e-mail to easily send the same message to every student in a group, and a group of students can use e-mail to work together on an assignment.

Communication Technologies

Much of the discussion above has related to choices about how text-based material is distributed. Often this choice is based on the levels of interaction required between the recipient and the sender. The communications technologies used to support interaction are frequently divided into two broad categories:

- Asynchronous (or deferred-time) technologies, which do not require participants to be present simultaneously. Examples include postal correspondence, electronic mail, and computer conferencing.
- Synchronous (or real-time) technologies, which require participants to interact at the same time, generally prearranged. These technologies include telephony, audio-conferencing, audio-graphic conferencing, videoconferencing, and multi-user object-oriented environments (MOOs).

This is an important conceptual distinction for making decisions about which technologies to use to support educational processes - it will be returned to when considering technologies for delivery of audio and video media.

AUDIO

One of the primary ways in which humans communicate is by using sound or audio. As communication plays a fundamental role in education, it is not surprising that audio is a key component of many educational initiatives. To illustrate, conversation, debate, counselling, and lectures all use this medium frequently.

Bates attests that a great deal of the educational use of audio centres around the human voice. A great advantage of listening to a voice is that it can be modulated, in other words, the voice can vary in pitch, intonation, pace, volume, and emphasis. Of course, audio resources can make extensive use of music and sound effects as well as human voices. Thus, 'audio is

possibly the most undervalued of all media. Audio technologies are cheap, easy to use, accessible and generally educationally effective'.[8] Audio resources are effective for supporting communication skills and for explanation of concepts. They can be used in combination with other media (such as text, graphics, or video) to provide multi-sensory input, and are important for teaching appreciation of music or identification of sounds. Audio can also be used to create a specific mood or atmosphere. Pronunciation and language skills can be supported. In all these instances, though, audio resources, especially when transmitted via radio broadcasts, are transitory.

Several underlying assumptions exist about audio resources. One of the most important – and abused – is that audio resources assume homogeneity among listeners. On this basis, many developing countries have developed audio resources (distributed via radio broadcasts) as part of a strategy to democratize distribution of educational materials or correct bias towards urban areas and middle class schools.[9] This democratization argument is very powerful, but essentially erroneous. While it may be possible for distribution to be democratized through broadcast, distribution is a quantitative entity. It does not follow logically that educational impact, a qualitative and far more complex phenomenon, will necessarily be similarly democratized or distributed. Audio resources have differing abilities to support interactive learning. Unless interactivity is intentionally part of the instructional design of a resource, it is not likely to be implicit to it.

Audio resources have real potential to assist children with developing communication and language skills through practice. There is, however, some concern about whether or not these resources can do anything more than simulate a conversation between 'tape teacher' and 'tape student', and whether or not synchronous use of radio broadcasts promotes active learning by that student.

Audio resources have also been used successfully with early childhood development learners and foundation phase students. In some examples, resources used auditory stimulation to encourage exploration and development of other sensory experiences and awareness. This form of stimulation can potentially create any environment in a listener's mind, because it relies on the power of imagination and creativity of scriptwriters, listeners, and caregivers. Like most effective use of educational media, audio is best used in combination with other media.

Technologies for Delivering Audio

Audio can be delivered using radio, audiocassette, music/audio compact discs, or computer applications. We focus on the former two options as the latter are discussed under integrated multimedia.

Radio

Dubbed 'the most accessible technology in terms of cost and comprehension', *radio* has been used in education ever since it became available. It has been used for school broadcasts, in-service teacher support and training, and adult literacy and basic education campaigns. In combination with tutorials, print materials, local listening groups, and face-to-face meetings, radio has been used in many countries to teach a wide range of subjects at the school and

[8] *ibid*, p. 138.
[9] Olsson, M.(1994). *Institutionalising Radio Science in Papua New Guinea: A Response to teacher demand for interactive radio instruction.* Washington: LearnTech.

college level. Several large distance teaching universities in Britain, Indonesia, Spain, and Thailand use radio in many of their distance education courses. Now that audio-cassette recorders are more widely available, educators can more easily compensate for the ephemeral nature of radio broadcasts and its fixed transmission times. Where students have access to telephones, phone-in discussion programmes can help to overcome the one-way nature of radio broadcasting.

Audiocassettes

When audio materials are recorded, they provide significant educational advantages over radio. Audiocassettes are less glamorous than technologies such as the Internet, or television but, as an educational technology, potentially have a more positive impact on learning processes than radio. As a technology, audiocassette recorders give educators and learners the power to record audio resources for asynchronous use. Teachers and students can also purchase complete sets of programmes, which would have added advantages of being well organized and clearly labelled. Use of recorded audio resources allows learners greater control over the duration of the listening-learning process, as well as its frequency or quantity.

Recording radio broadcasts is not a simple process. The type of equipment available in the home or learning and teaching site such as a school (separate radio and tape recorders are less effective for recording than combined radio-tape players), the skills and coordination required to record radio broadcasts, and storage and cataloguing of recordings impact on this process. Provision of cheap, efficient, and coordinated distribution of audio resources by a broadcaster is one way of simplifying the process and encouraging asynchronous use of audio resources.

Audiocassette recordings of radio resources do, however, differ in style and educational effectiveness from audio resources intended for individual use as part of a course. Students have, for example, reported that course-based supplementary audio materials were more helpful than radio-based learning materials intended for broadcast use.[10] Audiocassette resources and associated technologies provide students with stop-start and review facilities, while teachers can exploit opportunities provided by 'the hidden nature of the next part of the tape to be played'.[11] Replay and pause facilities have been found to be effective for analysis or revision-type learning activities.

In combination with print materials, audiocassettes allow for simultaneous audio and visual stimulation, while students can move between media at their own pace. This flexibility is important in resource-based learning and learner-centred education. Use of audiocassettes also allows students and teachers the opportunity to leave their hands and eyes free. Bates lists the following advantages of using audiocassettes as learning materials:

- To analyse or process detailed visual material…The purpose of the cassette is to 'talk' students through the visual material;
- To enable students through repetition to obtain mastery in learning certain skills or techniques (e.g. analysis of language, language pronunciation, analysis of musical structure and technique, mathematical computation); and
- To analyse or critically review complex arguments, or carefully structured logical arguments.[12]

[10] Bates, A. (1984). *Broadcasting in Education: An Evaluation.* London: Constable
[11] *ibid*, p. 205.
[12] *ibid*, p. 248.

A variety of formats and styles is available to producers of audiocassette resources. The traditional format of audiocassette resources is the 'Reith Lecture', where an eminent person presents a series of lectures on cassette. Other possibilities include: 'talking' students through a learning process; music; synthesized sound special effects; naturally occurring events; the cacophony of sounds on streets; extracts from political speeches; recordings of sports and dramatic events; or the voices of ordinary people participating in a panel discussion, radio talk show, or phone-in. Educational audio programmes can use music, talk radio, documentary, literature review, lecture, panel discussion, news, current affairs, debate, drama and other common formats.

The educational value of audiocassette resources is dependent on the extent to which they encourage interactivity. For example, a 'tape teacher' or sound special effect can encourage (cue) students to practise pronunciation, translation, grammar, or to turn the page of a printed text. This supports communication and language skill development. If instructionally designed to do so, audiocassette resources, can encourage students to summarize in written form what they have heard, thereby reinforcing mastery of verbal and written literacy skills.

Audiocassette resources have also been used with secondary school students, to present different points of view of a range of people. They can be used to familiarize students with an argument or even a story or play. They provide a useful way of showing students how course materials are linked to events occurring in the wider society. If audiocassettes include a commentary about an event or experience, they can be useful in motivating students and allowing them some opportunity to experience an unfamiliar event emotionally.

Audio resources are effective for supporting communication skills and for explanation of concepts, stimulation to encourage exploration, and development of other sensory experiences and awareness. This form of stimulation can potentially create any environment in a listener's mind, because it relies on the power of imagination and the creativity of scriptwriters, listeners, and caregivers.

After print, the humble audiocassette is the most widely used technology in distance education, in both single- and dual-mode institutions.[13] Audiocassettes are cheap to produce and distribute, can be listened to almost anywhere, and can be easily re-used. In arts, science, and technology courses, they can be used in conjunction with print materials (diagrams, illustrations, photographs) to provide 'audiovision,' with an instructor or expert providing commentary and guidance as the student views the material. The educational potential of audio in such subjects as drama, poetry, and music is self-evident. Audiocassettes can provide instructions for hands-on manipulations or procedures ranging from carrying out a home experiment to learning to use computer software. They can also personalize a print-based education course, enabling the student to hear the instructor's voice as he or she explains concepts developed in the print materials.[14]

VIDEO

Video has a wide range of potential educational applications. It is a good medium for providing students with an opportunity to view that which they would not usually experience (for example, the inside of an aeroplane cockpit). Video can be used to show text and

[13] Southern African Global Distance Education Network web site. www.saide.org.za/worldbank/Technology/
[14] *ibid.*

graphics. It can also be used to show a lecture or presentation, often referred to educationally as a 'talking head'. A person can be shown talking about a subject, and this presentation could either be broadcast live, pre-recorded, or combine live and pre-recorded material. The latter might mean that a presenter could show lecture aids, such as notes, diagrams, charts, or photographs while talking through explanations or complementary commentary. Video clippings of processes or events might also be included in such presentations. Video can also show what is being explained, as it happens in the 'real world'. Video can be particularly useful educationally for showing movement or procedures. It is a good medium for actualization, visualization, and story telling.[15] While video is often criticized for being ephemeral and fleeting, this can also be viewed as its strength. A good story can be presented without interruption, gripping viewers and enabling them to see processes played out over time. When used on videocassette or computer, video can be interrupted and reviewed at will. Nevertheless, it can be viewed continuously, presenting a set sequence of events in an appealing and entertaining manner.

Video can be used to capture and reflect on student performance. For example, teachers could learn by seeing themselves in the classroom, actors or sports players can reflect on their performance, while students might improve their presentation skills by seeing how they come across on camera. With a video camera, students can produce videos, using this to present an assignment or to share an experience with other students. Although the above uses of video may be regarded to be the domain of small and expensive educational courses or programmes, this need not necessarily be so. Snippets of material developed in the above ways might quite conceivably be integrated into video resources that are broadcast via television or distributed on videocassette.

One way in which the educational impact of video resources can be measured is to examine impact on student and teacher interactions. In South Africa, a typical student-teacher interaction is authoritarian, rigidly structured, and does not invite flexible or challenging interactions between teacher and pupil,[16] although ironically, it is these latter types of interactions that are necessary for supporting participatory democracy in society. Educators and broadcasters agree that video makes innovative styles of teaching and learning possible, and shared student/teacher viewing potentially can change the power dynamic between teacher and student.[17] Of course, it can just as easily reinforce authoritarian teacher-centred patterns.

Multi-cultural classrooms are often sites of invisible, but very real, hegemonic struggle for cultural dominance.[18] Thus, for example, the content of a geography lesson on 'farming technology' can benefit from video information on traditional and non-traditional methods of farming with which a teacher may be unfamiliar. Video resources can provide support to teachers within a multi-cultural classroom, and have the potential to challenge often-invisible resistance to alternative viewpoints in a classroom.[19]

[15] Schippers, K. Informal presentation on educational broadcasting, meeting held 16/03/1999. SAIDE.
[16] Donald, D. (1991). 'Children with special education needs: The reproduction of disadvantage in poorly served communities' in Dawes, A. and Donald, D. (1991). *Childhood and adversity: Psychological perspectives from South African research.* Cape Town: David Phillip.
[17] Moses, D. and Croll, P. (1991). *School Television in Use.* London: John Libbey and Co.
[18] Walkerdine, V. (1991). *Schoolgirl Fictions.* London: Verso.
[19] Moses, D and Croll, P. *op cit.*

Video-based learning resources can introduce interesting factors into debates about the merits of literacy versus oral-based learning and cultures. The use of video resources such as archival footage might add to an understanding of the history of a country. Because video resources most often are accompanied by audio tracks, they tend to rely on multiple media to present information that is neither purely oral nor purely literal. In this way, video can show behaviour, nuance, and relationships in a variety of contexts that simultaneously demand oral and literary skills.[20]

The educational impact of video resources depends, at least in part, on the extent to which instructional designers include interactive learning activities for students. Viewers, whether adults or children, do not come to the screen with 'empty minds', but have prior learning experiences that are relevant to how they access and use visual information. In an age where we are expected to receive, process, and discriminate between messages at very high levels, video resources need to challenge what students know and potentially can know. Integrating recognition of prior learning into the instructional design process (especially of television broadcasts) is, however, complicated by the fact that audiences tend to be assumed to be 'homogeneous', while distribution of the message is 'democratic'.

A correlation exists between video comprehension and reading comprehension, as does a cognitive interdependence between viewing and reading skills.[21] Educationally, video's strength is the attractiveness of its content, not its complexity. This is important for developing and using video resources in the classroom. Several international studies have examined this issue, and it is clear that learning from video is only possible if teachers and parents support a young student's learning process. Conceptualization of viewing has changed significantly, to the extent that it is now commonly regarded as a skill that can be taught. Learning from video therefore demands the development of particular skills. One study tested this hypothesis, finding that, if viewing skills are taught to children, it significantly improves their ability to learn from video resources.

Increased demand for visual literacy skills is often used by romantic, 'pro-technology' groups to justify their argument that each classroom must have a television. Certainly, visual displays of information are widespread and growing in sophistication, and clearly children's cognitive development must, by necessity, include development of these skills. Findings from cognitive research support these claims. Today's children draw on visual memories several hundred times more often than their parents, who rely mostly on literal associations. The importance of enhancing visual literacy skills is forcing reconsideration of the traditional schism between logical/verbal/numeric and spatial understanding/manipulation/imagery skills. Visual literacy research suggests a stronger interdependence between these skills, encouraging that both be developed together and not to the other's detriment. As with all other skills, however, the development of visual literacy skills in video resources must be an overt objective of the instructional design process. Simply watching video does not 'automatically' develop visual literacy skills.

[20] *ibid.*

[21] Kelley, P. and Gunter, B. (1996). *Helping Viewers Learn from Television: a new approach to increasing the impact of the medium.* Journal of Educational Media, 22, pp. 23-29.

Technologies for Delivering Video

Video material can be recorded on electromagnetic tape, and replayed using *videocassette* machines. Videocassettes store video in an analogue format. A range of other technologies can also be used for recording and replaying video materials. Video can be delivered via terrestrial or satellite television broadcast, using videocassettes or videodiscs, as part of video conferences, or across the Internet.

Television

Television programmes are far more costly to produce and to transmit than radio programmes, especially if they are broadcast over public networks and expected to meet production standards similar to those of news, documentary, and entertainment programmes. Narrowcast programmes can be produced on smaller budgets, but simply placing a lecturer in front of a television camera and transmitting the results is generally considered an ineffective use of the medium for education (although this approach is widely used in the vast Central Chinese Television University). Television comes into its own in a mixed-media distance education course, used to demonstrate scientific or laboratory experiments, to broadcast field trips, case studies, or performances, and to help visualize dynamic processes and sequences of events. In cultures where television viewing is passive and recreational, however, it can be difficult for students to change their viewing habits and see television as an educational medium. In addition, unless students have access to recording equipment, at home or at local study centres, the ephemeral nature of the broadcast must be taken into account in determining its educational objectives and its place in a structured educational course. [22]

From an educational perspective, broadcast for immediate viewing is subject to several limitations. The most notable of these are:

- Learners are required to gather at a certain place (where a television is) at a certain time;
- Learners have no control over the pacing of the broadcast;
- Broadcasts tend to encourage passivity amongst learners (and strategies employed to overcome this problem inevitably start generating significant additional cost, usually leading to serious financial inefficiency);
- Integrating other media with video broadcast live is very difficult to achieve, and, when applied, very often leads to inefficient use of both broadcast technology (an example of this might be leaving 'dead' spaces to allow students to consult a printed resource) and the medium (this type of integration most often leads to quite boring television); and
- Broadcasts tend to be organized in time packages that are much longer than the time an average student is able to concentrate fully on the television screen.

In summary, it is much easier to develop poor quality than good quality educational television broadcasting. There is a very narrow band of educational applications for video that is accessed by learners via a broadcast signal.

Of course, broadcasts can be recorded using a *videocassette* recorder, thus turning the broadcast infrastructure into nothing more than an alternative distribution mechanism. Obviously, videocassette can also be distributed separate to a broadcast. The major advantage of either recording a broadcast or using a videocassette is that videocassettes can be used when and how people desire. Learners or educators can choose when to screen a video and which sections of it to use. It can be paused, or rewound and reviewed, if desired. This can be educationally useful if, for example, sections of the video (particularly those depicting

[22] This paragraph on television is drawn from the Southern African Global Distance Education Network web site. www.saide.org.za/worldbank/Technology/

movement or procedures) need to be shown repeatedly. The ability to watch and re-watch video can also be exploited by learners using video as part of a self-paced, resource-based learning environment, in which they watch the material in their own time. All of these features facilitate the integration of use of other media into the video-watching experience. In a structured learning site, videos can also be stored for re-use every time a course is run, allowing for effective amortization of costs of many student cohorts.

Videodiscs

Videodiscs perform the same function as videocassettes but operate in a similar manner to CD-ROM discs. A laser beam detects tiny pits that have been burnt into the plastic coating of a disc. Images can be accessed randomly rather than linearly. Videodisc players cost about the same as videocassette recorders, but are not commonly used in South Africa because of the expense of buying discs. In this section we have focused on videocassettes, as these are most widely used in South Africa.

INTEGRATED MULTIMEDIA

Most computer and broadcast technologies allow for the integrated use of a number of different media. The integration of media has, however, also long been a common strategy used in the traditional classroom environment. To illustrate, a teacher might explain a concept (face-to-face contact), while writing notes onto a chalkboard (text). Learners might then watch a television programme (video), before completing a worksheet (text), and discussing their responses in a group (face-to-face contact). Convergence of information, communication, and broadcasting technologies is rapidly increasing the ease with which media can be integrated, as well as allowing for delivery of multimedia resources via common technological platforms. In the above examples, separate technologies of a chalkboard and chalk, a television, and printed material were necessary. Computer technology allows text, audio, and video material to be accessed via a single platform. Furthermore, because all three media can be stored as digital files, they can increasingly be accessed in a number of ways. They may, for example, be stored and extracted directly from electronic databases, accessed via the Worldwide Web, distributed on CD-ROM, or broadcast and accessed using televisions and set-top boxes.

In education, multimedia has come to mean the integrated use, in a computer-based system, of digitized text, audio, graphics, animation, and video to present elements of course content. These elements can be presented in many different ways, allowing learners to choose their own path through the courseware using keyboard or mouse interactions. Developing good multimedia courseware is a highly skilled task requiring knowledge of subject matter, instructional design skills, and familiarity with authoring software. Multimedia courseware may be presented on a CD-ROM for use on a stand-alone personal computer or over the World Wide Web through networked computer terminals.[23]

The readily available and robust Web browser software and tools for Web software development have made it relatively easy to design customized web environments for education and training. These environments may combine courseware resources (hypertext pages, multimedia) and scheduling aids with tools allowing tutors, trainers, and other participants to interact both asynchronously (email, computer conferencing) and synchronously (audio and video links). The environments can be configured in different ways

[23] Southern African Global Distance Education Network web site. www.saide.org.za/worldbank/Technology

to support different types of learning activity (individual, small group, plenary). They can also contain aids for instructors for course design, class management, knowledge structuring, testing, and evaluation.[24]

SOUTH AFRICA'S TECHNOLOGICAL INFRASTRUCTURE

Above we have outlined a range of media and technologies and described in-principle educational applications for these. Decisions about technologies used to support education cannot only be made on the basis of this information, however. South Africa has already invested in technological infrastructure in various ways, and these existing and potentially available platforms must therefor also be considered.

BROAD OVERVIEW OF SOUTH AFRICA'S TECHNOLOGY INFRASTRUCTURE

As has been noted in many policy and research documents, South Africa is in a significantly different position from other African countries concerning use of information and communications technologies (ICTs). The following descriptive analysis indicates this:

> Despite recent progress, Africa remains far behind the developed world in terms of Internet connectivity and usage. For example, it is estimated that 1 in 6 people use the Internet in North America and Europe whereas the comparable figure for Africa, excluding South Africa, is 1 Internet user for every 5,000 people (the figure for Zimbabwe is 1 in 1,100). Even South Africa, with an Internet utilization rate of 1 in 65, is below the world average of one in forty five.[25]

As with all other African countries, the challenges faced by South Africa are a combination of problems shared with other countries and particular problems created by the country's unique history. This is illustrated in the following statistics on telecommunications infrastructure:

> As in many areas of South African life, there is a great imbalance in access to telecommunications services. South Africa is the 14th largest user of the Internet in the world, with state-of-the-art communication systems (including cell phones) in many urban areas. In most rural areas, however, there is very poor service, with many South Africans never having made a phone call. The number of phone lines per 100 people (the teledensity) is 9,5 % overall for South Africa. In some wealthy suburbs this figure goes up to 50, whereas in parts of the Eastern Cape the teledensity is around 0,1.[26]

The challenge of increasing telecommunications density and access in rural areas is common to many African countries, however there is an additional element of restoring equity in a society that has been ravaged by many years of minority rule, which have resulted in a fundamentally skewed distribution of resources and access to technology infrastructure.

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[24] *ibid.*

[25] Tom Butterly, Director of Information Management Consultants in Zimbabwe, provided this information. For more of this report, please see the following *Constraints to the Development of the 'Wired' Economy in Africa*. http://www.nua.ie/surveys/analysis/african_analysis.html

[26] Universal Services Agency, http://usa.org.za/policy.htm.

Nevertheless, the point remains that South Africa has, in certain sectors of society, a reasonably well developed ICT infrastructure. There are: two cellular telephone networks (with a third planned); a terrestrial telecommunications carriers (which has achieved the tele-density outlined above); three public terrestrial broadcasting channels, a private pay channel and an additional private free-to-air channel which started broadcasting in 1998; relatively sophisticated satellite broadcasting infrastructure provided by two companies; and an entrenched culture of Internet use in some sectors of society. In this section we examine the penetration and coverage of these various technology service providers, focusing on broadcasting, telecommunications and the Internet. In appendix eight, we have described each of these technologies in detail and provided an indication of costs for each variation.

Television

Television signals can be transmitted using terrestrial ground transmission, cable, or satellite. As cable is not used in South Africa, it is not discussed here.

Terrestrial television uses radio and microwave techniques to transmit a composite signal of amplitude modulated (AM) pictures and frequency modulated (FM) audio via an antenna which covers a geographical limited area by line-of-sight. A receiving antenna enables the decoded picture signal to be displayed on a television screen and the audio signal through a loudspeaker. The International Telecommunications Union allocates frequencies for terrestrial broadcasting to individual governments, who then reallocate bandwidths to broadcasting corporations. The bandwidth available for terrestrial transmission is, therefore, limited. This has implications for using terrestrial transmission for educational purposes, as educational programmes have to compete for airtime with programmes designed for different purposes.

Sentech describes itself as the backbone of broadcasting in South Africa, as it owns and operates approximately 180 terrestrial transmitter sites, where short wave, medium wave, FM, television and more than 1200 Multi-channel Multipoint Distribution System (MMDS) transmitters are accommodated to serve the various broadcasters in South Africa.[27] Sentech has a network of transmitting stations scattered through out the country. Some transmit FM radio and television signals, while others transmit either one of these or modulated frequency (MF) signals.

Despite these numerous transmitting stations, terrestrial television signals do not reach all part of South Africa. In all provinces, there are areas where no television signals can be accessed. These areas seem to be most dense in the Northern Cape, northern parts of the Eastern Cape and parts of Kwazulu-Natal and Mpumalanga. This map clearly indicates these areas:

[27] Sentech (1999) *Profile of Sentech Pty. Ltd.* p.1.

While this appears rather bleak, as significant geographical areas are without any access to television, when one matches this to the population density in these regions, the picture is more positive. From this comparison, it becomes clear that in most areas that have no access to television services, the population density is less than five people per square kilometre. A small region in the southern part of Mpumalanga, bordering Swaziland, has no access to television services and the highest population density (more than 500 people per square kilometre). Map two in appendix fifteen gives a clear and detailed breakdown of the population density of regions that receive no terrestrial television services. Not all regions in South Africa have access to all television signals distributed by Sentech. The following table indicates the percentage coverage for each television channel[28]:

Television channel	Percentage coverage
SABC2	85%
SABC1	83%
SABC3	72%
Etv	63%
Mnet	46%
CSN	29%

[28] Sentech data as at 1/2/1999.

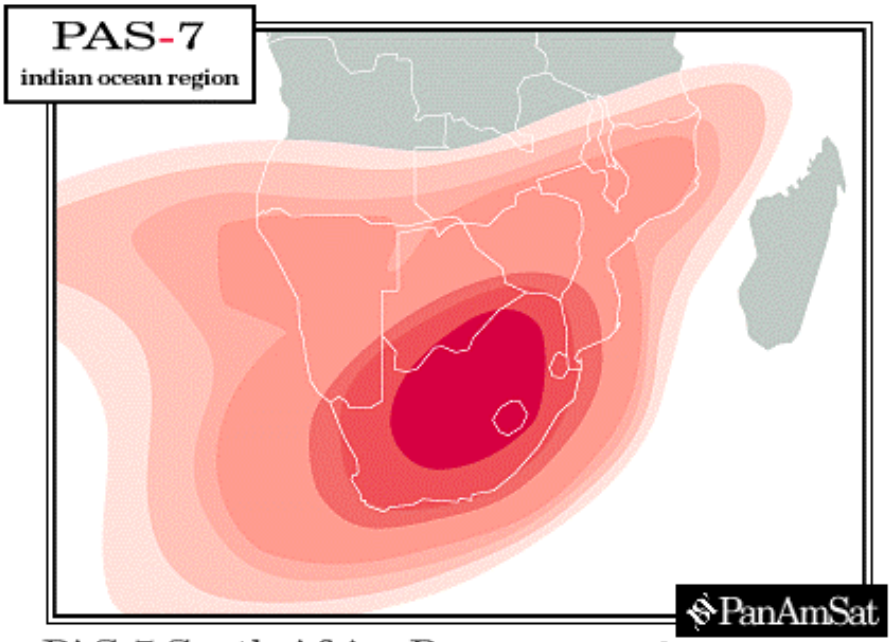
Map three in appendix fifteen gives the geographical distribution of regions that access one or more television services, and maps four, five and six indicate coverage for each of SABC's channels. While South Africa's private pay channel has a limited terrestrial reach (at 46%), it now forms part of the DSTV satellite television suite (as do the three SABC channels) and is therefore accessible to more people in South Africa and the rest of continent. It has between 1.1 and 1.2 million subscribers across 41 Africa countries. [29]

Satellite television makes use of a satellite in a stationary orbit around the earth that acts like a giant mirror. The video signal is beamed up to the satellite by a ground station and then beamed down again over a large geographical area (known as the 'footprint' of the satellite). The satellite signal is received by the parabolic receiving dish of the user. Satellite transmission is limited by the number of satellites available and by available frequencies for transmission. Satellites have to broadcast at frequencies that do not interfere with either terrestrial broadcast frequencies or other satellite broadcasts. As with terrestrial broadcasts, there is therefore limited bandwidth available for satellite television transmission, although this is much larger than that available for terrestrial signals.

Currently there are two main satellite service providers in South Africa: Sentech and Orbicom. The later provides Multichoice satellite uplinking for DSTV, which is broadcasting in digital (MPEG-2) format from PAS 7 using Irdeto encryption. The former provides uplinking for the SABC, as well as e-TV, an independent terrestrial television service. Channels are currently free-to air, but an encrypted bouquet is to follow soon using Nagravision encryption. [30] Eutelsat is another service provider, which covers large parts of Eastern South Africa. [31]

Sentech offers satellite coverage for South and sub-saharan Africa using Ku-Band and C-Band transmission. Ku-band satellite transmissions provide 'direct-to-home services offering a choice of television and radio channels'. [32] The following diagram indicates the footprint for Sentech's Ku-BAND transmission on PAS-7 at 68,5° East. The darkest area has the strongest signal, and the lightest area the weakest. A 90cm antenna will receive a high quality signal in the second darkest area.

[29] http://www.mnet.co.za/annual/index.html. Both figures 1.1 and 1.2 million subscribers are quoted in the Mnet annual report for 1999.
[30] www.sasat.com. South African Satellite TV Information
[31] *ibid.*
[32] Sentech publicity brochure.

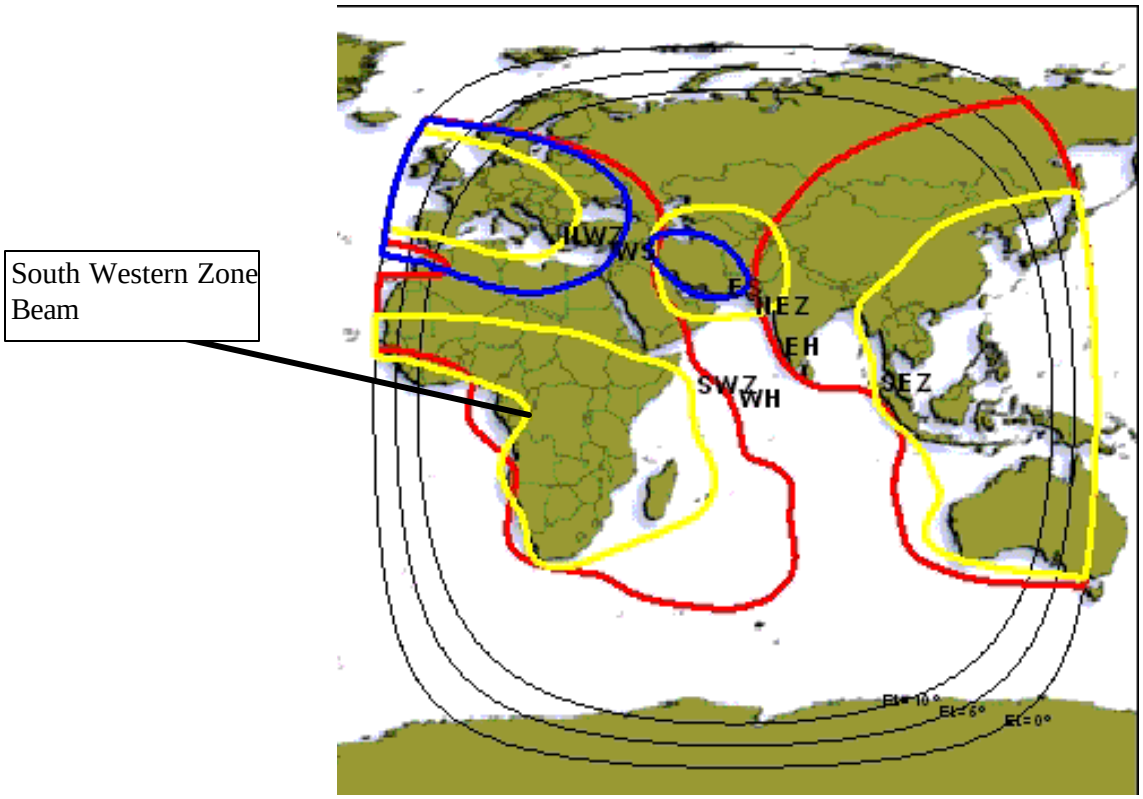


PAS-7 South Africa Beam: Ku-Band
EIRP Levels

Capacity on this band is available on the VIVID MPEG2-DVBS platform and the signal is encrypted using NAGRAVISION encryption.[33]

C-band transmissions are used mainly for 'network linking of television and radio signals to regional input points, using both analogue and digital transmissions'.[34] The following diagram indicates Sentech's C-Band footprint on INTELSAT 602 at 62° East. The footprint is inside the South Western zone beam over sub-Saharan Africa, and is labelled the South Western Zone Beam. In this case, a 3.5 m antenna will operate satisfactorily inside the footprint. The capacity is available on a MPEG2-DVBS platform and the signal is encrypted using NAGRAVISION encryption.[35]

[33] Graphic and explanation supplied by Nic Marais, Manager: Satellite Projects, Sentech, e-mail received 21 October 1999.
[34] Sentech publicity and information brochure.
[35] Graphic and explanation supplied by Nic Marais, Manager: Satellite Projects, Sentech, e-mail received 21 October 1999.



Sentech has several bouquets of channels, both analogue and digital. The digital bouquet on MPEG2 has ten channels, five free-to-air and three encrypted channels. Sentech's Pas7 bouquet includes nine channels, all of which are detailed in appendix eight.[36]

DSTV, on the other hand, has three separate bouquets:

- The basic bouquet has various television channels grouped as general entertainment, movies, sport, news, inf otainment, children, music TV, and free channels, as well as 58 audio channels.
- The commercial bouquet, which requires a separate subscription, consists of seven television and two audio channels.
- The separate subscription bouquet consisting of five tele vision channels, including TeleTuks, and the Shoma Foundation, scrambled education channels, and four audio channels.

These are also detailed in appendix eight. [37]

Radio

Like television, radio can be distributed via terrestrial or satellite broadcast. In South Africa, radio signals are most commonly broadcast terrestrially by Sentech, which offers 'signal distribution for terrestrial sound broadcasting in short-wave, medium-wave and VHF/FM'[38] (frequency modulated) servicing community and private radio broadcasters, as well as the public broadcaster. The SABC has FM regional radio stations for each of the eleven official

[36] www.sasat.com. South African Satellite TV Information
[37] *ibid.*
[38] Sentech (1999) *Profile of Sentech Pty Ltd.* p. 2.

languages of the country. Like television however, this FM signal coverage is not universal and number of areas in the country receive none of these FM language services. The following map indicates the areas that receive no FM radio services. When compared with television coverage map shown above, the patterns are very similar.

When one examines population density figures in regions that have no radio access, once again it is clear that for most of these areas – particularly those in the central and eastern parts of the country – there are fewer than five people per square kilometre. This is shown graphically in map four in appendix eight. Most of the western parts of the Eastern Cape, parts of Kwazulu-Natal, Mpumalanga, and Northern province have population densities of between 81 and 100 people per square kilometre.

Obviously these statistics do not indicate who has access to which radio stations. When considering the coverage for each of the eleven radio stations, it is clear that English and Afrikaans radio services have the greatest reach. Map six in appendix fifteen shows which areas have access to Afrikaans and English services and which can access an African language and English and Afrikaans. It indicates that large parts of the Northern Cape and Western Cape, and isolated areas in North West and the western part of the Eastern Cape can only access English and Afrikaans services. The following table gives some indication of the

radio coverage for each of the regional language radio stations (far greater detail and clarity is evident in the maps 8 A through K in appendix fifteen).

Language	Station	Coverage
Afrikaans	Radiosondergrense	All provinces with numerous gaps particularly in parts of the Northern Cape and western areas of North West
English	SA FM	As above
Isindebele	Ikwezi FM	Most of eastern part of Mpumalanga. Some AM coverage in western parts of North West and Gauteng using Ga-rankuwa and Welgedacht existing AM coverage.
Isiswati	Lingwalagwala FM	Parts of Gauteng, Most of Mpumalanga and sill over coverage to parts of Northern province and North West bordering Gauteng
Isizulu	Ukhozi FM	Most of Kwazulu Natal and Gauteng, with spill over into bordering areas of Free State and Mpumalanga
Sepedi	Thobela FM	Most of Northern province and Gauteng, with spill over coverage into bordering areas of Mpumalanga and north West.
Sesotho	Lesedi	Most of the central and eastern Free State, Gauteng and small isolated areas in Mpumalanga and Eastern Cape
Setswana	Motsweding	Most of North West and Gauteng, some parts of Northern Province, Free State and Northern Cape adjacent to North West.
Tshivenda	Phala Phala FM	Northern and central parts of the Northern Province and part of Gauteng.
Xhosa	Umhlobo Wenene	Most of the Eastern Cape, isolated parts of the Western Cape, North West, Gauteng, Free State and Northern Cape
Xitsonga	Monghana Lonene FM	Central and eastern parts of Northern Province, North eastern areas of Mpumalanga, parts of Gauteng with spill over coverage into north east of North West.

As far as satellite radio transmission is concerned, both Sentech and DSTV offer audio channels on their satellite television bouquets. Recently, WorldSpace has also entered as a satellite service provider in South Africa, 'airing digital satellite radio channels from the Afristar satellite over the entire African continent including South Africa'.[39]

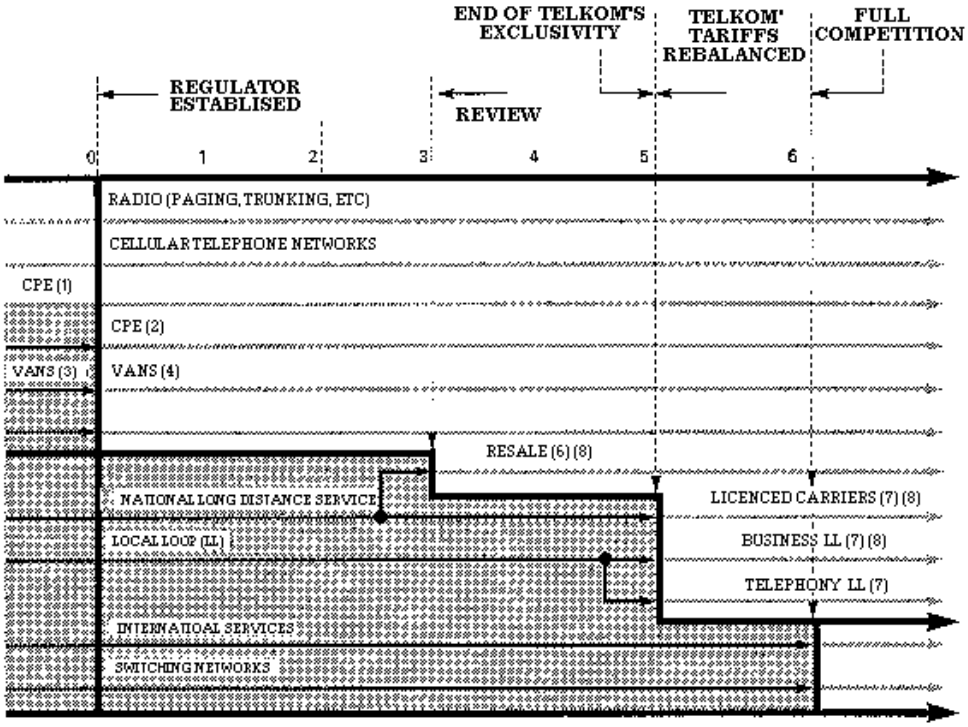
Telecommunications Penetration

South Africa now has official policy and legislation governing telecommunications. Perhaps the most immediately obvious aspect to this policy, which was released in 1996, is that it granted a period of exclusivity to the existing terrestrial telecommunications carrier – Telkom SA – in certain areas:

> Telkom will be licensed to operate the PSTN [public switched telephone network] and the public switched data network (PSDN) for a period of exclusivity with clear-cut contractual obligations and performance criteria, as determined by the Regulator. The rough aim is to install 20 telephones per 100 population by the year 2000, recognizing that this in part depends on demand, which itself depends in part on affordability. Telkom's stated plan to double the existing network and fully modernise it is seen as a viable means to accomplish the universal access/service goals.[40]

The policy does, however, map out clearly how this period of exclusivity is expected to pan out, as the figure below indicates.

[39] www.sasat.com . South African Satellite TV Information
[40] http://www.doc.gov.za/docs/policy/telewp.html.



In addition to this, however, the policy, and legislation which flowed from it, has also established two important new mechanisms. The first is the South African Telecommunications Regulatory Authority, which takes responsibility for regulating telecommunications activities in South Africa, both in areas where monopoly has already been eroded and in those areas reflected in figure two where it will be removed gradually. The second is the Universal Service Agency, which has been tasked with the responsibility of extending telecommunications access in South Africa's historically disadvantaged communities.

In terms of the exclusivity licence granted by the (then) Ministry of Posts, Telecommunications and Broadcasting in 1997, Telkom has the exclusive right to provide

public switched telecommunications services for a period of no less than five years.[41] Part of this licence agreement was the specification of numerous targets that Telkom has to meet in extending its public services and reach. In the first two years of its license, 'Telkom had installed more than 900 000 new telephone lines, including 59 600 payphones'[42].

> The company also provided first-time service to 1 381 villages, installed 7 955 lines for priority customers 9schools, hospitals, local authorities and libraries) and replaces more than 740 000 outdated lines.[43]

These statistics are not particularly meaningful until compared to the targets set in its licensing agreement. The following quote indicates Telkom's rollout of new and modernisation of existing telephone lines in the 1998-1999 financial year and compares this to its targets:

> [Regarding] modernisation of existing lines…the target for 1998/99 was 13 000. Telkom modernised a total of 518 105 lines during this period. In terms of new lines installed, Telkom added another 502 750 to its network during the period under review, as compared to its licence target of 460 000. This means it connected over 1370 new customers every day, bringing the total customer base at the end of March 1999 to 5075 417. We also tool telecommunications services to communities in 920 villages exceeding our license target of 610 by 50 percent.[44]

The following operational statistics give clear indication of the total telecommunications infrastructure provided by Telkom in South Africa[45]:

	1999	**1998**
Main telephone services	*5 075 417*	*4 645 065*
Pay phones	153 476	127 272
Manual exchanges units	*89*	*127*
Total automatic exchange units	3 512	3 019
Digital exchange units	3 388	3 019
Analogue exchange units	124	357
Percentage working lines connected to digital exchanges	92.5%	82%
Transmission circuits (1 000km)	*256 694*	*156 000*
Optical fibre (1 000km)	*360*	*343*

Telkom's exclusivity ends in the year 2002, 'by which time Telkom will have installed and expected number of lines of 7 170 000'.[46]

When compared to global averages of teledensity, South Africa remains below the world average. South Africa has 33.32 telephones per 100 households, while the world average is 39.90. By way of comparison with developed countries, the United States of America and France have 100 telephones per 100 households, while Japan and the United Kingdom have 96.2 and 96 telephones per 100 households respectively. For further comparison, Argentina

[41] Telkom, (1999) *A leaner more effective Telkom hits its licence targets yet again,* Telkom News Desk, 28 May 1999, http://www.telkom.co.za//news/article_160.htm.
[42] Telkom (1999) *Telkom reports to parliament on the first two years of its mandate,* Telkom News Desk, 8 September 1999, http://www.telkom.co.za/news/article_184.htm.
[43] *ibid.*
[44] *ibid.*
[45] Telkom, Operational Statistics for the year ending 31 March 1999, http://www.telkom.co.za/annual_report 1999/pg04.htm
[46] Telkom, (1999) *Telkom SA Ltd In response to the Discussion paper on the definition of Universals Service and Universal Access within South Africa,* Notice 1114 of 1999, Data of submission: 6 August 1999.

and Chile have 54 and 53.9 telephones per 100 households respectively.[47] Despite being below the world average, South Africa fairs very well compared to other African countries, and its neighbours in particular, as the following table indicates:

	Telephones per 100 households	Telephones per 100 people
South Africa	33.32	11.84
Botswana	12.81	4.83
Swaziland	5.80	2.19
Zimbabwe	5.10	1.47
Zambia	2.30	0.94
Lesotho	1.80	0.90
African average	6.10	1.85
World average	39.90	12.88

These national averages for South Africa hide the provincial variation and great disparities between rural and urban areas in the country. The following table summarizes land-line telecommunications penetration by province in South Africa:

Province	Telephone services	Business telephones	Telephones per 100 people	Digital telephone services
Eastern Cape	398 491	117 516	6	92%
Free State	268 005	74 085	10	94%
Gauteng	1 879 478	865 540	24	93%
Kwazulu-Natal	842 255	285 599	9	93%
Mpumalanga	198 118	68 253	7	98%
North West	219 736	60 605	6	96%
Northern Cape	99 509	26 572	11	93%
Northern Province	142 796	50 923	3	95%
Western Cape	1 027 030	345 092	25	90%

From this, it is clear that the Western Cape has the highest telecommunciation penetration per population with Gauteng close behind. While even the teledensity of the Northern Province is above the African average, Gauteng has a teledensity eight times higher than this province.

South Africa also has two GSM cellular network operators, Vodacom and MTN. A third cellular license is also due to be granted soon. It has taken these operators 'less than five years to put more than 2.3 million cellphones in the hands of South Africans'.[48] MTN's 'national coverage currently stands at 600 000 km^2, which constitutes 49% of geographical South Africa and allows 76% of the total population to be within cellular coverage'.[49] The national map of MTN coverage indicates that most of this its coverage is on national roads and urban areas.[50] By comparison, Vodacom's network covers 52% of South Africa's land surface and can reach about 80% of the population.[51] Vodacom 'currently switches 30% of telephone volumes in South Africa and 10% of Africa's (sic). It covers almost 13 000km of

[47] Telkom, *South Afric Information per Province 1999,* Integrated Networking Planning, Network Development plans Telkom SA.
[48] Knott, A Chief Executive Vodacom Group (March 1999) *Case Study of the South African Market,* e-mail received from Ivan Booth, 25/10/1999.
[49] http://www.mtn.co.za/news/pr/pr1198-2.html
[50] http://www.mtn.co.za/coverage/nationalmap.html
[51] E-mail received from, Ivan Booth, 25/10/1999. *Vodacom Fact Sheet - October 1999,* http://www.itweb.co.za/office/vodacom.

national roads'[52] and 'presently has some 2.4 million customers (1.9million active).'[53] This is in stark contrast to original projections of 500 000 Vodacom customers with in the first five years of commencing operations.[54]

Internet Connectivity

Internet connectivity is another key indicator of a country's technology infrastructure. Unfortunately however; 'the art of estimating how many are online throughout the world is an inexact one at best. Surveys abound, using all sorts of measurement parameters'.[55] NUA surveys makes the following 'educated guess' as to how many are online worldwide as of September 1999, on the 'basis of observing many of the published surveys over the last two years'.

Region	Number of people online
World Total	201 million
Africa	1.72 million
Asia/Pacific	33.61 million
Europe	47.15 million
Middle East	0.88 million
Canada & USA	112.4 million
Latin America	5.29 million

As has been noted in the above section as well as in many policy and research documents, South Africa is in a significantly different position from other African countries with regard to use of ICTs as the following statistical analysis indicates. Using the above NUA survey data, South Africa accounts for 92.04% of the Africa's Internet users with 1622 000 people online. Egypt is the next highest African country with connectivity estimated at 40 000 accounting for 2.7% of Africa's people online.[56]

Despite the relatively healthy position of South Africa on the continent and its recent progress in Internet connectivity recent reports indicate that for the first time in five years Internet usage in South Africa is slowing significantly:

> The 3rd edition of the South African Internet Services Industry Survey, released today (23 June 1999), reveals that growth in the number of South African Internet subscribers fell below the 100% mark last year, to 86%. This means that, for the first time since the Internet became commercially available in 1994, the user base did not double over the year. Media Africa, the country's leading specialist Internet researchers, conducts the survey of Internet usage in South Africa every six months. The 3rd South African Internet Services Industry Survey 1999, which has been endorsed by the Internet Service Providers' Association (ISPA), estimates a total number of Internet users in South Africa at the end of December 1998 as 1 266 000. These include dial-up subscribers, corporate users getting access at work, and academic users getting access at learning institutions. Media Africa forecasts

[52] *ibid.*
[53] *ibid.*
[54] *ibid.*
[55] http://www.nua.ie/surveys/how_many_online/index.html
[56] http://www.nua.ie/surveys/how_many_online/africa.html A table of African connectivity estimates for September 1999, has been included in appendix eight. It details the estimates and sources of information for the survey of 52 African countries.

> this overall total to grow to around 1,8-million by the end of 1999 - bringing growth of the total market this year down to 50%. [57]

The decline in growth should not deflect attention from the large numbers of new users that are coming online. Indeed, as absolute numbers increase, percentage growth should be expected to decline. South African Internet Service Providers are fighting for subscribers in the relatively new market of dial-up users which can expect 'at least 220 000 new subscribers' this year.[58] The quotation below offers further evidence of the fact that the country's Internet infrastructure is relatively well developed (although still very skewed socially in terms of access):

> Once again, in the fifth year of the South African ISP industry's existence, at least 20 ISPs continue to command a strong customer base - each with more than 1000 dial-up subscribers. This reaffirms the researchers' rejection of the belief that only the large providers could build up a substantial client base and survive longer than a year or two[59]

NATIONAL INFRASTRUCTURE INITIATIVES

With the above overview of current technology infrastructure and service providers in place, we now turn to reflecting on national systems that provide access to educational technologies in the country. Given the diversity and complexity of South African society, it is simply not possible to provide an exhaustive analysis. Instead, we have selected two key education networks – schools and Multi Purpose Community Centres – to give concrete expression to the levels of technology infrastructure available in sites of teaching and learning in South Africa.

TECHNOLOGY INFRASTRUCTURE IN TWO KEY EDUCATION NETWORKS: SCHOOLS AND MPCCs

SCHOOLS

Most South African schools get by with minimal levels of resources, inadequately trained and few staff, poor quality learning materials, shortages of classrooms and the absence of libraries and laboratories. To many of these schools, technological equipment is an unaffordable luxury.

Until recently the only quantitative data regarding available technologies in schools was the Schools Survey of Needs conducted in 1996. This research was limited in its examination of ICTs, as its brief was to examine all aspects of resource provision in schools. This situation is soon to change as the national Department of Education has commissioned an audit into ICTs in schools. This is being conducted by the Education Policy unit at the University of the Western Cape and will be published in the near future. At the time of writing, this audit was

[57] http://www.mediaafrica.co.za/sisnew.html, *Growth in Internet usage slows down*, Press Release, Johannesburg, 23 June 1999.
[58] Goldstuck, A (1999) quoted in http://www.mediaafrica.co.za/sisnew.html, *Growth in Internet usage slows down*, Press Release, Johannesburg, 23 June 1999.
[59] *ibid.*

not yet published. As such, the data used in this section has been drawn from the 1996 School Survey of Needs and draft (and unconfirmed) data from the audit itself.

Data from the School Register of Need survey indicates the extent of under-resource in schools. It revealed that, in 1996, 83% of the country's schools had no media equipment, 72% had no media collections and no equipment, 68% had no materials, 36% had no or inadequate stationery, and 52% had no or inadequate supply of textbooks. The survey made it very clear that lack of technology infrastructure in schools is widespread, especially in the Eastern Cape and Northern Province. Many schools do not have the basic requirements in place to be able to use new technologies, as in 1996 only 41% of schools had grid electricity, and only 38% had telephones. Provinces with greatest need in schools are the Eastern Cape; Northern Province; KwaZulu-Natal; Free State; and North West.

The table below gives an indication of the number of schools with electricity, exchange line telephones, and two or more computers. Marquard classifies these schools as having 'telecommunications potential', as with very little additional infrastructure, they could have access to the Internet. [60] The table also takes account of the number of learners and educators in each province, in order to give an indication of learner and educator access to technologies. The data has been drawn from the 1996 Schools Register of Needs survey. [61]

Province	Schools	% total	Learners	% total	Educators	% total
Eastern Cape	197	3%	102,063	5%	4,906	8%
Free State	146	5%	74,655	9%	3,254	13%
Gauteng	566	25%	366,721	25%	17,038	32%
Kwazulu-Natal	331	6%	227,553	8%	10,008	13%
Mpumulanga	108	6%	58,853	6%	2,531	10%
North-West Province	101	4%	54,752	6%	2,306	7%
Northern Cape	97	18%	37,105	19%	1,666	23%
Northern Province	23	1%	13,477	1%	695	1%
Western Cape	498	28%	295,999	33%	13,419	38%
TOTAL	**2 067**	**8%**	**1 231 178**	**10%**	**55 823**	**15%**

As has been previously mentioned, the above statistics are from the Schools Register of Needs conducted in 1996, clearly the information, though still valuable, is outdated. The draft findings of the research into ICTs in schools conducted by the EPU reveals that there has been an increase in basic infrastructure across the country since 1996. [62] The survey distinguishes up-front between schools that have computers and schools that do not. Suitable samples were identified for each of these groups and separate questionnaires distributed accordingly. The preliminary results from this survey are encouraging. When questioning

[60] Marquard, S. March 1998, Telecommunications Potential of SA schools as indicated by the 1996 Schools Register of Needs, http://www.school.za/research/srn96.htm. Data on the number of modems per province, collected for the School Register of needs Survey, was supplied to SAIDE by EduSource. Unfortunately these statistics proved to be unreliable and have therefore not been included here. For example, data on Northern Province reflects that in 1996 there were 37 schools that had two or more computers, and 248 schools with modems.

[61] Marquard, S. (March 1998). *Telecommunications Potential of SA schools as indicated by the 1996 Schools Register of Needs*, http://www.school.za/research/srn96.htm.

[62] This data is drawn from the preliminary findings of the *National Survey of ICT Education in South Africa*, as reflected in a first (unpublished) draft of the research report kindly made available by the Education Policy Unit in September 1999. This data reflects a work in progress and is to be still be reworked as a second draft before final publication later in the year. The final report should be consulted to verify these preliminary findings

schools *without computers* (n = 453) on whether of not they had additional resources necessary to house computers, the y responded that, since 1996:

- 48.8% had acquired electricity,
- 44.7% had acquired telephone lines and
- 22.6% had acquired additional classrooms.[63]

These schools (in the *without computers* category) were then asked to indicate which technologies they had available at the school. This tables summarizes the preliminary findings:[64]

	Primary Schools (n=281)	**Secondary Schools (n=101)**	**Combined (n=58)**	**Total Schools (n=430)**
Televisions	18.1	30.7	39.6	23.5
Computers	3.2	6.9	10.4	4.9
Videcassette Recorders	15.3	24.8	33.3	19.5
Radios	8.2	14.9	18.8	10.9
Wind-up radios	2.5	2	2.1	2.3
Overhead projectors	26	26.7	45.8	28.4
Slide & tape recorders	4.3	8.9	8.3	5.8
Tape recorders	16	15.8	20.8	16.5

When asked to choose, from a range of options, for which purpose computers would be used, the most common response from respondents in without computer category was for school administration (36.4%), followed by 27.4% of respondents who chose 'teaching tool' as their first choice.[65]

From the schools *with computers* category (n=962) the following draft data is relevant:

- 44.8% of these schools have 30 or more computers, 44% have between 11 and 29 computers and the remainder have less than 10 computers;
- 59% of schools have computer networks and 50% have a file server;
- 35% of primary schools and 65% or secondary schools reported having Internet access (giving a total percentage across the sample of 41% with Internet access);
- 85% of the schools with Internet access gain access via a modem (dial-up networking) while 3% use an ISDN line and 8% use a leased line;
- The average Telkom costs per school is R398.96, with a high variation (range is R5994) and significant differences between for each province; and
- The ISP costs show similar patterns with an average cost of R493.37 (but a range of R8999 and significant provincial variation).[66]

The following table gives some indication of e-mail penetration in *schools with computers:*

[63] *ibid.*
[64] *ibid.*
[65] *ibid.*
[66] *ibid.*

	None	Less than 50%	More than 50%
Management staff	57%	29.5%	13.5%
Administrative staff	73.2%	16.1%	10.7%
Teachers	47.7%	41.3%	11.1%
Learners	44.1%	45.4%	10.4%

This table indicates that in 57% of schools surveyed management staff have do not have personal e-mail accounts, while in 29.5% of schools less than half of the management staff have personal e-mail accounts and in the remaining schools more than half of the management staff have e-mail accounts. It is read similarly for administrative staff, teachers and learners.[67]

MULTI-PURPOSE COMMUNITY CENTRES

Recent research on Multi Purpose Community Centres (MPCCs) gives an indication of how many such centres already exist in South Africa and their use of information and communication technologies. Responses from 235 MPCCs nationally were processed and analysed, while details of a further 206 centres, classified as 'non-MPCCs', were collated. The draft findings are as follows[68]:

Province	Number of MPCCs	% with telephones	% with computers	% with e-mail
Eastern Cape	54	76	61	20
Gauteng	52	100	94	38
Kwazulu Natal	46	87	37	28
Western Cape	30	97	87	57
NorthernProvince	23	61	35	9
Mpumalanga	9	89	44	75
Free State	8	100	88	13
North West	7	100	86	70
Northern Cape	6	100	67	20
National Total	**235**	**87 %**	**66%**	**30%**

Researchers were surprised by these findings, and were encouraged to learn that there was such a high level of ICT usage. Even in rural areas, 73% have telephones, 47% have computers and 18% have e-mail, and 36% of the MPCCs have five or more computers.

SUMMARY

In this chapter, we have laid the groundwork for understanding media and technologies and their potential applications in detail. We have realized that decisions about using technologies to support education cannot be made solely on the basis of theoretical understandings of the educational usefulness and strengths of the identified technologies. As a result, we have attempted to provide some overview of the technology infrastructure in South Africa. We have focused on broadcasting, telecommunications, and Internet coverage and penetration in order to identify and build on investments that have already been made into these technology

[67] *ibid.*
[68] National Information Technology Forum, (May 1998), *Multi-Purpose Community Centre Research Report*, Benjamin P (Ed), version 3.0, http://www.sn.apc.org/nitf/mpcc. This is a draft report.

platforms. Finally, we have presented a snapshot into the existing technology infrastructure in two key educational networks - schools and multipurpose community centres. With this platform in place, we now turn to a consideration of key lessons that have emerged in the application of different technologies to support education and training around the world.