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Digital Educati...

DEEP IMPACT: an investigation of the use of information and communication technologies for teacher education in the global south

by Jenny Leach

with Atef Ahmed, Shumi Makalima and Tom Power

DFID Department for International Development

DEEP IMPACT: an investigation of the use of information and communication technologies for teacher education in the global south

DEEP Project Team, Open University

2005

DEEP IMPACT: *an investigation of the use of information and communication technologies for teacher education in the global south*

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Comments on this report are welcomed.

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Glossary of Terms

Asynchronous electronic conferencing: A conference/meeting using e-mail or similar software that allows several people to participate by posting messages or other forms of information over a period of time to suit each participant.

Continuing professional development programmes (CPD): Courses offered to serving teachers; these cover a very wide range of needs and purposes. The lengths of courses vary markedly; there may, or may not, be formal qualification at the conclusion of the training.

CD-ROM (compact disc): A computer-storage medium that contains a range of data stored digitally, such as words, graphics and sounds. These can store up to 250,000 pages of text.

CMC: see Computer-mediated conferencing.

Computer-mediated conferencing: Development of electronic mail designed to support many-to-many communication. Each conference comprises users who have a common interest in the conference's subject matter.

E-mail: electronic mail; messages sent and retrieved in electronic form via computers.

Information and communication technologies: Technologies that provide the ability to communicate and send information over space and time. This has become a popular term because of the remarkable speed and capacity with which the new digital technologies can transmit information.

Internet: also known as the 'net'; the intercommunicating computer networks which host and provide access to the World Wide Web, file transfer, e-mail, news and other services.

Open learning: An educational approach which focuses on 'the provision of learning in a flexible manner, built around the geographical, social and time constraints of individual learners, rather than those of an educational institution' Bates (1995)

Portfolio: A collection of work that clearly shows the development of a course participant over the duration of a course or module. These portfolios may include examples of pupils' work and commentaries by other teachers who observed the teacher implementing the activity.

School-based activities: Activities that are carried out in the classroom, in the school or in field-work; they might involve pupils or other members of staff.

School-level support: This occurs when a component is built into an open and distance learning programme that focuses on providing support to the learner within the school itself. It can involve a formal mentoring programme with experienced staff or simply the formation of a study group among teachers at a school.

Short messaging system (SMS): electronic messages sent via cell or mobile phones, also referred to as text messages.

World Wide Web (WWW): or simply the web. A distributed information service on the Internet of linked documents, accessed using a web browser such as Microsoft Internet Explorer or Netscape. On the web, any document can be linked to any other document.

Acronyms

CPD	Continuing Professional Development
DEEP	Digital Education Enhancement Project
DFID	Department for International Development
ICT	Information and Communications Technology
OU	Open University
PC	Personal Computer
PPMU	Programme, Planning and Monitoring Unit
SA	South Africa
SMS	Short message service
UFH	University of Fort Hare

The names of the schools and teachers in the study have been changed.

Executive Summary

The scale of the demand and need for primary school teachers if the Millenium Development Goal of Universal Basic Education (UBE) is to be achieved far outstrips existing provision. The countries of sub-Saharan Africa face particular challenges: over 40 million children of primary school age are without school experience and the numbers are growing. The Digital Education Enhancement Project (DEEP) is an applied research project exploring the ways in which information and communications technology (ICT) can improve access to, and the quality of, teacher education in the global south.* It is focused upon three key research questions:

• What is the impact of ICT use on the pedagogic knowledge and practice of teachers and the communities in which they live and work?
• What is the impact of ICT-enhanced teaching on student achievement and motivation?
• How can teacher education and training be developed to ensure that teachers have the capacity to exploit the potential for ICT?

There is a dearth of research on the application of ICT to teaching and learning in developing country contexts, specifically in the key areas of literacy, numeracy and science at the primary level. In addition there are currently few, if any, examples of planned investigations into how mobile technologies can be used to support teacher education in sub-Saharan Africa. The project's aim is to inform policy makers, educational researchers and others interested in ways in which new forms of technology can enhance teachers' capabilities and improve knowledge and professionalism in the global south.

DEEP was funded by the UK Department for International Development (DFID) and co-ordinated by the Open University (UK), with the University of Fort Hare (UFH), South Africa and the Programme, Planning and Monitoring Unit (PPMU), Egypt. The research was carried out in 12 primary schools in Egypt and 12 in South Africa with 48 teachers (two per school) and involved over 2,000 primary school students. Teachers worked in pairs to implement and evaluate a short, curriculum-focused, school-based professional development programme, using a range of new technologies including hand-held computers. Activities focused on the teaching of literacy, numeracy and science. ICT was used in some significant ways by schools as a whole, as well as many of the communities in which project teachers lived and worked.

The following headline findings are suggested by this study:
• All project teachers in both contexts quickly developed confidence in using desktop/lap-top and hand-held computers for a range of purposes.
• Development of basic computer skills was largely unproblematic.
• The majority learnt to use a variety of digital softwares and other peripherals in a short time frame.
• Frequency and type of use of these softwares and peripherals varied considerably within and between contexts.

ICT use enhanced teachers' professional knowledge and capability by:
• extending subject knowledge;
• enabling planning and preparation for teaching to be more efficient;
• developing the range of teachers' existing pedagogic practices.

All teachers introduced ICT into planned lessons with their classes and there was wide-ranging evidence of positive outcomes.

The majority of teachers were highly motivated to succeed in using ICT for their own and for their students' learning despite numerous challenges:
• Where technical support was scarce, teachers worked to solve the problems.
• Security issues were successfully and pragmatically addressed in a variety of ways relevant to context.

The nature of the uses of ICT varied according to context, particularly with respect to:
• teacher access to adjacent technologies;
• geographical location;
• local educational and cultural practices;
• home language;
• teachers subject specialisms.

ICT facilitated new forms of teacher-to-teacher co-operation.

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* The 'global south' encompasses the following countries:
Africa, Latin America, the Middle East, the Caribbean, Asia and the Pacific.

There was no significant correlation between teachers' prior use of ICT and the ICT-enhanced classroom practices they developed during the programme:
- Some of the most sustained, and effective practice was developed by teachers with no previous experience of ICT and/or no prior experience of using ICT for teaching.

There were more women participants than men; successful outcomes were equally visible for both men and women.

Students in both contexts quickly developed confidence in using desktop/lap-top and hand-held computers for a range of purposes:
- Development of basic computer skills was unproblematic.
- The majority learnt to use a variety of digital softwares and other peripherals (e.g. Word, Calculator, Powerpoint, Internet, E-mail, games, scanner, printer, photocopier, camera) in a short time frame.

Students used ICT to carry out a range of literacy, numeracy and scientific activities and there were the following outcomes:
- Students showed high levels of motivation in using ICT both within and out of lessons.
- A range of achievements, including improvements in literacy and science learning, were reported by teachers, school principals, parents – and students themselves.
- Increase in school attendance was also evident in both country contexts.

The majority of teachers reported using the hand-held computers on a regular basis for a variety of functions, including classroom activities:
- the hand-held's small size and weight meant teachers could have the device with them wherever and whenever they wished, facilitating 'anywhere, anytime professional learning'.

Where mother-tongue interfaces or software were not available this limited the effective uses of ICT for both personal and professional purposes.

Existing cost analyses of ICT use for teacher education in developing contexts are likely to be inflated because they are based on outmoded forms and uses of ICT:
- They should take account of a range of important factors including the significant recent development in cost-effective, powerful mobile technologies.

Educational uses of ICT must be strongly grounded in educational and pedagogic principles, employ quality resources and ensure that professional support is paramount.

Teachers' evaluations of the programme were positive and attrition was low: only one school failed to complete. Within both countries there has already been an active commitment to build on the research: the approach has been welcomed as offering potential for widening opportunities for continuing professional development, as well as laying a strong basis for innovative strategies to address the challenge of poverty. A key lesson from the study is that investment in high-quality programme design and implementation is necessary to realize the potential of new modes of teacher education using ICT.

Outcomes of the study suggest that teacher development should not be isolated from student- and curriculum- focused ICT developments. Forms of ICT, software and associated training should be primarily determined by the purposes and context of use: this means they must be strongly focused on schools and classroom practice. School-based professional development uniquely permits ICT to simultaneously provide the medium, context and content for: teachers' personal and professional development; new and improved curriculum, school and classroom practices; student learning and activity. DEEP provides evidence that teachers and students can quickly develop a range of ICT skills in the process of using digital technologies for curriculum purposes, providing collaborative and peer learning approaches are exploited. This approach challenges conventional views of ICT teacher training (i.e. off-site courses focusing discrete IT skills), as well as more conventional views of ICT provision in schools (i.e. desktop computer suites for the development of individual students' IT skills).

The findings also suggest that such training could be developed to encompass the educational needs of rural communities more broadly. ICT innovations could be looked at holistically, not just in relation to schools and their teachers but also to the needs of communities more widely. Such approaches would help ensure a range of additional benefits such as strong learner support networks, multi-use of costly equipment, consistency in approach to childhood and adult literacy and cross-cutting delivery across the range of Millennium Development Goals.

The study also offers some new parameters around which different models could develop in the future, for example: competition 'bidding in' by schools for a project placement, thus creating a sense of ownership and responsibility; self-help

approaches to 'technical' support; partnerships between educational institutions, crossing national and international boundaries; multi-use of ICT ensuring full exploitation of provision; self-monitoring procedures to ensure security; and private sponsorship of ICT.

Key policy implications raised by the study:
- Policy planning for the development of national systems of teacher education should explicitly recognise the increasingly important role of ICT and its potential for increasing access and improving quality.
- ICT policy and practice must be closely matched to local contexts and needs, with a particular focus on classroom relevance and learner achievement.
- The potential of new, mobile technologies needs further investigation in a wider range of contexts and purposes.
- Further evidence is urgently required as to the way in which new forms of technologies, particularly mobile technologies, can impact on the logistics/costs of ICT provision for teacher education.

In addition to these broad policy implications, the study suggests a number of key principles that determine the quality of ICT-enhanced school-based teacher education in developing contexts:
- personal access to ICT;
- ICT appropriate to local setting and conditions;
- opportunity to integrate ICT activity into daily routines and practices;
- use of ICT-supported peer and team learning;
- focus on ICT for curriculum and classroom purposes, not skills;
- availability of relevant content in an appropriate language medium;
- provision of local, national and international professional e-networks;
- assessment practices relevant to ICT-enhanced learning;
- user evaluations of the relevance of ICT hardware, software and related curriculum uses for learning;
- strong vision of the potential of ICT for learning from national ministries and educational policy makers;
- visible political determination to plan for ICT access by schools and their communities, ensuring synergy across and between adjacent services (e.g. education, healthcare, agriculture);
- research and development that strengthen exemplification of the way ICT can be effectively used by teachers and students, in order that evidence, rather than rhetoric, becomes the authority.

The research study shows that new digital technologies are appropriate for use in the African context. They have the potential to revolutionise the quality of training when carefully integrated within programmes that are pedagogically strong and well supported.

Teachers and schools in poor environments can benefit from the many advantages that ICT is currently affording richer peers, whilst leap-frogging expensive mistakes made in more developed countries. Mobile digital devices, that have to date been largely aimed at the business market, could be exploited by teachers and students for a range of professional and learning experiences. Teachers, together with parents, governors, school principals and community members, have reported that the use of new technologies had positive effects on areas central to Universal Basic Education (UBE), including attendance, motivation and the quality of student learning.

Most significant of all, perhaps, the study suggests that the use of ICT in some of the poorest parts of the world, if well planned and implemented, could have a significant impact on the self-image, confidence and professionalism of teachers. In this sense ICT offers the potential to redefine and enhance the status of teachers within communities and more broadly across the societies they serve.

> **This study concludes that teachers and schools in poor environments can benefit from the many advantages that ICT is currently affording richer peers, whilst leap-frogging expensive mistakes made by more developed countries.**

Chapter 1: **Introduction**

'In poor communities the scarcity of trained local personnel (teachers, health workers, agricultural extension workers) and the impediments they face in accessing vital information and enhancing their skills, perpetuates the low educational attainment… of these communities... .'

(Marker et al., 2002, p. 7)

'[There are]...several regions far from achieving universal primary education and, in the case of sub-Saharan Africa, actually lagging behind... The less developed regions as a whole account for 97 per cent of the 113 million children not in school.'

(OECD, 2000, p. 12)

'Hi
Things are changing bit by bit. Our technology skills are being developed. No one can believe that rural school educators and learners can use computer technology the way we do. We are so confident and we are so proud of ourselves.'

(E-mail, teacher, Eastern Cape)

Significance of the study for teacher education

The Dakar summit[1] of 2000 set an ambitious target to provide primary schooling for all children by 2015. International and national policies have become focused on this key Millenium Development Goal and, although its full achievement remains unsure, there has been important progress in many countries. Equally challenging, however, although much less discussed, is the task of training the existing teachers and recruiting the millions of new teachers required if the goal of Universal Basic Education (UBE) is to be meaningful.

The countries of sub-Saharan Africa face particular challenges if they are to achieve this aim: over 40 million children of primary school age are without any experience of school and the numbers are growing. Four out of every ten primary age children in sub-Saharan Africa do not go to school (UNESCO, 2001); of those who do, only a small proportion reach a basic level of skills. The number of primary school age children in the region grew from over 82 million in 1990 to 106 million by 2000. It is projected to rise to 139 million by 2015 (UNESCO, 2000). These statistics need to be set against another reality: amongst the existing teaching force, in most sub-Saharan African countries, are thousands of unqualified or, by the standards of the day, underqualified teachers. In the last few years HIV/Aids has also begun to impact on teacher supply overall.

Across the region national governments, often supported by international organisations such as the World Bank or national ministries for international development such as the UK's DFID, are supporting teacher education programmes. Nevertheless, policy development in relation to teacher education in many countries, particularly in sub-Saharan Africa, remains weak (see the findings of the MUSTER project: (http://www.sussex.ac.uk/usie/muster). The scale of the demand and need, however, far outstrips the existing provision that is still largely provided via conventional teacher training institutions. School-based models of teacher education will be important in the future to complement existing provision offered by the bricks and mortar teacher training institutions. This has already been acknowledged in both the countries, Egypt and South Africa, in which the research reported here took place. In Egypt the Education Enhancement Programme (EEP), funded by a combination of European Union and World Bank resources, has been extending primary teacher education through new open and distance learning programmes. In South Africa at national level a major review of teacher education was carried out in the mid 1990s. Particular attention was given to non-campus-based provision, particularly distance education (SAIDE, 1995) which, under the policies of the apartheid era, had been primarily provided for black teachers and was of a questionable quality. The Eastern Cape Province (in which this research took place) was and remains one of the most disadvantaged parts of the country. In the mid 1990s over 130,000 unqualified teachers were working in a poorly provided school system. The Imbewu project (funded by DFID) has been providing a comprehensive programme of systems and school-wide improvement comparable to the EEP programme in Egypt, but teacher access to continuing educational and professional development remains limited.

The potential of new technologies for teacher education

The advent of new information and communication technologies has provided a new impetus to research the potential of computer technology in the countries of the global south. A study carried out by DFID, for example, concluded that 'properly deployed, ICTs have enormous potential as tools to increase information flows and empower poor people'(Marker et al., 2002, pp. 4–5). It recommended that governments should 'mainstream attention to the information and communication aspects of poverty and appropriate uses of ICTs in the development process'. This process should include 'providing concise, evidence-based material drawing on research and experience about what works and what does not' (p. 5). Raj Dhanarajan (2001), formerly President of the Commonwealth of Learning, has pointed out that 'if applied with thought, extreme sensitivity and knowledge…[ICTs] afford the means to extend access to education and training to the knowledge-poor, the unreached, the isolated and those who have been ignored for too long' (p. 134). A study of computer costs and other issues in developing countries carried out for DFID by Cawthera (2001) also concluded that 'the training of teachers in the use of ICT in schools is an important aspect of provision which may often be overlooked and under budgeted'. He suggested that in contexts such as sub-Saharan Africa, where there is simply not the capacity to train and retrain the huge numbers of teachers currently required, 'school-based, computer supported teacher training might be part of the solution to this problem. Technology could make teacher training experiences better and shorter' (p. 10).

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[1] A World Education Forum took place in Dakar, Senegal in 26 - 28 April 2000, at which the 'Dakar Framework for Action' declared that education is not only 'the key to sustainable development', but also 'a fundamental human right'. It stated that by 2015 all children must have access to and be able to complete primary education.

In many contexts, however, despite the advocacy to explain the potential of ICT from organisations such as DFID, UNESCO and the World Bank, policy around ICT and teacher education still remains to be formulated. Traditional thinking – that Africa and its people cannot benefit from ICT for a number of social and economic reasons (the `penicillin not Pentium' argument) – maintains a strong hold in many circles. Kofi Annan, speaking in 1999 to the Millennium Assembly, spoke of the 'yawning digital divide', with more computers in the USA than in the rest of the world combined and as many telephones in Tokyo as in all Africa. 'Visions of a global-based economy and universal electronic commerce, characterised by the 'death of distance', he said, 'must be tempered by the reality that half of the world's population has never made a telephone call, much less access the Internet' (OECD, 1999). Yet there are signs of dramatic changes in relation to ICT access, infrastructure and costs within sub-Saharan Africa. The statistics are changing daily. 'In 1999 there were 1.5 billion telephone lines worldwide...while today there are nearly 2.5 billion. In just four years we have added 1 billion lines to the 1.5 billion we had connected in all the years before – and 75% were installed in the developing world' (Utsumi, 2003). Africa now has twice as many telephones as Tokyo and these are becoming used in more sophisticated ways by the day.

Over the last five years mobile phone use in Africa in particular has increased at an annual rate of 65%, twice the global average. Although overall only 6% of the population use mobile phones (compared with 2.8% with land line access), Africa is by far the world's fastest-growing mobile market (Minges, 2004). As Minges says, 'the mobile communications sector has to qualify as one of Africa's success stories' (p. 1). Fig. 1 illustrates this trend.

In the light of such developments, the Declaration of Principles of UNESCO's World Summit on the Information Society asserted in December 2003 that 'ICT now offers the capacity to reduce many traditional obstacles, especially those of time and distance, and for the first time in history makes it possible to use the potential of these technologies for the benefit of millions of people in all corners of the world.' The Plan of Action goes on, 'Everyone should have the necessary skills to benefit fully from the Information Society. Therefore capacity building and ICT literacy are essential. ICTs can contribute to achieving universal education worldwide, through delivery of education and training of teachers, and offering improved conditions for lifelong learning, encompassing people that are outside the formal education process, and improving professional skills.' This vision is distilled into a concrete target (18: 'make available the benefits of new technologies – especially information and communications technologies') within the Millennium Development Goals.

In this context the use of ICT in school-based settings is being seen as potentially more effective in improving standards of classroom instruction than more traditional (often infrequent) modes of face-to-face campus-based support. Given such increases in access, combined with the drop in costs of equipment and connectivity (as commercial exploitation focuses on the value of the use of the equipment and the connectivity, rather than on the equipment and connect costs themselves) it now seems urgent to develop a well-founded experience of the way in which teacher education can benefit from these completely

Mobile subscribers per 100 population
December 2003

Country	Subscribers per 100	2003 growth, %
South Africa		27
Botswana		14
Morocco		19
Gabon		26
Tunisia		116
Congo-Brazzaville		45
Namibia		38
Mauritania		42
Egypt		31
Côte d'Ivoire		24
Senegal		41
Cameroon		54
Africa total		38
Kenya		24
Algeria		212
Ghana		102
Zimbabwe		12
Uganda		53
Mozambique		126
Nigeria		97
Congo		93
Mali		439
Angola		42
Rwanda		38
Zambia		37
Sudan		72

Fig. 1: Mobile phones in Africa (Minges, 2004)

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new means of communication. Creative and radical solutions to the problem of teacher education in the global south need formulating (Moon, 2000; Dladla and Moon, 2002). It seems inevitable that new school- and community-based forms of training will increasingly have to be put in place. Such schemes have the potential to exploit recent developments in communication and information technologies. They can also benefit from the recent experience of creating high-quality, school-based courses – strongly focused on improving classroom practices.

Against this background, the RITES group[2] based at the Open University (UK) has been exploring a variety of different models of teacher education, primarily school-based in nature but increasingly looking to the way in which new technologies, as connectivity in all its forms becomes affordable and accessible, will contribute to addressing the needs of teachers working in highly challenging circumstances in all parts of the world (Leach and Moon, 2002). The Digital Education Enhancement Programme (DEEP) represents one of the more recent outcomes of this exploratory work. It is currently one of the very few examples (perhaps the only example) of a planned investigation into how mobile technologies can be used to support teachers working in the circumstances of sub-Saharan and North Africa. The findings from the study provide therefore an important foundation for policy development and for further research activity on the uses of ICT and teacher education.

[2] Research Group on International Development in Teacher Education across Cultures and Societies.

Chapter 2: **Research Study Aims, Design and Methods**

Study aims and objectives

The aim of this research was to investigate how information and communications technologies (ICT), effectively used, could significantly improve the teaching and learning of literacy, numeracy and science in the primary schools of Egypt and South Africa. The study is one of a number commissioned by DFID, within its theme 'Researching the issues: Globalisation, ICTs and their educational implications', aimed at extending the evidence base of how new technologies can contribute to the Millennium Development Goals.

The objectives of the research were:

- to identify existing literature relevant to the use of ICT by teachers;
- to develop, on the basis of this literature, a framework of strategies and activities for teacher development focused on the teaching of literacy, numeracy and science using ICT;
- to use the generic framework to develop locally relevant professional development programmes for primary teachers in Egypt and South Africa;
- to create a web environment that linked the research sites;
- to identify schools and teachers in each context to participate in and trial these programmes;
- to investigate the effectiveness of the use of the ICT-enhanced activities within the pilot schools;
- to elicit elements of the framework that could be extended and used internationally for other programmes of professional development.

The study was carried out between March 2001 and May 2003, at various locations in and around Cairo, Egypt and the Eastern Cape Province, South Africa by a joint team representing the Programme Planning and Monitoring Unit (PPMU), Egypt, University of Fort Hare (UFH), South Africa and Open University (OU), UK.

The DEEP project

The study proposed that 48 teachers (two per school) in 24 selected primary schools (12 in Cairo, 12 in the Eastern Cape) would follow specially devised professional development programmes that would enable them to integrate a range of ICT-enhanced activities into their teaching of literacy, numeracy and science. The teachers would be supported in these activities by PPMU, UFH and OU staff through workshops and school visits, a range of multimedia resources, as well as through a web environment. The implementation of the programmes, together with an investigation into the impact of these ICT-related activities on participating teachers, students and their communities would be investigated through researcher observation, field-work and monitoring carried out jointly by the partner institutions. The local co-ordinators in Cairo and the Eastern Cape would each be assisted by a small team of specialists at various points throughout the project. This project became known as the Digital Education Enhancement Project (DEEP). The original time scale of the study is set out in Appendix 1a.

The key research questions derived from the study were:

What is the impact of ICT use on the pedagogic knowledge and practice of teachers and the communities in which they live and work?

What is the impact of ICT-enhanced teaching on student achievement and motivation?

How can teacher education and training be developed to ensure teacher capacity to exploit the potential for ICT?

These questions speak directly to the core goals of DFID, the major funder of this study, since they focus enquiry on:
• improvements in the quality of learning in schools and communities;
• educational content, processes and outcomes;
• the basis on which long-term benefits of the research can be built.

The acquisition of state of the art, hand-held computers for use within the programme created two additional, complementary questions:
• What are the benefits of using the hand-held computer in a professional development context?
• What are the limitations?

There is a dearth of research on the application of ICT to teaching and learning in developing country contexts, specifically in the key areas of literacy, numeracy and science at the primary level. It was planned that this exploratory study would lead to a larger and more comprehensive research study covering a number of countries.

Anticipated outcomes
DEEP was established as an applied research project, providing a range of support for teachers; the following assumptions were derived from the research objectives and key questions:
• first, that student achievement and motivation can be enhanced by the effective use of ICT;
• second, that teachers' professional knowledge can, through training, be developed to ensure such improvements;
• third, that whilst due attention must be paid to national and local contexts, the global phenomenon of ICT is creating cross-national understandings about new ICT-enhanced teacher approaches that can bring about improvements in teaching and learning.

Selection of schools and teachers
Schools were selectively sampled in line with criteria jointly drawn up by the project team and project advisers of the participating institutions:

'The school principal must endorse the project and be clear how it will benefit the school.

Each school must nominate a pair of teachers willing to work together. Participating teachers must be:
• *motivated and dedicated to teaching and learning;*
• *enthusiastic about new teaching methods;*
• *keen to find out how computers can help learners;*
• *willing to undertake basic computer training and invest up to 30 hours of time over a one year period to the project (some of this time in the classroom).'* [3]

(DEEP Scoping Paper, 2001)

Project schools and teachers in Egypt were chosen jointly by the PPMU and the Egyptian Ministry of Education from primary schools representing a variety of catchment areas across the governorate of Cairo. Each school chosen had a minimum of one computer plus Internet access, in line with the original research proposal: 'In each country, schools with adequate equipment and connectivity, within a limited geographical area, will be identified to act as trial schools for the research'. Most of these schools served areas of extreme poverty and their teachers had widely varying backgrounds and prior experiences. The UFH team, in accordance with university and provincial principles of equity and entitlement, decided they could not restrict schools from participation on the grounds of limited or no ICT access. Selecting only from the small number of schools already advantaged in this way would make them further advantaged in an educational community where poverty is the norm rather than the exception. A UFH panel composed of three university staff, a member of the Ministry of Education, Eastern Cape Province and two primary teachers accordingly short-listed schools from 91 expressions of interest generated by a local radio programme. To ensure that selected schools reflected local demography, the panel took account of location and type, size and enrolment, as well as infrastructure (e.g. rural/peri-urban; with/without electricity; with/without telephony). Participant teachers were also chosen with regard to a range of age groups and prior educational and ICT experience. Nine of the twelve schools finally selected were without any form of ICT, 50% without telephony and one third without electricity.

[3] DEEP project Scoping Paper, March 2001. This paper was drawn up at a Scoping Workshop held at the Open University, UK; no incentive other than training, nor any promise of ICT equipment, was offered to schools.

DFID

The core focus of the DEEP project was the use of ICT in classrooms and community settings by teachers who were interested in developing their teaching. As a group of teachers actively committed to new approaches to teaching and learning, they were certainly not representative of all teachers in Egypt and South Africa. They were in other ways, however, a highly diverse group in terms of the settings in which they lived and worked, the subjects they taught, their experiences and teaching styles, as well as in their prior ICT experiences. This diversity, we argue, constituted an additional strength of the evaluation data; it gave a more rounded view of their purposes for ICT use, than if we had looked at its use by a more homogeneous group.

Research design and methods
The first phase development of DEEP assumed a close engagement between the research team and the teachers and schools to be investigated. The Open University researchers were already, through previous joint projects, familiar with a range of PPMU and UFH staff, their institutions and the general context. As set out above, considerable thought was given as to how schools and teachers would be selected and an early decision made to focus the research on pairs of teachers and one class in every school. In both contexts, support for teachers and the monitoring of their response and progress was through an agreed joint schedule. At preliminary workshops PPMU, UFH and OU staff worked together on the research design and partners' respective roles; these were reviewed and adjusted locally during each of the periods of formal field-work.

The research aimed to capture trends across the project as they emerged over time. There was also a need (through case studies) to illustrate how the context (what we term 'the pedagogic settings') of the teachers and schools created particular social conditions for professional learning and development. An important aim of the enquiry would be to capture something of the meaning of life in the settings within which teachers were living and working. Our task therefore was to document the processes through which the teachers were introduced to a range of uses of ICT for teaching and learning and then to try and capture the types and qualities of real and ongoing ICT use (if indeed there was any) in their daily working lives.

The research design that seemed most appropriate for such a focus was qualitative survey research. Such an approach can generate a broad range of insights into practice by drawing on as many data sources as possible, including field-based observations, interviews, questionnaires, artefact collection, numerical aggregates of equipment or demographic characteristics (Knobel et al. 2002). We judged that such an approach would allow us to gain the deepest insights and

greatest level of understanding in the time scale allowed. It would also enable us to maximise the number of schools and teachers it was physically possible to research across the eighteen-month research period, given our small and geographically scattered research team.

The data collection encompassed all twenty-four project schools and included data from school principals, project teachers, students, parents and other members of the community. A range of methodologies was used including questionnaires, diaries, interviews, classroom observations (including video) and teachers' concept maps (completed at the beginning and end of the project). Electronic products, together with technically derived 'histories' of equipment use (e.g. lap-tops) were collected, as well as a range of correspondence from teachers and students in the form of letters, faxes, e-mails, message board postings and mobile text messages. The main unit of analysis organising this design approach was the 'pedagogic settings' of project teachers, a concept that is outlined below. Software tools were used to carry out aspects of data analysis. The wide-ranging data provide a unique insight into teacher practice and important pointers to the future direction of research where ICT is an element. Details of the data collection and analysis are provided in Appendix 2.

Conceptual framework of the study

Literature review
A literature review (Appendix 3) on the uses of ICT for teaching and learning (including teacher education) informed the development of the DEEP programme of Professional Activities, as well as the research design. One theme to emerge from this review was that effective uses of ICT have been found, in a range of research studies, to enhance teaching and learning, particularly in the fields of literacy, numeracy and science. McCormick and Scrimshaw (2001) have set out a three-level analysis of ICT impact on pedagogy that has been taken up in other studies:

• ICT can make the process of teaching and learning more efficient;

• ICT can extend teaching and learning;

• ICT can transform the teaching and learning process including the nature of knowledge (p. 37).

Two other ideas arising out of the review seemed particularly important for this study: the complexity of ICT innovations within school and classroom communities (e.g. Bransford et al., 1999; Lankshear, 1997; Venezky, 2004; Knobel et al., 2002); and the central role of teacher expertise (including pedagogic and subject knowledge) in realising the potential of ICT to contribute to learner achievement and motivation (e.g. Vahey and Crawford, 2002; Marx et al., 1998; Cox et al., 2004). The review corroborated the first two assumptions of our study set out above (p. 9), although few research studies specifically addressing teaching and learning in Africa were found.

School-based teacher development
In the initial phase of programme development, the research team drew on its collective experience of implementing and evaluating teacher professional development programmes. The dominant paradigm of teacher education in developing contexts, as indicated in our introduction, locates training within teacher training institutions or study centres – often at a considerable distance from the communities and schools in which teachers live and work. The DEEP partners were interested in new paradigms that focus the process of teacher learning and change within school and classroom practice. Since 1999, for example, the PPMU's Educational Enhancement Programme (EEP) has introduced thousands of primary teachers in Egypt to new teaching approaches through a range of media (TV, print, audio, video, video conferencing and face-to-face training) and school-based Professional Activities (Diab and Leach, 1998). The OU used a whole-school approach in a government-funded CPD programme (Leach et al., 2003) that has trained over a hundred thousand primary teachers in the uses of ICT for subject teaching (literacy, numeracy and science at primary level). The UFH's Distance Education Programme (DEP), has achieved international attention (Dladla and Moon, 2002; SAIDE, 2002) for its school-based approach to teacher development with a strong conceptual emphasis on learner-centred teaching and the school as a 'learning community'. The DEP's Primary BEd. Programme draws particularly strongly on social context – the local environment and human resources (e.g. parents, local experts, local technologies) – as a resource for student learning. Teacher learners within the programme are encouraged to see the teacher's role as varied (e.g. facilitator, assessor, motivator, researcher, evaluator, mediator) but the teacher's overall goal is conceived of as *'change agent'*, a concept emphasised nationally as part of South Africa's education reform agenda. Programme support is provided by *abakhwezeli* (meaning those whose 'job was to keep the fire burning just right so that the food in the pot would cook well'). *Abakhwezeli* are not expected to teach the content of the programme. Rather, they facilitate discussion on issues arising, as well as progress on and implications of the issues explored in the programme. They have a key role to play in motivating teacher-learners in their studies – that is, in 'keeping the fire burning'. The importance of social setting in each of the partners'
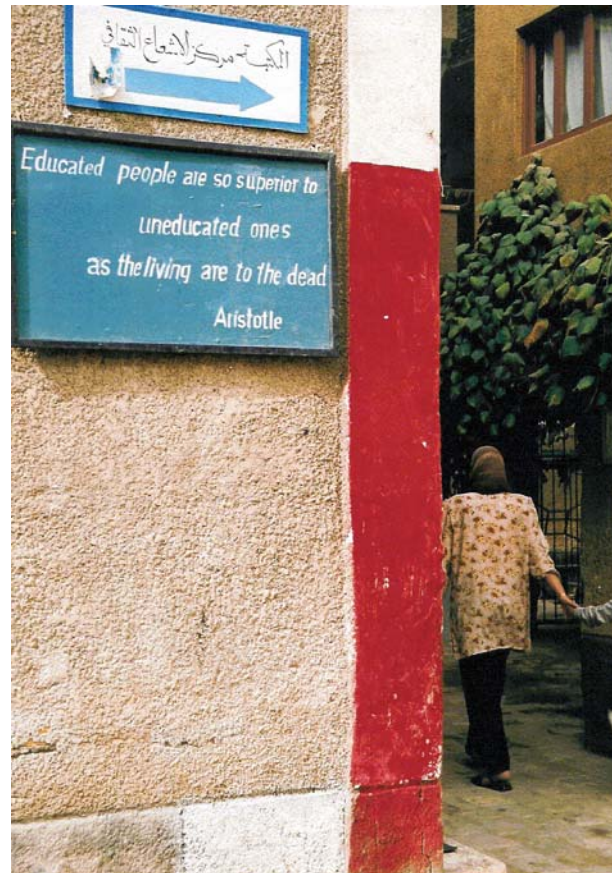
work is therefore emphasised in the following ways:
• teachers' professional identity, knowledge and expertise is seen as developing primarily within the context of local practice;
• the school is the main setting for professional learning;
• course design is built around school and classroom focused professional tasks;
• support mechanisms integrate school-based, peer support.

(Banks et al., 1999; Moon, 2000; Dladla and Moon, 2002; Leach and Moon, 2000a)

Fig. 2 sets out the characteristics of the two paradigms: traditional teacher-focused programme design and school and student-centred programme design, the latter taking account of context; providing opportunities for school and classroom based activity; involving experienced teachers in course design and preparation; and focusing on learning processes, as opposed simply to techniques and strategies.

The project team set out to encompass this situated approach to course design in the DEEP programme of Professional Activities.

Informing principles
Social practice theory (see Chaiklin and Lave, 1993) underpinned the conceptual framework of the research design. Such theory, drawing on disciplines as varied as psychology, sociology, linguistics, ethnomethodology, archaeology, anthropology and ecology (including Vygotsky, 1962; Lave and Wenger, 1991; Bruner, 1996; Engestrom and Middleton, 1998; Sen, 1999; Dobres, 2000; Zhao and Frank, 2003) enabled us to be aware of some of the key factors that make ICT innovations complex.

Fig. 2: Characteristics of traditional vs. school- and student-centred programme design (adapted from Stein et al., 1990)

Inputs to the design process	Traditional teacher development	Student-centered teacher development
Context	Particularities of context not factored into programme. Takes place away from schools, classrooms & students.	Particularities of context play an important role in programme development. Takes place in a variety of locations at least some of which occur in schools and classrooms.
Strategies	Focus on discrete activities, techniques, skills and materials. Dominant format is course materials, assignments, tutorials.	Focus on teaching for understanding and guiding of students' development of concepts. Uses a variety of approaches including the provision of school-based support and scaffolding of teacher participation in a variety of practice related activities.
Views of knowledge and learning	Teacher educators & academics set the agenda. Theories of teacher learning are based on the psychology of the individual. Translation of new knowledge to classroom is a problem to be solved (usually by the teacher).	Experienced teachers involved in developing the programme. Theories of learning include social, situational & organisational approaches. Challenge is to enable learning that is both immediately relevant to practice & builds a more generalised knowledge base.

The following principles seemed particularly important if we were to understand and document the experiences of teachers, students and communities learning to use unfamiliar technologies for the first time:

First principle, learning is social. It is as much a participatory process, in the sense of people jointly constructing knowledge within particular groups, workplaces or communities, as it is of individual development (Lave and Wenger, 1991; Rogoff, 1994; Cole, 1995; Greeno, 1997). It is also a life-long activity, as ongoing in work-based practices (Wenger, 1999; Engestrom and Middleton, 1998; Chaiklin and Lave, 1993) as it is in childhood development. Teachers not only work with learners, but are themselves learners.

Second principle, learning is always a situated and active experience. People are in essence agentive (Sen, 1999), proactive, intentionally focused (Bruner, 1996) on the purposes of the communities to which they belong; orientated towards 'mindful' learning activity such as remembering, planning, investigating, inventing, creating (see Dobres, 2000; Leach, 2001). Such learning in practice not only reproduces but can also extend and sometimes transform the social structures and communities in which it takes place.

Third principle, and most importantly for this study – cultural artefacts and tools mediate human learning and activity (see Vygotsky, 1962; Wertsch, 1995). From this perspective learning is distributed, or 'stretched over', the individual, other persons, activities, tools and artefacts (Lave, 1988; Putnam and Borko, 2000). Indeed we often enter into a kind of intellectual partnership with the tools that we daily take for granted. Ecology, with its particular focus on the relationship between organisms and their environments, provides useful metaphors that elucidate the symbiotic relationship between tools, activity, human learning and development (see Zhao and Frank, 2003). For example, the now commonly used notion of the 'affordance' of a particular technology is drawn from ecological psychology (Gibson, 1979)[4]. Culture thus provides the 'toolkit' of technologies, techniques and procedures with which different groups and communities learn about, respond to, act on and manage their experience of the world (Bruner, 1996). Whether it be the stick in the sand or contemporary forms of artificial intelligence, technologies, combined with what Bruner calls the 'soft tool' of language (e.g. shared symbols, special vocabularies, notational systems and the like), offer a range of affordances for making people smart (Norman, 1998), though none of them guarantee it. The commonplace cultural artefacts of

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[4] The combination of the paws of the squirrel and of a tree afford climbing; similarly our legs and a staircase afford climbing. We may also be able to climb a steep incline, but with much more difficulty.

educational settings – be they books, pens, abacuses, calculators, or sophisticated electronic data bases and statistical tools – all serve to potentially extend the reach of activity and learning in one way or another – including the practice of being a teacher.

Fourth principle, a social perspective removes the idea that there is a physical surround to a teaching and learning situation. It enables attention to be paid to the impact that the classroom, wider school and community have on the process of teacher and student learning, as well as the important role outsiders can play in communities when communication technologies are being used. The notion of 'learning communities' becomes increasingly important as the communications aspect of ICT develops, in particular as the national and international developments outlined in our introduction begin to have a direct impact on schools and classrooms.

Pedagogic dimensions For the purposes of the study we used the concept of a 'pedagogic setting' (Leach and Moon, 1999) to conceptualise a school or classroom community as a single unit of analysis, subject to the complex set of interactions outlined. Regardless of variation in geographical location, participant profile, infrastructure and resource, we propose that any teaching and learning (pedagogic) setting comprises a set of common and interdependent 'pedagogic dimensions':

- goals and purposes;
- learning and assessment activities;
- discourse;
- tools and artefacts;
- roles and relationships;
- views of knowledge and learning (that is, the types and form of knowledge and learning valued in the setting).

If any one dimension in the setting is changed (e.g. new tools introduced) so the other dimensions are affected. We judged this concept would help us differentiate, within the widely differing school communities of the study, between contextual variations of setting, as well as the more enduring aspects of pedagogy. It would caution us against pre-supposing the kinds of affordances new tools and artefacts might offer teachers and learners – and prevent us from oversimplifying their impact. The cultural meanings that teachers (and students) within the study brought to the new technologies, and hence their learning, would in part affect and be affected by how and for what purposes they used them:
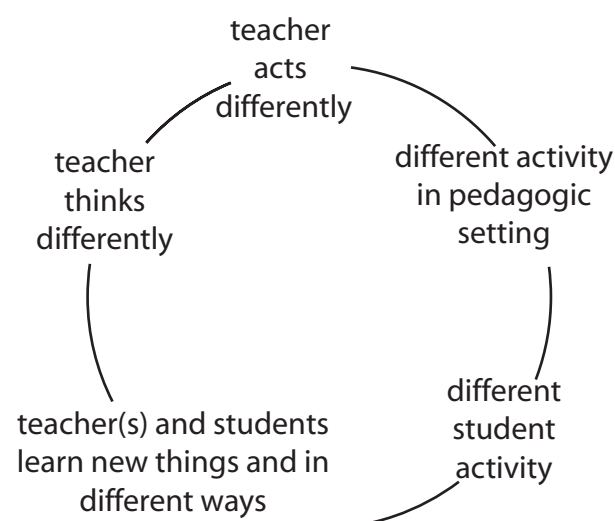
Teacher professional knowledge

We also needed a means to understand and analyse such change in teachers' thinking and practices throughout the project. To do this we used a model of teacher professional knowledge (Leach and Moon, 2000b) incorporating the pedagogic dimensions. Fig. 3 indicates our way of describing this knowledge. It is derived from the work of Lee Shulman (Shulman, 1987), but goes beyond his ideas in taking account of the highly contextualised nature of knowledge building and learning within educational communities as set out above. This representation of teacher knowledge emphasises the multiple identities of a teacher within any school community: as subject expert (subject knowledge); as subject teacher (school knowledge); as teacher (pedagogic knowledge). At the centre of this representation is the teacher's personal identity (personal construct) developed within a range of other, overlapping groups and communities (e.g. mother, friend, musician, baseball player, Muslim, Xhosa speaker etc.).

Fig. 3: Model of teacher professional development
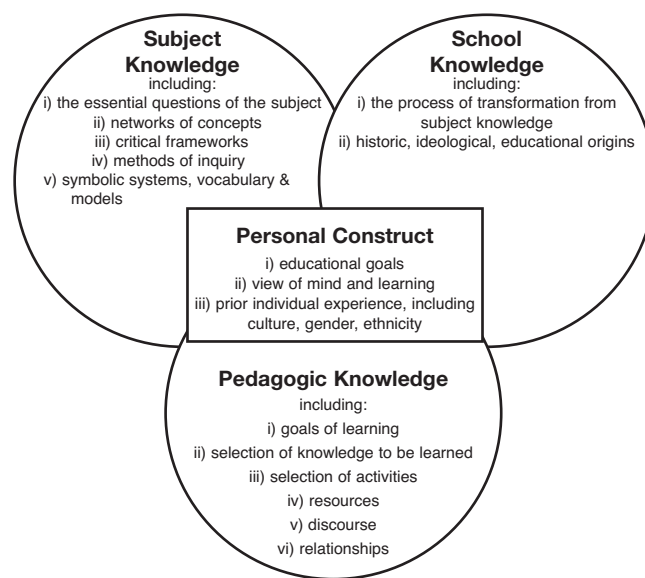
This representation of teacher knowledge, we judged, would enable us to map what the implications might be for individual teachers within the project when introduced to ICT. They may, for instance, change their view of subject knowledge or how they view and implement pedagogy. Personal identity in the model would be key to the way in which teachers react to change that can be as threatening, or as motivating, as that posed by ICT. This model was used in the project design and the categories of knowledge were used throughout the study as a means of interpreting and categorising teacher-related data, as well as a way of documenting teacher change.

Defining information and communication technologies

A broad definition of ICT[5] was used that emphasised the importance of the intersection of information technology, information content and telecommunications in enabling new forms of knowledge production and interactivity.

Many analyses of ICT, particularly in the development context, explicitly or implicitly equate ICT solely with desktop computers or computer suites. This definition provides a broader conception of ICT since it assigns equal status to traditional communication technologies (e.g. radio and TV), a range of newer digital devices (e.g. mobile phones, mobile computers) as well as a range of associated activities (e.g. the use and production of moving images, music making, text messaging, photography and mobile computing).

Really useful technologies, we surmised, become embedded into the everyday practices, the 'thinking as usual' of communities (Leach, 2001; Moon 2002). Research has shown that the ways in which ICT is used by teachers within educational communities has a far greater effect on learning than physical access alone (see Appendix 3). In conceptualising the ICT that would be integral to the DEEP programme, the project team was therefore guided by the new forms of activity and teacher knowledge it hoped might be appropriated by project teachers and their students within schools and classrooms (e.g. 'subject', 'school', pedagogic' and 'personal').

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[5] OECD (2000) Schooling for Tomorrow: Learning to Bridge the Digital Divide, Paris: OECD

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### Defining ICTs in the DEEP materials

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Intambanane: first flights with ICT

Unit 1 – Why ICT for ourselves, our learners, our community?   Select a page...   Go!

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WHY ICT?

During the INKANYEZI project you will be considering the ways in which ICT can:

- make teaching and learning more *effective*
- *extend* teaching and learning

and in some circumstances

- *transform* what you teach and what learners learn.

You will discover that, as with any tool, to be really effective, ICT must be an integral part of activities that have real meaning, purpose and value for learners. We will be looking at how ICT can make a real impact on learning outcomes in our schools.

But what exactly do mean by new information and communications technology?

Click on the image to enlarge.

The diagram above shows the three elements of information and communications technology that enable many new kinds of activities. We include in our definition of ICT television, radio, video players and recorders, as well as cell phones. However, INKANYEZI particularly focuses on:

- computers equipped with a range of software, including mobile, hand held devices;
- the Internet with its hyper linked, multi media web sites, e-mail and video conferencing capabilities;
- digital cameras.

We want to consider these as new resources that can be used to help students wonder, think, analyse, problem solve, explain – and also be creative. Read what one pupil from Butterworth High School wrote about the impact the use of ICT had on her and her class.

>>insert as thumbnail (do not have image)<<

Click on the image to enlarge.

We do emphasise from the start of the project, however, that we don't believe that all things learners are required to learn at primary school can be taught using ICT. Some times it will be no use at all for achieving curriculum aims! You as the professional have to decide when and whether it is 'fit for purpose'.

INKANYEZI will help you make such decisions. Have a look now at the next activity.

PAIR ACTIVITY

Documents Images Interactive Web links Videos Sounds

Earlier you made a list of the tools and technologies you had used in the last 24 hours. Did the list include any new information and communications technologies (e.g. cell phone, computer, TV)?

- Use the INKANYEZI entry questionnaire to help you discuss your current knowledge of ICT (If you don't have a copy of the questionnaire, you will find it by clicking on the text box above).
- Discuss what you think are the positive aspects of ICT.

Start with ICT you know well (e.g. cell phones or TV), then think about the newer technologies we have been discussing such as computers. To help you think about their use in the classroom have look at the video clip above in which pupils from Vuselela Primary School (near Queenstown) say why they found computers valuable in their learning.

- Now discuss any aspects of using newer technologies that concern you, either from a personal point of view – or as a teacher thinking about their use in the classroom. This might include lack of confidence in knowing how to use the technologies- or the unknown effect that they might have on your pupils or classroom ethos.
- Put your ideas into a PROS and CONS list, which we would like you to keep

PROS	CONS
(positive aspects of ICT) **e.g.** By listening to the radio I can learn about local weather and keep up to date with how my favourite football team is doing.	(worries and concerns about ICT) **e.g.** ICT can bring upsetting news of human tragedies far away which I can't do anything about.

During the project you can revisit this list with colleagues to make sure that concerns you have are addressed.

Chapter 3: **The DEEP programme development**

Purpose and nature of the programme
The focus of the DEEP professional development programme was to enable participating teachers to:
'explore and practise ways in which information and communications technologies (ICT) can improve, extend and in some circumstances transform teaching and learning in literacy, numeracy and science'.

(DEEP Study Guide, p. 2)

Structure and theme
The overall framework for the programme, developed by the project partners during an initial scoping week, was structured around a three-term period (see Fig. 5). It was planned that teachers would be invited to spend two hours or so each week studying and carrying out a range of professional development activities and a series of related classroom-based tasks.

These school-based Professional Activities were to be supported by a range of programme resources, planned around 10 Programme Steps, together with a series of face-to-face workshops and other forms of support. This framework, whilst providing high-quality resources, aimed to stimulate school- and classroom-based practices, created and owned by the teachers. It was hoped the resources would provide project teachers with a conceptual and attitudinal basis for coping with and seeking to alter their daily realities, in order to improve learning (Sarason, 1993).

Previous experience of programmes designed to introduce teachers to ICT for subject teaching suggests that a generic approach, which requires participants to make their own curriculum linkages, tends to lead to an over-concentration on IT skills. An environmental theme, Endangered Animals, was therefore chosen, which could be used to model a range of literacy, numeracy and science-focused activities.

Such an approach offered:
- a subject that would engage and motivate students in the 9–13 age group in both contexts ;
- a theme that would lend itself well to being explored through a range of ICT activities in each of the core areas of literacy, numeracy and science, directly related to both countries' curriculum;
- an area of knowledge that is a significant topic within the development context (see DFID 2002).

It raises key questions for people living and working in poor environments who crucially depend on the local environment for their livelihoods.

Fig. 4: Programme resources
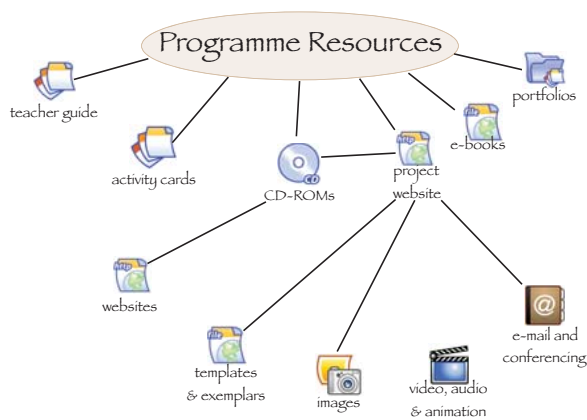
Programme resources
The project partners used a combination of e-mail and fax during the scoping phase to exchange successive drafts of the resources that would support this generic framework including:
- a short [print-based] **teacher guide;**
- specially designed **CD-ROM resources** including the core professional development activities, incorporating a range of related lesson plans, case studies, stories, video clips and websites;
- a **programme website** providing the CD–ROM resources on–line, also incorporating a discussion area;
- a **school portfolio**, comprising folder and blank floppy disc for gathering evidence (including electronic files) of teacher and student outcomes.

As a result of teacher feedback in the first three months of the programme, a further resource was developed:
- activity cards detailing Professional Activities to be carried out by the teachers, reflecting progression and development across the 10 Steps; these also summarised teacher and student outcomes (see Appendix 4).

DEEP IMPACT: *an investigation of the use of information and communication technologies for teacher education in the global south*

Fig. 5: Project overview.

Time Frame	Project Steps	Project Activities	Expected Educator Outcomes	Support
Term 1	STEPS 1–3	Purposes of Project	Develop shared understanding of the purpose of the project; Establish a baseline for the research;	Face-to-face launch workshop
	Introduction to the purposes of DEEP	Why DEEP?	Explore the DEEP activities; Establish patterns of group-working;	
	Research instruments	My Thoughts / Entry questionnaire / Concept mapping	Participate in curriculum activities modelling new pedagogic strategies, and plan their adaptation to own contexts.	(4 days)
	Introduction to Professional Activities	First steps into DEEP / Why ICT for me, our learners, our school? / Hare & Tortoise (Literacy activity) / Animals 1 (Science activity).		
	STEP 4	School-based application of First Steps into DEEP	Discuss the importance of ICT for learning; Organise your classroom for ICT; Evaluate a multimedia text; Use a web site to support students in scientific research; Establish focused exploratory talk in small groups; Use ICT as an information source for learners.	School-based Professional Activities and Classroom Tasks
	Introducing ICT	Step 4 Introducing ICT / Why ICT is important for educators and learners; ways in which ICT can support literacy and science in particular; considering how to introduce ICT to the learners, the school, and the community.		(Supported by school visits and cluster groups)
Term 2	STEP 5	5a Hare & Tortoise	Plan an interactive teaching and learning session; Model and demonstrate a writing activity which develops learners'understanding of a text; Enable learners to apply the model for themselves in pairs or small groups.	
	Planning to teach using ICT	Plan to integrate ICT within a literacy lesson – focusing upon short writing tasks to support students' understanding of fables and folk stories (**Intsomi**).		
		5b Animals (Science) / Developing effective practice when students are using the Internet or CD-ROMs to research a scientific .topic	Establish focused research in small groups; Use ICT to provide information and structure for learners.	
		5c Telling my story / Use e-mail to enable students to communicate with other people in new ways, extending their literacy skills. Focus on personal writing and the importance of audience in the writing task.	Plan new kinds of literacy tasks that focus on personal writing; Model and demonstrate this task in the classroom and get students to apply the model for themselves; Enable students to use e-mail to communicate what they have written to a real audience.	

			School-based Professional Activities and Classroom Tasks (supported by school visits and cluster groups)
Term 2	STEP 6 Teaching and learning with ICT (1)	**6a Animal Adaptations (science)** Encourage students to use electronic information for new purposes, in this case, taking a general 'animal information' resource, and creating new work on animal adaptations.	Consider strategies for teaching adaptation; Encourage students to use electronic information for new purposes or audiences.
		6b Animal Populations (numeracy) Numeracy in purposeful exploration; using ICT to help students experiment, develop creative strategies to solve numeracy problems relating to populations of endangered species.	Develop strategies that encourage students to apply and develop their numeracy skills through purposeful exploration; Situate learning in numeracy with genuine problems and data.
		6c Endangered Animals (science) Strategies to encourage students to organise evidence in support of a scientific argument; focusing upon why some animals are endangered. ICT used to enable students to quickly draft and re-draft their ideas.	Develop teaching strategies that help students organise evidence, in a logical sequence, to support their scientific argument.
		6d Animal Tales (literacy) Use electronic writing frames to enable students to plan a piece of persuasive writing, drawing upon the research that learners have carried out, and emphasising the importance of audience in the writing task.	Show learners how to construct persuasive writing; Model and demonstrate this task in the classroom and get learners to apply the model for themselves; Enable students to use electronic writing frames to support this literacy task.
Term 3	STEPS 7, 8 & 9 Assessing learning Evaluation	7 Learning review & presentation 8 Teacher evaluation 9 Learner evaluation	To review and affirm the learning that has taken place; To reflect upon the lessons learned, and the implications for future practice.
	STEP 10 Affirmation	10 Reviewing and affirming teacher and learner outcomes	To affirm the teachers, students, schools and communities – their shared learning and achievement. Affirmation Event (1 day celebration)

Professional activities and classroom tasks

In keeping with the conceptual framework set out earlier, school activities were seen as integral to the programme; all programme materials and resources were to be directly related to these. This link needed to be explicit. A cycle of Professional Activities, each one incorporating a Classroom Task, was therefore designed to prepare teachers to try out and evaluate a sequence of activities with their students (Fig. 6). This cycle of Professional Activities took the form of web-based units, each one focused on a key curriculum question or process. These units had a common frame, stucture and navigation: What do I know? Curriculum focus; Why ICT? Classroom Activities, Case Study, Resources. This common framework was designed to allow for increasingly demanding classroom activity, as teachers progressed in confidence, for example from simple literacy word processing and web-search activities about local animal species, to the e-mailing of research findings to students in other schools. The Professional Activities were also progressively focused to develop classroom organisation, planning, teaching and assessing with ICT.

This approach was seen as important in: avoiding an artificial division between theory and practice; providing a common framework for teachers in the programme, ensuring both consistency of experience and clear progression within this short course; giving a strong focus to outcomes for students and teachers alike; presenting pointers to the way other teacher professional development programmes might evolve.

Fig. 6 Cycle of professional activities and classroom tasks

It should be noted that the programme set out to introduce teachers and students to a wide range of classroom activities, some of them unrelated to ICT use. Teachers were provided, for example, with poetry, stories and paintings relevant to the project theme that could be used with students. Ideas for drama, outdoor field-work, as well as strategies such as peer tutoring, brainstorming, scaffolding and modelling processes were also introduced. Emphasis was placed on ICT as being one approach amongst many and that it should be used only when judged to be 'fit for purpose'.

Fig. 7: The model of programme support

Programme support

Workshops and school visits
Fig. 7 sets out the components of support planned for the programme; Fig. 4 (p. 15) indicates how it was planned that these elements would be integrated into the programme's overall structure. It was proposed that face-to-face support would comprise an initial launch workshop provided by literacy, science and maths specialists, followed by half-termly face-to-face workshops or school visits (alternating) together with a final evaluation workshop.

Teacher partners and the role of school principals
It was planned that teacher pairs would work together throughout the programme, carrying out and evaluating Professional Activities collaboratively. Professional Tasks were addressed jointly to them, inviting pairs to study activities together, share the computer and develop a joint portfolio.

School principals had agreed to support the teacher partners and fully endorse their work within the programme. The pairings were seen from the outset as an essential dimension of the support framework: *'It is considered that this approach will provide a mode of peer support/mentoring for participants particularly helpful in relation to their use of ICT for teaching and learning'* (Scoping Meeting Summary Report, March 2001). This approach reflected the notion of joint knowledge building, a key principle of the conceptual framework set out in Chapter 2.
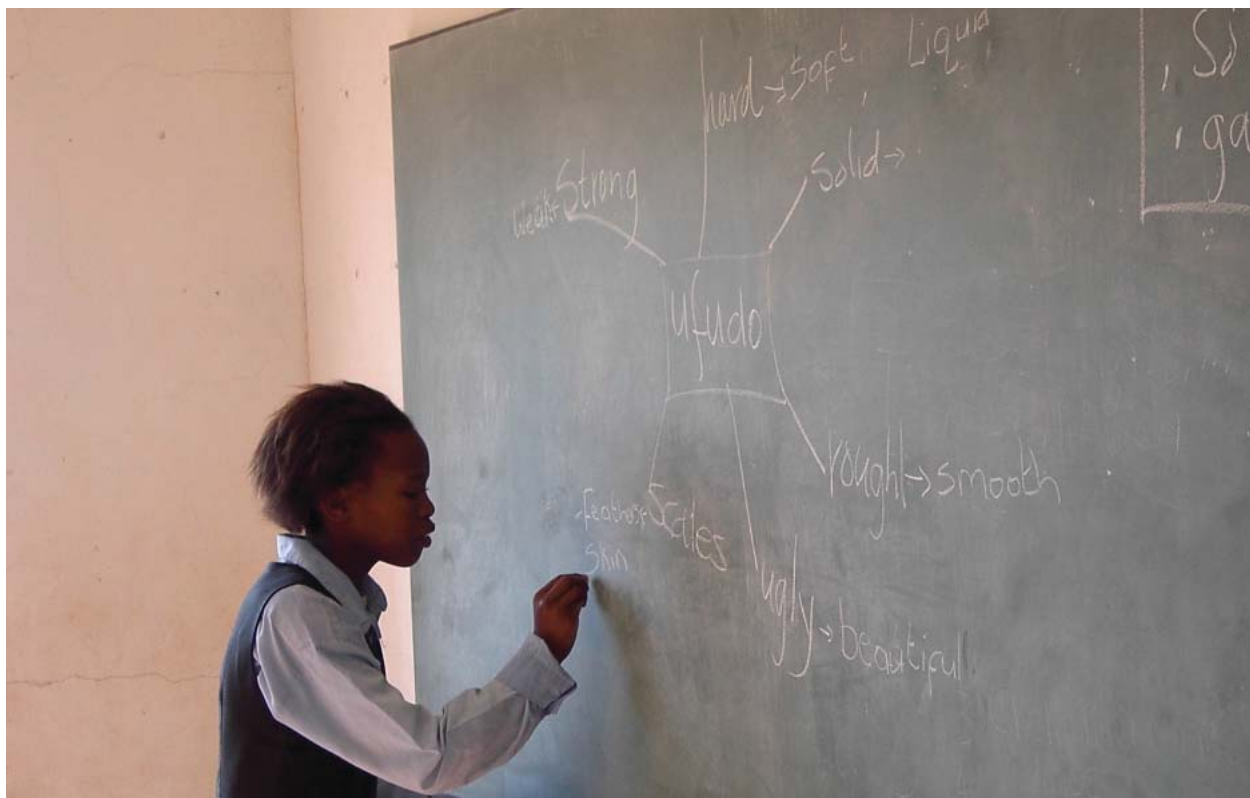
**Fig. 8: Example of a web-based activity for teacher partners
to carry out together**

Fig. 9: DEEP website home page

The DEEP website

A web environment was built to link the research sites, including a discussion area (DEEP TALK) in order to network participating teachers via the Internet. This would enable project participants to share experiences, resource difficulties, ask questions, or discuss student outcomes. The website also provided an on-line version of all the Professional Activities, as well as live links to a variety of web resources.

National support

National and local contacts with a range of organisations were also considered to be essential in setting up the programme locally, and in the ongoing development of provision (e.g. teachers unions, district authorities). In the case of Egypt the project was endorsed by the Minister of Education. In the Eastern Cape Province a programme Steering Group comprised the Dean of the Faculty of Education, UFH, a member of the Ministry of Education, Eastern Cape, two representatives of the main teaching organisations (SADTU and NAPTOSA), and a primary school teacher.

Country versioning of the programme framework

Once the generic framework and associated key resources had been established, country-specific elements were developed as follows:

• **Language medium.** The materials were developed in Arabic for Egypt and some Xhosa elements introduced for the Eastern Cape (the Eastern Cape programme itself was called Inkanyezi, which means 'glow worm' in Xhosa[6]).

• **National references.** Local imagery and references were introduced (e.g. quotations from Nelson Mandela (South Africa) or President Mbarak (Egypt) speaking about ICT) to ensure that the programmes fully reflected national settings; endangered animals specific to the respective Egyptian or South African heritage were provided for study and so forth.

• **Curriculum relevance.** Country-specific curriculum documents were referenced where relevant. Local resources, e.g. Arabic fables and Xhosa 'intsomi' (folk tales) common in schools, were introduced as supporting resources for literacy activities.

• **Locally specific case studies.** Illustrative case studies were adapted to reflect country-specific contexts and classroom practices.

Other country-specific developments that emerged during implementation of the framework (e.g. the nature of local training and support) are outlined in Chapter 4. New case studies continue to be written in both contexts based on emerging practice for future use.

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[6] Inkanyezi sisinambuzane esincinane, esikholisa ukuqapheleka ebusuku ngenxa yokudanya–danyaza kwaso. Udanya–cimi esiye simenze uthi "Ndileq' undibambe!". Kokukukhanya okuye kubenomtsalane ebantwaneni. Ayibobungakanani bayo obubalulekileyo, koko ligalelo layo ekukhanyiseni nakwintsunguzi yobusuku. Umntu ongaziyo kuye kuthiwe usebumnyameni. Nantsi inkanyezi engu–DEEP isiza nolwazi lwe Computer ebantwaneni. Masiyileqe siyibambe ingekathi "swaka!" (A glowworm is a small insect that is noticeable at night by flashing. It is the flashing that makes it attractive especially to children. Somehow you are drawn to chase and catch it because you want to capture the glow. It is not its size that is important, but its impact in illuminating even the darkest nights. In our culture, a person lacking in knowledge is said to be in the darkness. This glowworm (DEEP), is enhancing the use of computers in learning to children. Let us catch it before it disappears.)
Adi Kwelemtini, Project Co-ordinator, SA

ICT for teacher development: defining the questions:
In ICT innovations policy makers often start with questions about hardware and software: very often the first questions are 'How many computers?', 'How much do they cost?'

The project team started with a broad view of ICT and what it can achieve. This is important if young people are to be prepared for the reality of the wide range of technology uses in societies world-wide. Equally, approaches to technology implementation need to grow organically and sympathetically out of the real practices and needs of schools and their communities. The voices of teachers, students and parents interested in subject learning – science, literacy, mathematics, the visual arts, local history and the environment – need to be heard over the din of those who would define technological literacy in terms of low-level skills like 'inserting a CD-ROM' or being able to 'use keyboards and other input and output devices' (Stroup and Petrosino, 2003).

The voices of community leaders concerned with the development of expertise in healthcare, agriculture, civics, environmental conservation also need to be heard above those preoccupied with computer suites and 'office'-based applications. Rather than taking hardware and software designed primarily for business settings in wealthy environments as the starting point, from this perspective the key question becomes 'What forms of ICT?' related to the following questions:

• For what purposes will the ICT be used?
• Who will be using it?
• In what contexts will it be used?
• Will ICT use make current practices more efficient or extend or transform them in some way? How will we know?
• Are there new and important practices that only ICT can enable?

Learning technologies within the programme
As set out in Chapter 2, the selection of ICT hardware and software for use by teachers and students was primarily driven by the purposes of the programme. For example, in order to develop teachers' 'subject' knowledge to support new forms of science activity, provision of resources sufficiently detailed and broad to support professional enquiry was required. This implied Internet, CD (or DVD) -ROM access together with a range of high-quality, subject-focused multimedia resources related to the project's theme. Technical requirements were also driven by consideration of how the ICT might support the development of new 'pedagogic' knowledge, within the proposed classroom tasks. A display large enough for several students to be able to see the screen at one time and work together collaboratively would, for example, ideally be required. Multimedia can enhance the way learners research a topic, and present their findings to others, therefore support for sound, animation and video was seen as advantageous.

To facilitate teachers' 'personal' knowledge, particularly confidence in using ICT in the classroom, teachers needed to have access to ICT across a variety of settings [e.g. at school and at home]. This pointed to the need for devices that would allow for portability and the opportunity for teachers to 'tinker' and 'play' with ICT, as well as make mistakes in the privacy of their homes. During the project's scoping phase the DEEP team had observed with keen interest the widespread use of mobile phones in the rural areas of the Eastern Cape – and how important this mode of technology was to those living in isolated settings. Some teachers reported they walked many miles each week to the nearest source of electricity in order to charge these devices. This experience encouraged the team to think seriously about exploring the potential of hand-held computers that could flexibly support teachers' personal and professional needs within the programme.

In this way, starting from the kinds of Professional Activities that teachers would be encouraged to carry out and evaluate, and identifying the technologies that would enable such activity, a minimum specification for a professional ICT toolkit was created (Appendix 5: Technical specification and Appendix 6: Supporting infrastructure). The development of teachers' professional knowledge remained a key determiner in how ICT came to be defined within the programme. The hardware and software used drew wherever possible on what was already in place.

Desktop computers (Cairo)
In Egypt the project's school multimedia labs fulfilled the needs of the project specification for curriculum and classroom use – albeit at a basic minimum.

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ICT Professional Toolkit (used by project pairs in primary schools, Eastern Cape)

Shared lap-top for classroom use (with CD-ROM, Internet access, support for current generation software, microphone and speakers)

Project website & e-resources

All-in-one printer-scanner-photocopier

Allocation of ink; paper; personal e-mail account with ISP; small budget for Internet connection

Individual hand-held computer with digital camera and docking station

Software including: reference software; atlas; curriculum software; productivity software

Access to project digital video camera

Personal mobile phone (not provided by project)

Lap-top computers (Eastern Cape)
As a result of approaches to a range of donors, Microsoft South Africa (Social Responsibility Division) provided 16 new Mecer lap-top computers, manufactured in South Africa, to enable every project school to have one dedicated computer for the duration of the project. For equity, all project pairs/schools (including the four with existing ICT provision) were assigned a single lap-top; the remaining four machines were to be used by the local programme team.

Software
Each school was provided with an operating system and 'Office' software appropriate to their equipment. The DEEP websites and other software utilities were loaded onto all computer hard drives as part of the programme resources.

Personal hand-held computers and digital cameras
All project teachers were provided with a 'state of the art', powerful 'pocket pc' [206 MHz processor] and small digital camera add-on and docking station, to facilitate their own professional study.[7] The DEEP professional development activities were installed on these devices in the form of illustrated e-books, together with a range of other resources (e.g. case studies, exemplar lesson plans etc.). Whilst such technologies are currently not widely available, they are very likely to be so in a few years. In anticipating this, DEEP is providing a foundation for informing future practices.

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[7] As a result of a small grant from Hewlett Packard and the Open University,

DFID

Whole-school and project equipment
Project schools were provided with one printer-scanner-copier 'all-in-one', plus an allocation of ink cartridges and paper. One high-resolution digital camera was also given to each country team, to be shared by the project schools and co-ordinators and a single high-quality digital video camera was loaned to the Eastern Cape project team. Table 1 details this hardware and software, together with the kinds of personal, professional and curriculum uses it was hoped they would facilitate. The text in italics denotes uses, strengths and drawbacks that were documented during project implementation rather than considered at the outset.

Initial programme activities were designed to encourage teachers to consider how a range of familiar technologies were already an inseparable part of their daily lives, enabling them to achieve things that would otherwise be difficult – or even impossible. Teachers were also invited throughout the programme to consider and then evaluate for themselves how new forms of ICT might be used in their own teaching practices, in their particular settings and with their own students. No form of ICT was introduced within the programme unless it could be shown to make the teaching and learning process more efficient in some way or where it potentially extended or transformed the learning process (for teachers and/or students).
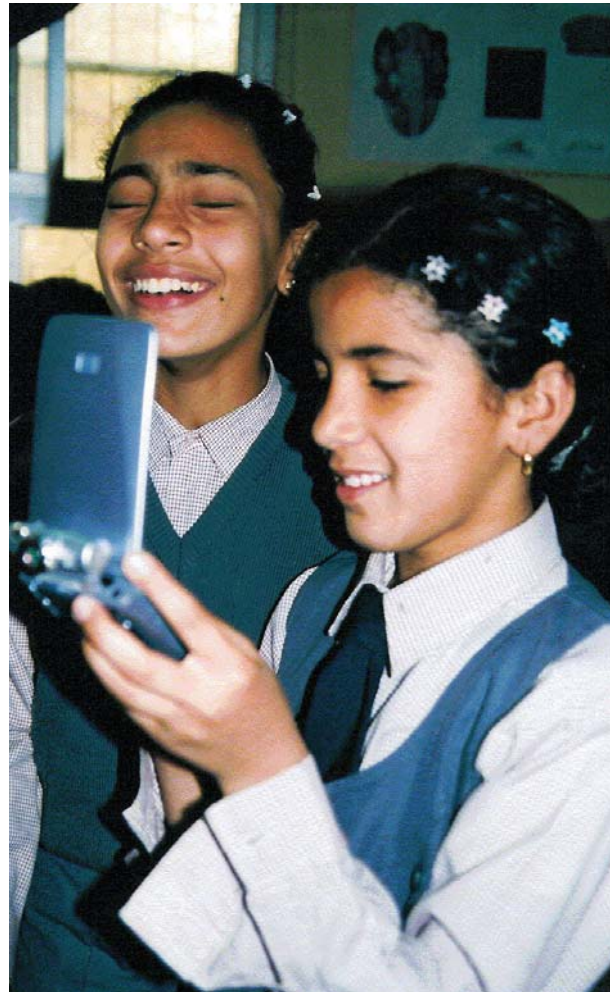
Table 2: Uses of the ICT Professional Toolkit   Note: italics are used in the table to indicate unplanned outcomes.

Programme ICT	Uses for teacher development (including curriculum purposes)	Types of teacher knowledge to be developed	Strengths	Limitations and requirements
Lap-tops* • Word processor • Spreadsheet • Presentation software • E-mail • Web browser (including audio, video and animation viewing) • Image viewer • Audio player • Games • 'Beaming' (infrared document transfer) • Docking station for hand-helds	**Personal and professional study** • Developing ICT skills • Communication • CVs, job applications • *Pursuing personal interests* • *Supporting own children's learning* • *Professional study* • Course materials • Subject knowledge • Examples of practice • Planning tools • Classroom resources • Reference information • Independent research **Personal & professional communication** • Collaborative working (partners from the same school working together at the computer) • Collaborative working (with peers at other schools, with the project team) • Document sharing/development • Displaying work (teachers and students) to parents, teachers and governors **Classroom uses** • Learning resource • *Reference library (e.g. thesaurus/dictionary/encyclopaedia)* **Serving the school and broader community** • *School and school principal administration (e.g. minutes of meetings, letters, policy documents, test papers, time–tables, school events, assessment records)* • *Adult literacy* • *CVs and job applications* • *Community announcements* • *Community projects* • *Entrepreneurial development* • *Correspondence with official bodies (telecoms, local authorities, grant applications, bills, letters of complaint, service providers, etc.).*	Personal School Subject Pedagogic	Flexibility – serves a range of curriculum and pedagogic purposes. Range of uses – can be extended and adapted by additional software or hardware. Mobility – enabling use in classroom/home/teacher workshops/church/hospital. Different user accounts enable a number of users to have a sense of ownership and personalisation, as well as fostering collaboration. Storing, organising and achieving information and artefacts. Operates without need for external electricity supply (albeit for a short time). *Can integrate seamlessly into a classroom setting (teacher or students desks) and be moved around as required.* *Enables curriculum activity, not ICT, to be the visible focus of classroom. This may remain true even if there are several machines available for use in the classroom.* *Small size, and free–positioning, mean the computer need not interrupt lines of sight in the classroom, between learners and teachers.*	Short battery life. Needs care and protection from impact, water, dust, extremes of temperature and humidity. Screen size rarely suitable for whole-class teaching without use of external monitor/data–projector. Small speakers often inaudible except for small groups or quiet environments.

	Curriculum uses		
Lap-tops continued	• Composing texts and multimedia • Presentation to authentic audiences • Transforming texts • Information literacy • Scientific literacy • Knowledge of language (e.g. spelling/grammar/meaning/genre) • Open-ended investigations • Bilingual reading and writing (e.g. Bible texts in Xhosa and English; bilingual on-line dictionaries) • Collaborative learning • Problem solving • Peer tutoring • Communication • Photographic work • Developing cultural understanding of world beyond local environment through access to and engagement with images, information, people and institutions beyond the local context • Presenting work **Intellectual tool for the development of** • Critical thinking • Information handling • Higher-level conceptualisation • Problem solving • Collaborative tasks • Joint decision making and reflection • Complex group interaction • Research		Can equally well support individual, pair or group collaborative work. With the addition of data-projector, can be used with large groups of teachers in a teacher workshop. *When technical support is required, machines are relatively easy to transport to and from schools/support centres.* *The power consumption of a lap-top (around 40W) is up to ten times less than that of a desktop (200–400W).*
Desktops		As for lap-tops	When permanently 'situated' at a particular location, desktop less likely to be damaged 'in transit' than a lap-top. When permanently situated, cables and peripherals may be permanently connected, saving time in 'setting up' for each use. May be more robust in design and construction than comparable lap-tops.	Requires permanent external electricity supply. Large and fixed physical presence can obstruct lines of sight between teachers and students.

| **Desktops continued** | As for lap-tops | As for lap-tops | May have larger displays than comparably priced lap-tops, making them more suitable for some forms of group-work or whole-class teaching. *Features in common with lap-tops:* Serves a range of curriculum and pedagogic purposes. Range of uses can be extended and adapted by additional software or hardware. Storing, organising and archiving information and artefacts. | *Desktop computers cannot easily support the teacher in a range of non-classroom contexts: e.g. home study; teacher workshops. When technical support is required, machines may be difficult to transport, especially in contexts where most teachers do not have cars, and schools situated on unmade roads. Where (as is often the case) classrooms are not secure, the room needs securing, or the computers need to be moved to and from a strongroom (or local home) each time they are used. Moving desktop computers in this way involves a high risk of harm (to machines or people) and makes for demanding set-up/take down. The power consumption of desktop machines is typically five to ten times that of a lap-top. It is hard to see a classroom with ten to twenty desktop computers in it as anything but a computer suite.* |

	Pedagogic			
LCD panel for OHP*			*Useful for set up and feedback for large groups (teachers or students). Minimises need for worksheets. Unlike chalkboards, where teacher/students' work is ephemeral, LCD panel used in conjunction with computer allows groups to share, reflect, modify and reuse work. When combined with a lap-top highly portable, and can serve a number of purposes and locations (classroom, staffroom, workshop, cluster meeting).*	*Without careful planning, such displays lend themselves to didactic or presentational teaching. Can only be used in conjunction with an OHP, and is therefore quite cumbersome – being best suited to a fixed location.*
Data projector*	As above		When combined with a lap-top, highly portable and can serve a number of purposes and locations (classroom, staffroom, workshop, cluster meeting)	
Hand-helds • Word processor • Spreadsheet • Web browser (including audio, video and animation viewing) • Camera and image viewer *• Audio recorder/player* • Games • Diary • Contacts • 'Beaming' (infrared document transfer) • Docking station for hand-helds	Mainly personal and pedagogic, but research findings indicate strong potential for subject and school.	Many of the functions for desktop or lap-top computers as above. In addition support anywhere – any time learning. Additional functions: **Personal and professional development** • Readily accessible learning resources • E-books enable personal learning, study, planning and information – material can be bookmarked, highlighted, annotated and text extracted. Classroom use: *• Use of the stylus input is resonant of a notepad and pen, extends the learners affordance of note taking from the familiar paper/chalkboard, into the hand-held electronic notepad.* **Professional and curriculum uses** • Mini–multimedia showcase (e.g. reading kinetic poetry; hearing Martin Luther King speech; listening to animated fables, watching videos of effective classroom practice (e.g. peer tutoring)). • Photography. *• Voice recorder (language work and recording information and events e.g. Mark Shuttleworth visit).* *• Support for field-work/school trips.* *• Facilitates collaborative work, both for groups of students and of teachers – device small, easy to pass around.* • Collaborative work encouraged by quick and simple facility of 'beaming' electronic notes and other artefacts	Ultra-mobility. 'Anywhere–anytime' learning. Flexibility – serves range of curriculum and pedagogic purposes. 'Personal' computing – constant access and a sense of ownership, gives teachers liberty to 'play' and explore ('…it is my companion'). Sense of 'personal ownership'; encourages teachers to take care of device. Runs for several hours of continuous use (often equating to several days/up to a week's use). Remarkably robust in the challenging contexts of this study. Teachers feel safe and secure carrying these 'invisible' devices, compared to the conspicuous and attractive lap-tops.	*Requires regular (daily/weekly depending upon use) recharging. Prone to total data and partial application loss upon battery failure.**** Synching with main computer can be prone to failure.**** Small screen size requires re-design of educational content developed primarily for larger computers. Limited storage capacity (for multimedia),**** although use of memory cards may overcome this.*

** LCD panels were not provided by the project but are standard in Egyptian multimedia labs.

*** Data projectors were not provided by the project but were often borrowed to be used in training and cluster meetings.

****With the particular handhelds used in the study.

Mini-cameras	• Photographing resources for classroom • *Photographing classroom work* • *Documenting student progress* • *Objectifying experiences (teacher and students) to help critical reflection* • *Scientific and social sciences project work and field-work* • *Photographing for display, presentations, and teacher and student portfolios* • *Displaying school work to teacher/student peers, principals, governors and inspectors). Important in involving parents in settings where adult illiteracy is high.*	Pedagogic	Very small form – can easily be kept ready for use. Easily shared (taking and viewing). *Ideal for field-work.* Doesn't require separate batteries or charging. 'Invisible' and secure. Instant and share–able images, readily integrated into other documents. Minimal ongoing costs.	Low resolution images. Shutter delay can mean you miss capturing the intended moment. No flash. Relatively low-quality image compared to traditional camera.
Digital cameras	As above	Pedagogic Personal	Instant and share–able images, readily integrated into other documents. High-quality images. Can be tripod-mounted.	More bulky and conspicuous. Requires batteries. Requires cables to transfer images (easy to mislay).
Digital video camera	As above In addition to the functions of the still cameras, the DV cameras also: *Provide access to new medium and genre of moving image production that can be utilised across the curriculum.* *Enables students and teachers to practice authentic roles, e.g. naturalist, journalist, interviewer, subject expert.*	Pedagogic and subject knowledge	As above Provides a sophisticated presentational tool. *Captures events and performances for representation to different audiences and for reflection and evaluation.* *Film is a unique medium – offering unique opportunities for teaching and learning.*	Battery life needs monitoring.
Multi-function printer-scanner-photocopier	*Facilitates printing multiples of resources, e.g. class worksheets/exam papers.* Student and teacher work can be printed or scanned for presentation purposes including self-assessment portfolios. *Scanner can be used to scan and copy data to scale, e.g. book of local herbs.* Useful for admin, e.g. class register/official correspondence *Staff use for multiple copies, e.g. sports programme, minutes of staff meetings.* *Income generator for school and community, e.g. printing of obituaries, CVs, validation of birth certs, etc.*	Pedagogic	Range of uses in one device.	

Mobile phones including: contact SMS	Personal and Professional Communication, within the community of practice, via SMS messages and voice calls. Arranging cluster meetings and other face-to-face sessions. Arranging access to resources (such as the video camera and other shared project equipment). Accessing technical support (such as notifying the project team of problems, signalling that further communication/support is required).	Personal School	In South Africa, the mobile phone is ubiquitous, mainly due to the large geographical scale and land-line infrastructure. It is a technology most teachers are familiar with, and had access to. SMS messages provide low-cost, easy-access, national and international communication. SMS enables reliable communication between participants in different nations. In these contexts, SMS seems to be served by a more robust infrastructure than e-mail. Voice calls allow for more in-depth, immediate and personal communication.	SMS is limited to a small number of characters (160), often needing to be followed up by more involved communication through other means.

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Chapter 4: **Programme implementation**

Egypt: Cairo

Context

Cairo, Al Qahirah, is the largest city in the Middle East and in Africa, with a population of nearly 17.8 million. Egypt as a whole has a population of over 66.4 million; GDP per head is $1,470 Egypt is a relatively ICT-poor country; in 2002 there were only 16.6 computers per 1,000 of the population, and only 177.2 fixed-line and mobile telephones per 1,000 of the population.[8] Internet use has dramatically increased, however; in 1998 there were 100,000 Internet users and in 2002, 1.9 million (Yousry and Alta, 1997).

The education system in Egypt is composed of four stages – primary, preparatory, secondary and university. Primary education is mandatory for children between the ages of six and twelve and all primary schools teach the same national curriculum. The curriculum emphasises teaching of the basic skills and knowledge related to Arabic, mathematics and science. It also covers a relatively wide range of subjects such as social studies, art education, music, English language, computer studies, educational activities, practical skills and physical education.
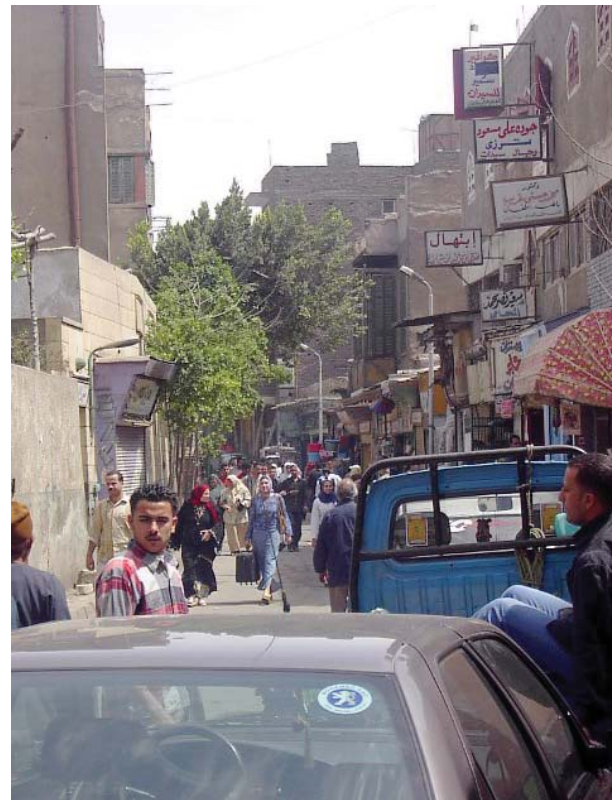
The demand for primary education has significantly increased in the last two decades. As a result, the number of students who require basic education is sharply increasing and the Egyptian Ministry of Education has put huge efforts and investments into building new primary schools to cope with the increasing numbers (Egypt Human Development Report, 1998/99). The Minister of Education is strongly committed to reforming education and enhancing Egyptian students'

Fig. 10: Egyptian primary education (first cycle of basic education): weekly lesson timetable

Subject	Number of weekly periods in each grade					
	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
Religious education	3	3	3	3	3	The sixth grade will be carried out in the school year 2004/2005
Arabic language	12	12	12	11	11	
Arabic calligraphy	2	2	2	1	1	
Foreign language	–	–	–	3	3	
Mathematics	6	6	6	6	6	
Social studies	–	–	–	2	2	
Science	–	–	–	3	3	
Educational activities and practical skills	10	10	10	–	–	
Art education	–	–	–	2	2	
Physical education	–	–	–	3	3	
Music	–	–	–			
Practical areas	–	–	–	1	1	
Maintenance	–	–	–	1	1	
Computer science	1	1	1	–	–	
Library	1	1	1	1	1	
Total weekly period	**35**	**35**	**35**	**39**	**39**	

Note: The sixth grade was reintroduced in 1999. (It was abolished in 1988-9.)

[8] Source: World Development Indicators database, last update April 2001, 2001 Data for comparison: UK: population 60.5m; GDP per head $31,860; 366.2 computers per 1000 of population; 19,800,000 Internet users Germany: population 82.5m; GDP per head $30,810; 434 computers per 1000 of population; 30,800,000 Internet users.

learning experiences through the use of ICT: 'In order to achieve the objectives of development, we need to prepare a new generation who can deal with the language of this era, which is information and communication technology. This generation should be able to cope with the technology and integrate it' (Bahaa El-Din, 1997, p. 118). Since 1995, the Ministry has implemented a number of policy initiatives that have resulted in large-scale investments in ICT for teachers and schools. ICT is now a compulsory part of the national curriculum; it is planned that all middle schools will have at least 10 computers and all higher schools between 15 and 20. ISDN lines have been adopted in many Cairo schools. A number of Ministry multimedia programmes have also been designed for use in various subjects and many schools have been provided with advanced science laboratories to enhance students' exploration of science. In addition, large numbers of schools are now receiving educational digital satellite channels transmitted by the Ministry of Education. Since 2000, Microsoft has contributed nearly US$600,000 in cash and software to non-governmental organisations in Egypt to support a wide variety of ICT programmes and projects. In 2005 about 1,000 basic schools will be supplied with 14,000 computers with Internet facilities (ISDN) and programs such as Datashow, funded by the EU. Other educational ICT projects include Smart Schools, funded by USAID and an e-learning project in 7,500 schools funded by the World Bank and USAID.

Many primary schools Egypt-wide now have a small multimedia suite funded and specified to a common format by the Ministry.

Project schools

The 12 project schools are scattered across the city, representative of a wide range of locations, encompassing areas of severe poverty and deprivation (see Appendix 7). El-Nagah School, in El Sharabia district, for example, is in northern Cairo, an area that has the second-highest population density in the city, according to the 1994 census. It suffers from unreliable water, electricity and telephone supplies and overcrowding due to virtually non-existent urban planning. Tiba School is situated at the heart of the oldest part of Cairo, in Bab-El Sharia, an historic inner-city area.

Map 1: The greater Cairo region: DEEP Schools[9]
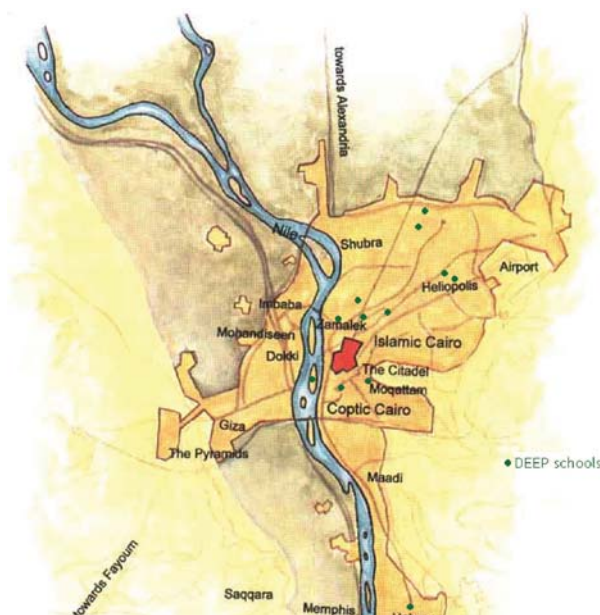
To the south-east Al-Ahramat School is the only non-Cairo school, situated in 15th of May City, a New Town in the desert, built in the 1980s away from the population concentration. Although financial incentives for new industry exist, there is a reluctance on the part of businesses to move from traditional centres in Cairo[10] and whilst many infrastructure projects are implemented, the region still faces urban problems such as unemployment and lack of housing.

The school profiles are as varied in some respects as their settings, within the parameters of a national curriculum and common entitlement to the modest ICT provision also indicated in Appendix 7. Al Ahmarat with 1,010 students is the largest school; Al Amal (206 students) and El Hekma (110 students) are the smallest. Most of the schools have more male than female students; all but two, by contrast, have more female than male teachers. Naguib Mafouz School, for example, has 950 students of whom 565 are male and 485 female; of its 65 teachers, 21 are male, 44 female.

[9] http://www.cairotourist.com/index.htm
[10] http://www.tradepartners.gov.uk/egypt/profile/04_geography/area.shtml

In most cases, students travel between ½ a mile and 2 miles to get to school. The school day generally begins at 07:45/8:00 and ends at 14:00/14.30 although in some schools students stay behind to work on extra-curricular activities. Class sizes in project schools, smaller than many schools country-wide, are between 30 and 45. On average 4% of students are unable to meet the school fees which are £E250 (GBP25) per annum. All the schools have a multimedia suite, mostly installed some three years prior to the start of the project. The general picture is as follows:

Fig. 11: Multimedia suite, Cairo
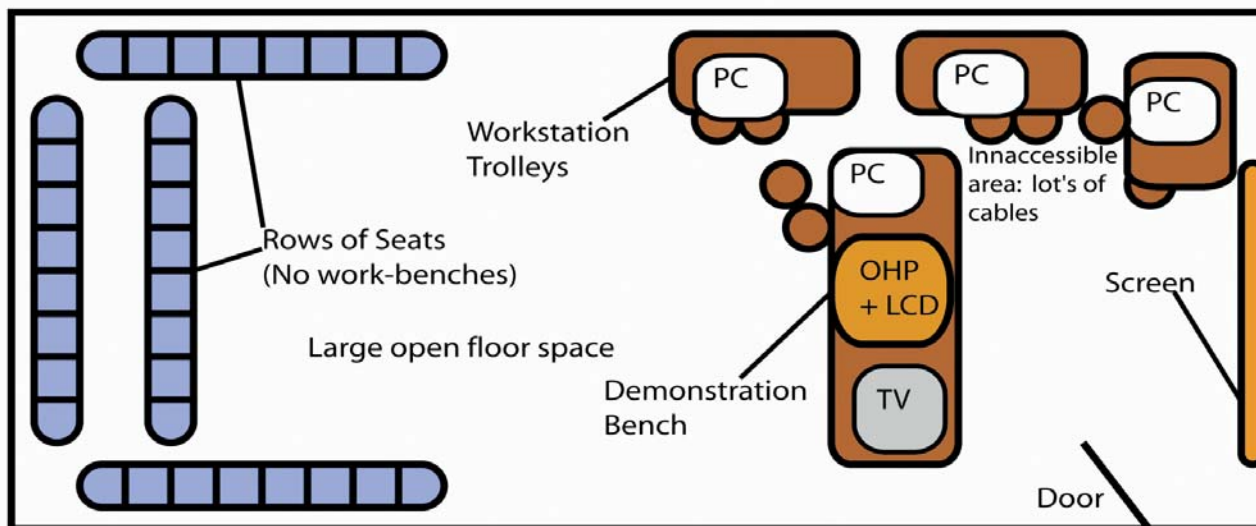
- An OHP projector and LCD panel for use with the projector;
- A TV and video player (and usually a satellite TV receiver);
- A multimedia computer (normally a PC, sometimes an Applemac) and printer;
- Between 1 and 4 additional PCs on desks or trolleys (2 is the average in project schools).

El-Shrouk has had a suite of ten computers for more than 8 years, but this is exceptional; the average is two PCs per school. The arrangement of equipment in the media lab at Naguib Mafouz is typical of most schools visited (see Fig. 11). All project schools have connectivity to the Internet.

A large 'demonstration bench' at the front of the room houses the main computer, projector and TV equipment. Behind this is a screen for the OHP, and clustered together around this area the remaining PCs. Student seating is typically arranged in rows, facing (as far as is possible) towards the front of the class. Such arrangements are geared to whole-class teaching using Ministry CD-ROMs.

In some media labs, such as the one at Al Amal, the seating area also has work-benches for students to carry out other activities with or without the teacher. However, such an arrangement is an exception, not the rule.

Project teachers
At the outset of the project the majority of project teachers were in the 20–30 age range and just over half were women; 21 (88%) of the teachers had been teaching for 3 years or more and only 7 had previously been involved in a CPD programme. Arabic is the home language of all participants. 22 (91%) among the teachers had 'some' experience of using computers, but of these, only 3 (12.5%) had used computers 'a lot' and only half (11) had used them in teaching and in these cases only 'a little'.

Fig. 12 Prior use of ICT, Cairo teachers

Technology	No. used before (%)	No. never used before (%)
Computer	22 (91.7)	2 (8.3)
Mobile phone	19 (79.2)	5 (20.8)
Television	24 (100)	–
Radio	24 (100)	–
Internet	8 (33.3)	16 (66.7)

All the teachers had prior experience of television and radio for personal use. Two had their own PC and six had some experience of computers via a friend's machine. Appendix 7 details the prior experiences, subject focus, grades taught, as well as previous ICT and CPD experience more generally of teachers in the project.

South Africa: Eastern Cape Province

Context

Situated at the opposite end of the continent, Eastern Cape Province is one of South Africa's former homelands. The poverty gap in this province is greater than anywhere else in South Africa. South Africa as a whole has a population of 45.3 million and a GDP per head of US$2,500.[11] In Eastern Cape Province GDP per head is US$432.

South Africa's first White Paper on Education and the National Education Policy Act of 1994, after the democratic transition, set out its intention to 'redress the imbalances of the past through the implementation of new teaching and learning strategies…flexible delivery of services and the equitable distribution of technological and other resources'. Educational policy was designed to 'develop a problem solving and creative environment' in which new technologies would be harnessed 'to produce knowledge, growth and development'. Such long-term policies take time to develop and are still to be effected, particularly in the poorest regions of the country. In 2002 across South Africa as a whole there were 72.6 computers and 410.5 fixed-line and mobile telephones for every 1,000 of the population and 3.1 million Internet users.[11] Most of these resources, however, were concentrated in urban areas. While some rich suburbs have 70 phones per 100 people, in parts of the country this statistic falls as low as 0.1 per 1,000 people – the same is true for access to PCs (Accenture, 2001).

South African teachers are still adjusting to and implementing a revised primary curriculum steered by principles intended to promote personal and social development and transformation for the 21st century (Chisolm, 2000). Its goals of social justice, equity and development are pursued by confronting a dual challenge: (1) of the past and moving beyond the legacy of apartheid, and (2) of the future and developing a curriculum that will provide a platform for the knowledge, skills and values for innovation and growth, cultural creativity and tolerance for an African renaissance. The national curriculum has six learning areas: languages, mathematics, science and technology, social sciences (history and geography), arts and culture and life orientation. Critical outcomes and learning area statements specify outcomes and assessment standards that are intended to promote both conceptual coherence and integration.

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[11] 2001 data for comparison (World Development Indicators database, last update April 2001):
Spain: Population 41.1 million; GDP per head $22, 690; 168.2 computers per 1000 population; 19, 800, 000 Internet users
France: Population 82.5 million; GDP per head $30, 810; 434 computers per 1000 population; 30, 800, 000 Internet users

The values of a new society striving towards social justice, equity and development through the development of creative, critical and problem-solving individuals lie at the heart of this curriculum. In theory this approach provides a visionary, outcomes-based curriculum framework – one which promotes integration and conceptual coherence within a human rights approach, paying special attention to anti-discriminatory, anti-racist, anti-sexist and special needs issues (Chisolm, 2000, p. 6). Training for teachers in the demands of this new curriculum and related pedagogies has in practice, however, been highly variable, especially for those living and working in remote areas.

The right to basic education, including adult basic education, is also enshrined in the South African Constitution. One policy initiative has been the 'The Norms and Standards for School Funding', which seeks to give effect to funding provision for schools. This funding policy aims at providing redress to the most underdeveloped and poorest schools and communities by directing that 60% of available recurrent non-personnel expenditure should go to 40% of the poorest schools in each provincial education department. The major difficulty with this policy is that the total redress funding remains inadequate to reduce inequalities. Another key policy initiative, the 'Exemption of Parents from the Payment of School Fees', allows for parents who cannot afford to pay school fees to be either partially or completely exempted, depending on income. The major concern with this policy is that it does not provide for free education, as entrenched in the international instruments, since it only exempts parents on application, and once certain conditions have been met. This creates various difficulties – parents are required to carry out cumbersome procedures for obtaining the exemptions, which many find difficult to understand. The policy furthermore does not address the victimisation experienced by students and parents who cannot pay school fees. In many instances this results in parents not sending their children to school (Education Policy Unit, 2002).

Project schools

The range, type and intake of project schools in the Eastern Cape typify the region as a whole, as indicated in Appendix 8. Three are located in towns and have some resources. The rest serve largely remote and disadvantaged rural locations where unemployment is high, agricultural opportunities are limited and resources are scarce. Six of the schools have no electricity and five no telephone connectivity, and they can only be reached by several hours' drive on unmade roads. The schools also vary in the range of technologies and other resources they provide. Two of the three town schools are relatively well equipped. One (Inkwenkwezi) has a small (albeit out of date) school library, some science equipment, a television and video player, and musical instruments including a piano and a small computer lab with four computers. Ufudo has a small suite of refurbished computers. Elintla is the only well-equipped rural school, with a computer suite housing 16 computers. The remaining schools, by contrast, have negligible resources; one utilises an old tape recorder and cassette as accompaniment to the choir and most have a small number of class books. Many of the classrooms have poor natural lighting and fragile furnishings. None are heated, although temperatures can fall below zero in the high ground during winter, and many have no windows. Three of the schools' classrooms have dirt floors and children sometimes have to stand during lessons because there are not enough desks or chairs. In one school floorboards from some of the classrooms have been removed by members of the community to provide firewood during a cold winter or for building materials for makeshift housing.

Map 2: Eastern Cape DEEP schools

School sizes and profiles are indicated in Appendix 8. The largest is Indlovu, with 960 students; the smallest Izingwe, a farm school with 155 students. The majority of project schools have more male than female students; all but two schools, by contrast, have more female than male teachers. In most cases, students travel between one and three miles to get to school. The school day generally starts around 07:45/8:00 and ends at 14:00/14.30. Class sizes in project schools vary between 30 and 50+. 80% of schools province-wide charge school fees of between R1,200 and R1,500 (£120–150) per annum. Inkwenkwezi and Umceu fall into this category and Uxolo's fees are significantly higher at R2160 (£216) p.a. The majority of the project schools, however fall in the bottom 10%, the low-income school category: Izingwe's and Ingqanga's fees, for example, are R30 (£3) p.a. and foundation students at Iqhude pay R5 (50p). At Ubulumko, where school fees are set between R10 and 30 (£1-3) depending on the grade, 90% of students are unable to meet the payment.

Cluster groups and lead schools
In the Eastern Cape schools were formally allocated to one of three cluster groups as a key form of peer support. One town school in each cluster, each with Internet access, was chosen to be a lead school, acting as a base for cluster meetings: Ufudo (with a small suite of desktop computers), Inkwenkwezi (4 desktop computers) and Uxolo (single desktop PC housed in the corridor outside the school principal's office).

Project teachers
Of the 24 teachers 17 (71%) are female; Xhosa is the home language of the majority. At the outset two-thirds of the project teachers were in the 40–49-year-old age range.

14 (58%) of the teachers had never used a computer prior to the project. The majority (18, or 75%) had never used the Internet and none owned a computer. Of the 10 teachers who had prior experience of computers, 5 had 'occasionally' used them in relation to teaching; 4 of the 5 were based in the project's town schools. The other 5 had 'occasionally' used a computer at an Internet or study centre, or with a friend, but never for teaching. Previous applications of the technology were overwhelmingly for 'personal use' (21, or 87.5%).

Fig. 13: Prior use of technology, Eastern Cape teachers

Technology	No. used before (%)	No. never used before (%)
Computer	10 (41.7)	14 (58.3)
Mobile phone	15 (71.4)	6 (28.6)
Television	21 (87.5)	3 (12.5)
Radio	19 (82.6)	4 (17.4)
Internet	6 (2.5)	16 (66.7)

Case Study 1 describes the daily challenges typically faced by rural school teachers within the project, through a focus on one school in the project.

Case Study 1: Facing the challenges
Ubulumko School is a rural school with 300 students, located in the Mnquma Local Municipality. In common with many rural areas of the Eastern Cape, Ubulumko is affected by poverty, unemployment, lack of social amenities and inadequate infrastructure.[12] These problems are ongoing, despite government efforts to create a successful Integrated, Sustainable Rural Development Strategy. There are no other development initiatives in the area. Indeed Mnquma falls within the poorest 10% of the most deprived areas of South Africa.

The village is reached by an hour's difficult drive from the main N2 via an unmade road, offering remarkable views across the Kei River gorge but virtually inaccessible in the rainy season. Few adults between the age of 20 and 50 reside there: many have died from AIDS, and surviving able-bodied adults live in towns or cities most of the year round in order to make a living. On average students live within a 2-mile radius of the school, mostly with grandparents or other relatives. Fees are between R10 and R30 (£1–3) per annum, depending on the level of study; 90% of students are unable to make this payment. Classrooms are mostly bare, concrete-floored constructions with delapidated wooden desks; the youngest learners are taught in dark, crowded, thatched rondeavaals.

The project partners and their students
Nomvula is in her late 30s. She has been teaching for 11 years; this is her seventh year at the school. She has a B.Ed, STD and her subject specialism is science. She is an expert in the study of Xhosa and recently completed a Diploma in Translation (Xhosa/English). Prior to the project Nomvula had negligible contact with computers and had taken part in no other CPD programme. The improvement of her school and the development of students were her reasons for applying for the project: 'I'm interested in seeing myself involved in many projects to improve the learning situation.' Project partner Nomsa, in her 40s and with no prior experience of computers, has a similar commitment to the students. Nomvula appears to take the lead in the partnership.

There are 40 learners in the DEEP class. They are much shyer with visitors than their fellow students in the project's town schools and greatly lack self-confidence. Observation of their activity as they forgot about the research team and worked with digital cameras around the school during one field visit showed them to be curious, quick to learn but also as demanding as children living in deeply challenging circumstances anywhere can be.

Accessing contemporary forms of knowledge and information, as well as communicating with communities beyond the immediate confines of the village, is a significant challenge. Within the village there are a few battery-operated TVs and the school has a radio, though these machines are frequently out of action. There is electricity in the school, although this service can be fragile, but no telephony – nor in the village more generally. Because of the paucity of resources in the school and large classes, a good deal of teaching is done by rote or the copying of notes from chalkboards. On the first visit one researcher observed a ten year old in one classroom incorrectly copying copious notes about AIDS into a notebook.

Nomvula uses a mobile phone to communicate with friends and colleagues, as access to a wireless network is possible from the village; she is an avid communicator via SMS.

[11] Eastern Cape Provincial Government: Speech by Mec Mamase at the Eastern Cape Rural Development Summit, http://www.ecprov.gov.za/speeches/agriculture/2000/summit.htm, 2000.

Programme support in practice

Basic skills training and launch workshops

The programme resources, particularly the website, took longer in preparation than originally envisaged, necessitating some delay to programme launch. In Egypt the launch was postponed for an additional three months in the aftermath of 9/11. The revised timescale of activity across the research period overall is shown in Appendix 1b. Since many project teachers were novice ICT users, an intensive three-day basic skills training was provided for all participants immediately prior to project launch. In Cairo this was carried out in an IT teachers' centre; in Eastern Cape it took place in UFH's science laboratory. Project teachers were well taught by IT specialists (in Cairo the IT adviser of the centre; in South Africa a VSO working at UFH).

Launch workshops took the form of four days of curriculum-focused sessions led by literacy, numeracy and science specialists (January 2002 SA; March 2002, Cairo). The IT specialists remained on hand to help with problems such as failure of Internet access during this period. This intensive period gave a solid grounding for IT knowledge and skills. In the Eastern Cape the initial three days of basic skills training, followed by a four-day launch workshop, took the form of a week's residential. The researchers observed that this cemented firm collegiality that proved to be important for teachers when they returned to their schools.

The workshops modelled a range of classroom, curriculum-focused activities: project pairs worked in small groups according to geographical location on collaborative as well as linked individual tasks. Introductory literacy, numeracy and science Professional Activities, and Classroom Tasks, were carried out by the teachers themselves, with the intention that these be repeated back in school, thus forming a strong and confident basis for the development of subsequent activities. Other launch sessions included practical seminars on matters such as: Introducing the DEEP programme to our school, class and community; Security issues; Classroom management; Health and safety. Teachers wrote poetry, accessed websites to carry out science investigations, used Excel to carry out numeracy activities, gave multimedia presentations evaluating their outcomes to peers and sent e-mails to project colleagues in Egypt and the UK about their progress.

The notion of 'affirming' learning is integral to education policy in the Eastern Cape and as a result affirmation events were built into both countries programmes. At the conclusion of both workshops, teachers were publicly presented with a certificate of participation at a formal 'affirmation' ceremony attended by Ministry officials, school principals and other key supporters of the research project. In the Eastern Cape, school principals and project pairs were formally presented with the lap-tops to be used within the project as part of this event.

Hand-held training

Teachers practised using and enjoying the hand-held devices in a two-hour session (launch workshop, March 2002, Cairo; May workshop, 2002, Eastern Cape, some 3 months after project launch) including: basic applications (e.g. Word, calculator, games, on-screen keyboard); use of the camera; how the infrared beam facility could enable document sharing; and how the device could be synchronised with the shared lap-top (South Africa) or school PC (Egypt). Pairs were also shown how to locate and open the programme resources on the hand-helds, including the e-books, how to bookmark and annotate pages, make new notes and access the related multimedia assets (e.g. audio of Martin Luther King; video clips of classroom practice; flash animation of a well-known fable).

Lessons learned during the launch training

Eastern Cape

The first launch workshop took place in the Eastern Cape. Intermittent, unreliable electricity and Internet access during the four days meant seminars had to be rearranged at short notice. Such physical problems were outweighed by the advantages of mobile lap-top computers, three workshop rooms and an extensive campus in which the teachers could work within their cluster groups. Such flexibility allowed teachers to work collaboratively with ease in various settings, including outdoors, enabling the curriculum specialists to model a range of individual, pair and group approaches to curriculum activities. Key project websites had been provided on CD-ROM for times when Internet access was not possible, which in the event proved essential.

Whilst the training was enthusiastically received, it became clear from feedback that the structure of the programme and project outcomes had not been made explicit enough within the Teacher Guide. As a result, Activity Cards were created

Fig. 14: Example pages from the DEEP e-books
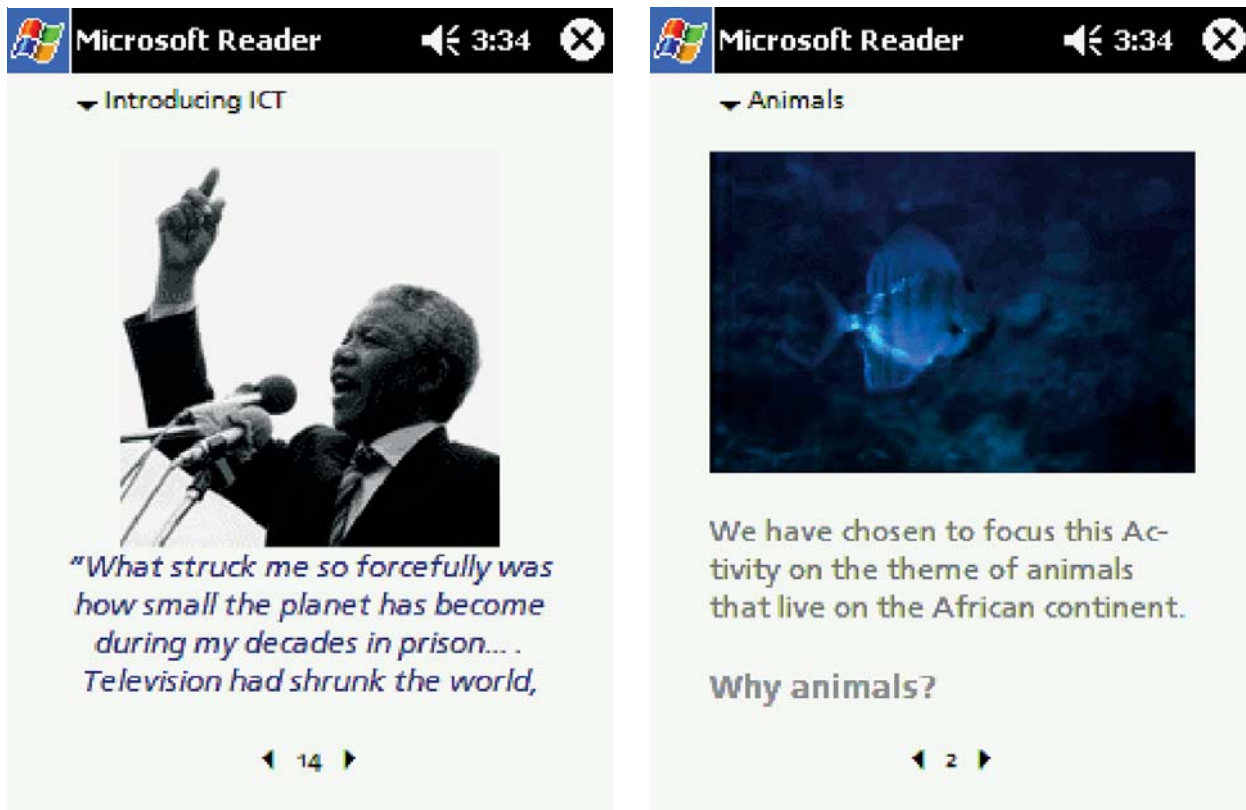
that summarised the 10 Steps of the programme, the resources to support each Step, together with a summary of teacher and student expected outcomes. The Teacher Guide was also revised. Teachers were given these revised materials at a subsequent workshop.

Cairo
Lessons learned in the Eastern Cape workshop were implemented in Cairo, including use of the new Activity Cards. The advantage of this setting was the use of a dedicated IT centre with relatively reliable, if slow, Internet access and display facilities. Teachers shared two or three to a desktop PC and for some sessions also used the project team lap-tops to enable team working.

The disadvantage of this context was that the IT centre was cramped; this made group work difficult. Sessions had to be more formal.

Although the Teacher Guide and activities were provided in Arabic, it had not been possible in the timescale to Arabicise all the electronic resources. This was a great disadvantage; in upscaling it would be essential to have the full range of Arabic resources from the outset. In subsequent workshops the PPMU's own centre was used and there was more flexibility for group working.

Key issues arising out of the launch training:

• need for clarity of structure and purpose;

• strong underpinning of intensive basic skills training (2–3 days) essential for novice ICT users;

• teacher pairs seen as a 'work unit' central to the peer learning model;

• group activities based on cluster groupings (for rural areas);

• opportunity for collaborative, classroom-focused activities that are achievable, enjoyable, incrementally demanding and always strongly curriculum-focused;

• mother tongue activity and resources;

• 24-hour personal ICT access the ideal;

• availability of off-line resources;

• community ownership of security issues essential;

• constant focus on the importance of school and community involvement;

• ongoing affirmation of learning.

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Ongoing support

Three mid-project workshops were held in both contexts: in Cairo teachers attended workshops at the IT centre in the course of the programme, run jointly by the IT adviser and the local DEEP co-ordinator; teachers discussed progress and worked on new activities. In the Eastern Cape three workshops were held in May, August and September. The project faltered somewhat, however, in the second term after the tragic, unexpected death of the co-ordinator. The new co-ordinator was not established until September; her leadership demonstrated that strong project management was essential. In both contexts school visits were made and the VSO IT specialist accompanied the DEEP co-ordinator to cluster-group meetings to give further basic skills training and help trouble-shoot. This IT specialist returned to England in December 2002 and was not replaced. No dedicated IT support was available to the Eastern Cape teachers for the remainder of the programme.

> *I now have an e-mail account as you can see above. We had a workshop Saturday with those who turned up. A majority of the schools are connected thanks to R [ISProvider] who reconfig.d the lap-tops and made sure everybody was connected. During the workshop I showed the educators a trick or two on the scanner, so don't be surprised if you get something through the E-mail. I picked up two lap-tops from Mecer, which have been repaired. Sadly one of them had to have its hard disk reformatted, so we have to reload the software onto it. Now this is a question for you [_____], is there a way in which we can transfer data and information from one lap-top to another, and will it be simple? As far as I know we haven't got any of the discs to reload Windows XP and other software. Do you have any suggestions? Well I did say it was going to be brief, sorry to load a few problems off onto you. See ya!*
>
> *Message from IT support, Eastern Cape, to DEEP discussion board, September 2002*

Cluster groups and teacher leaders

Despite original careful planning, two rural schools in the Eastern Cape replaced the designated town schools as cluster leaders. Ingqanga, situated in an impoverished settlement, became the lead school for the Queenstown cluster despite being one of the poorest schools in the programme (Uxolo had proved to be too far away to be the host school). Its project partners emerged as strong teacher leaders. Ufudo, originally chosen as lead school for the King Williamstown cluster (the only former 'Model C'[12] school, with a computer suite of 25 Internet-enabled computers) did not actively participate in the project after the initial training week. Zama (Intambanane School, Case Study 6) and Sibusiso (Umceu

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[12] A Model C school during the apartheid era admitted only white students.

School) became leaders of this cluster and meetings took place at their schools despite poor road access and infrastructure. Inkwenkwezi remained lead school for the Butterworth cluster as originally planned; over the lifetime of the project Lulama was observed to develop as a strong teacher leader within that school, even though she had no previous CPD experience and little prior ICT knowledge. All six teachers, together with Peter and Connie (Uxolo, Case Study 4) continue to be active as teacher leaders in supporting project peers and other teachers in the province. They will take lead roles in the up-scaling of the programme.

In Cairo cluster groups were not designated, nevertheless eight teachers emerged as strong leaders: Saraa, (Case Study 2) and Gaber (both maths specialists); Inas and Nany (Arabic specialists); Mahra and Mamoud (science specialists); and Weret and Hosni from El Nagah. All will be subject leaders when the project is up-scaled to 72 rural schools in 2004.

Security issues

Security was a hot issue in both contexts where equipment is costly and poverty the norm. In Egypt most schools had secure classrooms for their labs and computers and many had local security or caretakers living on the premises. In the Eastern Cape the issue had been the focus of a launch workshop session and the topic revisited on several occasions during the residential. Discussions about strategies that would ensure resources were secure were linked to broader group discussions on how the project, its resources and technologies would be introduced to the students, staff and the local community of project schools. Workshop leaders and participants in both settings agreed that the school, parents and local community should be encouraged as far as possible to feel ownership and pride in the project and the resources it was bringing, to the children of their communities in particular. The first DEEP Professional Activity, 'Why ICT – for my learners, my school and my community?', and the first school-based Classroom Task, 'Introducing the computer and the project to our school principal, school staff, students and local parents', were designed to reinforce this approach.

In practice a different solution for security evolved in each community. At Iqhude, for instance, equipment was stored at the school principal's house each evening; Indlovu school already had a strong room; Ingqanga school used unobtrusive market bags to carry equipment to and from village homes at the end of each school day (pairs of students worked a rota for collecting and returning the equipment – see picture below). A discussion between two project teachers about their approach to introducing the computer to the school community can be found at www.open.ac.uk/DEEP.

Programme activities

By mid-project review in the Eastern Cape (August 2002), all of the project teachers had used the DEEP CD-ROM resources: 23 (94%) word processing; 8 (33%) spread sheets; 21 (88%) presentational software. All had used solitaire or other games and the camera and 5 (20%) had used websites other than those provided as part of the project. The computer had been used by students for classroom activities in all project schools, including:

• word-processed literacy activities (e.g. poetry, short stories, personal writing);
• finding, selecting and presenting scientific information from project websites;
• creating multimedia presentations (incorporating text and images) based on the cross-curricular project theme;
• creating spreadsheets on animal classification;
• reading and discussing multimedia fables and other texts;
• Africaans and bilingual language activities (Xhosa/English);
• taking photographs to incorporate into a range of activities.   *(Mid-project report to UFH, 2002)*

In Cairo at mid-project review (November 2002) all of the teachers had used the DEEP resources. 23 (94%) of the teachers said they had used word processing; 2 (8%) had made spread-sheets; 10 (40%) had used presentational software; and 6 had used websites other than the ones provided by the project. All had used the computer and camera within the classroom; student activities were broadly similar to those in the Eastern Cape, with the addition of Arabic language activities.

At the close of the project 23 (96%) of the 24 schools and their local communities participated in public presentations of project work to peers. Teachers confidently showed curriculum outcomes that had entailed use of word processing, presentation software, imaging, Excel, Internet, e-mail, camera, printer, scanner and photocopier for a wide range of numeracy, literacy and science activities. Students similarly presented numeracy, literacy and science activities that had involved exploration and use of websites; analyses of data using spreadsheets and charts; word processing in English, mother tongue and bilingually (in Arabic/Africaans/Xhosa); the creation of multimedia products. All the uses of ICT set out in Table 1 (Chapter 3) were observed during the course of the project.

In the sections that follow, project activity is briefly exemplified through a series of case studies across a range of settings, focusing on key elements of project activity: planning using ICT; approaches to the teaching of literacy, numeracy and science using ICT; team learning; teacher partnerships; and professional networks.

Planning using ICT
Step 5 of the programme focused on the planning process. Resources such as planning templates, examples of classroom lay-out, video clips showing activities such as peer tutoring, as well as practical approaches to managing and organising group work were provided on the project website, CD-ROM and hand-helds. Case studies exemplified the importance of planning when implementing ICT. Professional Tasks encouraged project pairs to plan lessons jointly.

Case Study 2 illustrates how project teachers used ICT to support planning and preparation, particularly lesson planning, classroom organisation and developing classroom materials. The teacher focused on in this case study was observed working in her classroom three times during field-work.

Case Study 2 'Now I come to be creative': using ICT for planning and professional practice
Saraa's school, El Hekma, is located on a bustling side street near the city centre on the east bank of the Nile, where there is rapid population growth resulting in housing problems, poor infrastructures and poverty; 5% of its 110 students are unable to pay the modest school fees.

In her early 30s, Saraa has been teaching for more than three years. She was keen to participate in DEEP because of 'a wish to develop and promote ourselves and abilities through adapting new means and methods applicable in our schools, and improve my own understanding through the computer'. Prior to the project her experience of computer use, both for personal and professional purposes, had been minimal, although she did have occasional access to a computer at her friend's home. A committed teacher, she is very interested in her specialist subject, maths. Occasionally she is required to attend in-service meetings run by an advisory maths teacher in the city. As part of this training she had been shown how to demonstrate CD-ROM numeracy activities to students using the school's overhead projector, linked to a computer.

Saraa reports that her capacity to plan lessons and schemes of work developed during the programme, she's begun to 'think how I could manage my classroom'. This account is borne out by observations of two lessons and by the range of products in her electronic portfolio, including a workbook planning how to teach place value in maths. Saraa suggests that the hand-held computer in particular has supported this aspect of her personal and professional development, because 'I am able to use it at home'. Prior to the project her only access to ICT was in the school's multimedia lab or at a friend's house. In the mid-project questionnaire (November 2002) she records that she has not really used the hand-held device. Towards the end of the second field interview (March 2003) it emerges she has begun to use it regularly.

'At first we didn't use it [the hand-held] to be honest with you. It saves time because at home I can prepare my lessons. I then download to the PC [at school]. This didn't happen before. This is better than using the pen! The whole process was easier than normal preparation. Preparing and planning lessons was routine, but now I came to be creative.'

It was observed that Saraa's preparing and planning impacted on her classroom practice. At the outset of the project her teaching had consisted solely of didactic, whole-class presentation, together with question and answer routines. Her newly developed ability to obtain and make resources – as well as carefully planning for their use – facilitated new forms of classroom activity. Students made presentations of their work to the whole class using the computer and linked OHP; they also took turns to use the computer in pairs or small groups while the rest of the class were working in their books.

'We [referring to her and her partner] were the only ones who opened the computer – and we placed – and we showed – the Ministry of Education CD. Now children have begun to work together; some of the students have taught a lesson to the whole class… I began to use co-operative learning.'

Saraa considers that students are interacting differently with her now:

'they even began to give me floppy discs with their own work on it! The students are very eager…….the machine is just like a friend!'

She also records that she has bought her own hand-held device:

'as it is very useful for my work and my personal usage. It cost me 2700 Egyptian pounds.'

We assume she bought an Arabic-enabled device.

Teaching using ICT

Approaches to literacy
Fig. 5 (pp. 16–17) summarises the kinds of literacy activities progressively introduced across the 10 Steps of the programme in which ICT was used to develop a sense of audience, allow for drafting and editing of work, recognising different genres or introducing new literacy forms (e-mail; multimedia writing). The pedagogic strategies introduced within the programme were informed by the view that learning is social and situated. Joint activity was often the unit of practice as well as analysis. A range of resources were provided to support these activities, including writing frames, a variety of carefully selected poems and stories, multimedia artefacts and illustrative video clips of literacy lessons.

Each Professional Activity was linked to a curriculum-related Classroom Task. Introductory literacy activities invited students to work in groups to write texts focusing on their own experiences, e.g. their village, school or a concept. Literacy activities facilitated and were in turn facilitated by use of the word processor, (e.g. font colour, type and size). In training sessions simple writing activities such as acrostic poetry were used to model what might be possible with students, whilst reinforcing teachers' basic IT skills and illustrating the potential of team learning. Teachers felt confident to repeat such tasks within their classroom settings, realising as they did so that collaborative activity can provide a social framework for ICT use – students could be encouraged to 'turn take' equitably and learn to work together at the computer, as well as to support each other in the learning process itself.

GAWULAYO	
Gqogqabantu beziphilele	You hounder of harmless people
Awunalusini empilweni yomntu	You have no compassion
Wonke umntu ukhala ngawe	All are complaining about you
Ukhohlakele	How cruel you are
Latha-latha ndini lesifo	You hollow, heartless disease
Awunalusini	You really have no compassion
Yahlukana neentsana zabamtu	Let our children be
Oh: uwuzalisile umhlaba ngamangcwaba.	You have already filled up our souls with graves. It's enough.

Gawulayo (The chopping disease – i.e. AIDS) A poem written soon after the launch training by a project teacher.

Teachers working in resource-challenged settings were particularly impressed by the support that the electronic thesaurus, grammar, spelling and dictionary facilities offered students' language development, as well as the flexibility of ICT software for producing quality mother tongue resources. 'It improves language skills for those [Xhosa speakers] who do not speak English. At the beginning they are stiff, we play games to facilitate their ICT skills! Now they love working and learning. We have made isiXhosa stories that are related to their experience. If the child can't read or write in his/her own language there will be a problem. It is easy to translate the skills you know from your mother tongue' (Teacher interview, 2003).

Digitising cultural heritage

'It is important that policies are developed that preserve, affirm, respect and promote diversity of cultural expression and indigenous knowledge and traditions through the creation of varied information content and the use of different methods, including the digitization of the educational, scientific and cultural heritage.'

Plan of Action,
World Summit on the Information Society

Literacy tasks encouraged use of the mother tongue, and bilingual activity where appropriate, as well as investigations into local culture and environment. Student activities observed included:
• studying local herbs: students and teachers collected herbs, scanned them and then made a booklet annotating their names and uses for medicinal puposes;
• presentation to parents on local environment and wildlife;
• composing illustrated local folk tales/*intsomi*;
• investigations into authors in the literary heritage (e.g. Naguib Mafouz);
• bilingual story writing (English/Arabic; Xhosa/English).

Case Study 3 'Now I become a young author of tomorrow'
This case study illustrates how one project pair interpreted and taught the Professional Activity 'Telling My Story': *Plan a literacy task that focuses on structuring a piece of writing; model and demonstrate this task in the classroom and get learners to apply the model for themselves; show learners how to use e-mail to communicate what they have written to a real audience.*
(Extract from DEEP Activity 5c)

The school
Uxolo School is located in a major town in Eastern Cape Province and is one of the better resourced in the project. The town is served by an adequate network of infrastructure, including a major national route and other secondary roads, and is advantaged relative to other areas. Nevertheless, many urban problems such as ongoing unemployment and homelessness, a legacy of former apartheid, affect the area.

The majority of the school's 259 students come from disadvantaged communities, many of which have been targeted by other development initiatives, including a local educational programme called *Imbewu*, that aims to 'develop all levels of the education system in order to establish, nurture and support development initiatives in strong vibrant educational communities.'[13] Due to this project, the quality of teaching, educational resources and the management of the school have improved. There is electricity and a telephone, but no means of transport. Available resources include a small class library and large hall.

The school is part of the Queenstown cluster. It was originally assigned to be the cluster's 'lead' school because of its resources and experience of new initiatives, but has not fully fulfilled this role because of its distance from the other schools in the cluster.

The project team carried out 3 days of observations in the school (August & November 2002 and March 2003).

The teachers' experiences
Peter is in his early 40s and has been teaching for several years at the school; he specialises in maths and science. Prior to the project he had used computers 'a little', but never in his teaching. Connie is one of the 3 school principals in the project; she specialises in literacy. In her 50s, she used ICT 'a little' for teaching prior to the project and acquired a desktop computer for her staff to use. The pair did not work together prior to DEEP but have now developed a good working relationship. Occasionally they plan and teach in the classroom together, as they did on the sequence of lessons discussed in this case study. Both teachers now use ICT between 3 and 5 hours a week in school. Connie uses the lap-top/hand-held between 5 and 8 hours each week at home, partly for school administration.

The influence of ICT on teaching, as well as on the school more broadly, is evident from the sizeable portfolio compiled by the teachers. They are both proficient in the use of 'Word' and have produced work sheets and lesson plans, as well as documents relating to the general administration of the school such as a financial report, minutes of staff meetings and reports of staff appraisals. Official school correspondence is word-processed and the project partners have written CVs. They also use the computer to research lesson material. Educator Diaries have been completed in detail, recording the success of engagement with the Professional Development science and literacy Activities (see Fig. 4).

Connie organises the students into groups for classroom tasks. Students have written their own animal fables and discussed the notion of morals in stories; they also produced poetry, wrote (and performed) a class play on endangered animals and posted messages about their work on the DEEP TALK noticeboard. Connie's students have used ICT most for 'investigating, research and presenting material'. She thinks this has improved their 'use of English, reading and spelling and accessing new information'. She herself has used ICT most frequently for obtaining information from the Internet such as on 'drafting school policies'.

Peter considers that use of ICT has 'improved and widened students' vocabulary and language use' and 'especially their science knowledge'. He uses the computer most for preparing maths lessons and organising the school and district sports activities. He often uses group arrangements. Initially, he introduced the lap-top to an 'expert' group of learners within his class who each then acted as a 'facilitator' of a class group. He records in his diary that DEEP has helped him to 'reformulate my approach to planning and teaching more generally'. The project team observed him teaching a

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[13] Eastern Cape Provincial Government, Department of Education, *Imbewu* Eastern Cape Educational Transformation Project, 2000. (http://www.ecprov.gov.za/projects/2000/imbewureport.htm)

science lesson in which students took turns to access the 'Enchanted Learning' website and carry out research and cloze activities using the lap-top, taking turns of 30 minutes or so each across the morning in small groups (August 2002). This was a highly effective lesson in terms of student learning and engagement.

Student activities: Telling My Story

Grade 7's classroom is small and dark; it can be cold in the winter months. It has a small class library. There are 30 students in the class; representative of the school intake as a whole, they are lively and bubbly. Three or four students share a wooden desk. One difficulty the teachers faced in implementing the project has been the sharing of the single lap-top computer with a fairly large, lively and very demanding class.

Connie and Peter planned the literacy sequence as a whole-class activity in order to minimise the problems of sharing a computer. Making sure that everyone had a role and activity in the project meant additional co-operation over computer use.

Extract from Uxolo portfolio

Grade 7: How the Giraffe Got Its Long Neck

Activity	Rescources	Evidence of learning
Reading the story	A printed copy of the story	Learners are able to read and understand the content of the story
Creating a new page/scene/scenario for the story as it unfolds – insert pictures, narration and dialogue	Previously prepared drawings Scissors, glue, paper, pencil	Learners are able to create a scene on paper using their own drawings.
Transferring the page onto a slide using the lap-top and the scanner	Lap-top computer, scanner	Learners are able to scan the scene that they created onto the computer, adding another page to their story. They are able to create a text box for the narration and speech bubbles for the dialogue.
Doing a worksheet on the Rhino	A copy of the worksheet and the information sheet to be done on the computer/a printed copy	Learners are able to interact with the available information and to complete a worksheet.
Doing a worksheet on the Giraffe	A copy of the worksheet and the information sheet to be done on the computer/a printed copy	Learners are able to interact with the available information and to complete a worksheet.
Doing a slide show to keep track of how the story develops	All previously completed pages of the story	Learners are able to do a slide show. They are able to read their own story. They are able to share it with other learners.

Planning sheet (Connie)

1. The learners read the story 'How the Giraffe Got Its Long Neck' at least three times.
2. They experimented individually with ways and means to re-formulate the *intsomi* as a story book for younger children, using a combination of dialogue and narrative.
3. Through class discussion they ultimately agreed on an overall plan together.
4. The learners worked in groups, each group responsible for one section (page) of the story. Every learner contributed an image and also wrote part of the narrative and dialogue.
5. Groups scanned the background scenes for their page using the scanner, so that individual contributions made a creative whole, and then created text boxes and speech bubbles for the narrative and dialogue.

(Based on Connie's teacher diary)
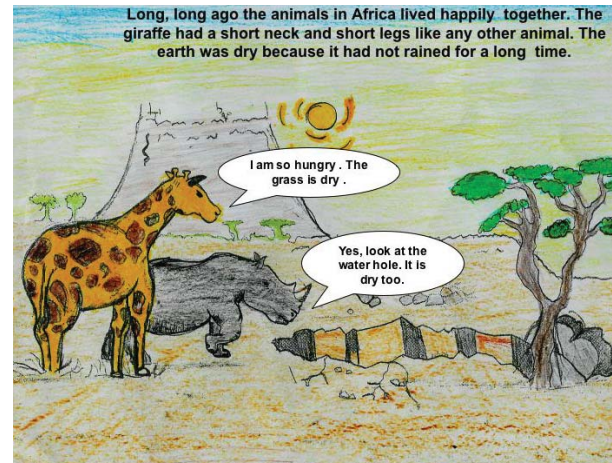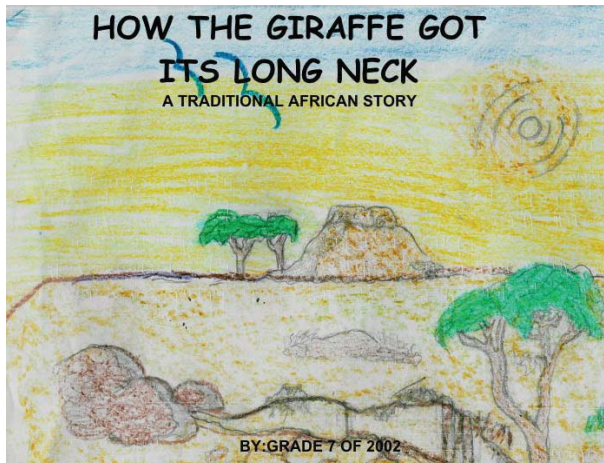
The local team diary recorded observation of some of this work:

Week 29th October - 1st November 2002 Visit to Uxolo, Grahamstown

Doing some excellent work with the learners, who in return produce excellent results.

Saw a lesson with the 'Giraffe and Rhino' fables as the theme. Learners created their own pictures, scanned and inserted their pictures, read stories, highlighted words they didn't know and answered questions about the Giraffe and Rhino.

No major concerns, seem quite happy with what they are doing, but if they continue through to the second phase, they will have to start again with new learners, as the grade sevens will be split and moved to a secondary school. I don't see this as a problem. It looks as if the lap-top is being used by the learners outside school hours.

Connected to the Internet and E-mail

(Extract from local project team diary)

Throughout the project the teachers provided each other with support. This co-operative approach encouraged important discussion about how ICT could be used in planning and teaching. Both project partners 'strongly agree' that using the computer has made their teaching more effective and feel that the acquisition of new skills and the ability to help learners to use the computers is a major achievement. Now that they feel confident using computers, they are keen to continue using ICT for classroom tasks. Connie reports that she could never go back to *'not using ICT…I feel in touch with the latest developments in education…It enables us to progress into the 21st century by leaps and bounds. They [students] need to be properly equipped to use ICT because of the age in which they are growing up.'*

(Exit questionnaire, 2003)
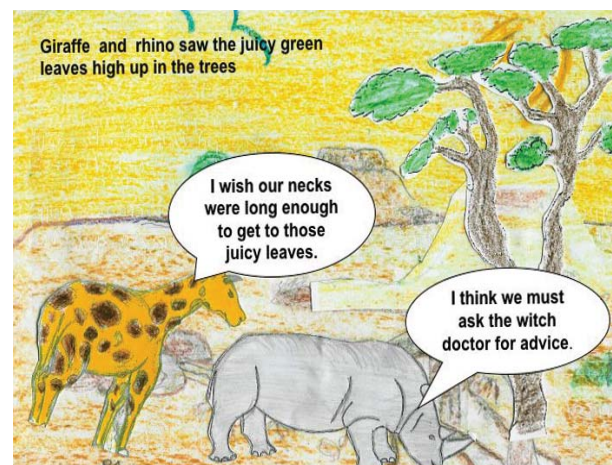
Giraffe drank all the medicine and soon his legs and his neck started feeling strange .His neck grew further and further away from his legs and the ground .His legs grew longer and longer.

Giraffe closed his eyes tightly and when he opened them, the world around him had completely changed. He opened his eyes and shouted …..

It's working!!
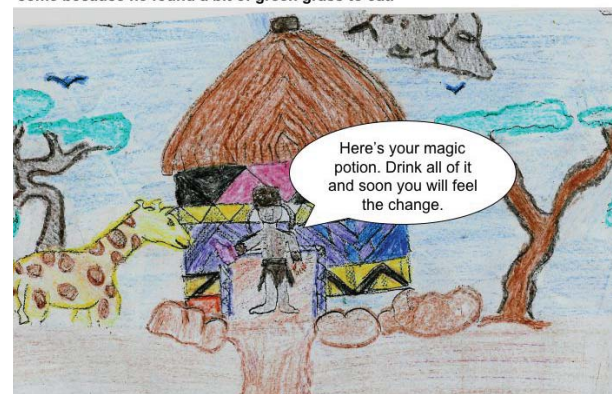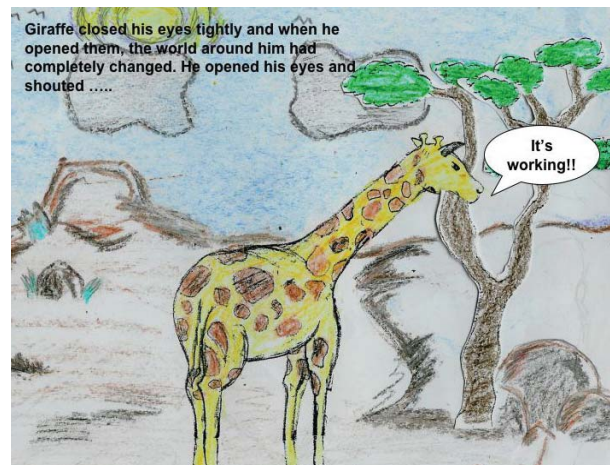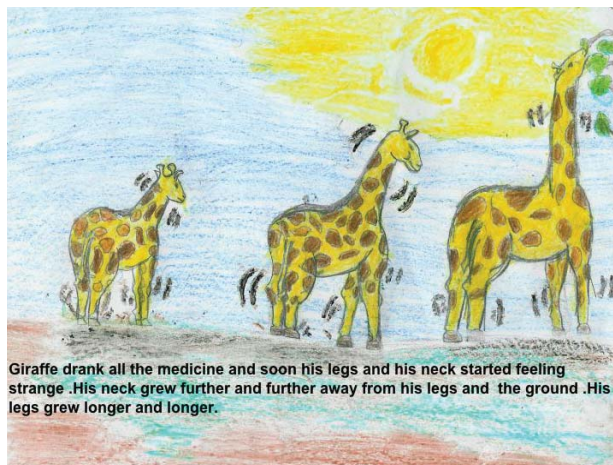
Approaches to science

The Introductory science activities encouraged teachers to get students to observe and compare the features of familiar vertebrates (goats, pigs, birds, snakes and dogs) and less familiar ones (made available through rich websites such as 'Enchanted Learning'), then to generalise to the characteristics of the vertebrate groups. Exploration of animal adaptation used a mix of local resources (for example the skulls of carnivores and omnivores) and electronic sources (for example, on the camel and the African wild dog). Teachers and students alike were invited to create presentations that showed key adaptive features; they chose one particular endangered animal, and considered the causes of its endangerment.

Study materials included subject knowledge resources aimed at the teacher, such as information on animal classification, adaptation and niche; access to the 'redlist' of endangered animal information (as used by practising biologists); classroom resources (student-friendly websites, animal 'fact files'); and pedagogic aids – templates (e.g. for bilingual writing frames), exemplar documents, strategies for challenging naïve understandings.

The approach aimed to facilitate the integration of whatever local/natural resources were available, with a study of environments and animals beyond the immediate locality. Teachers were encouraged to develop a degree of independence in their students – inviting them to choose the animals they wished to work on; identifying features they thought were important; agreeing questions to explore; determining what to present, and how to present it best. In this way students' everyday concepts were extended to include scientific theoretical concepts. Students' learning activities included guided investigation that allowed them to orientate themselves theoretically to the surrounding world (Vygotsky, 1978).

Case Study 4 Developing scientific literacy

Case Study 4 sets out the experiences of Nomvula, a natural science specialist with no prior experience of the computer or Internet. See Case Study 1 for an introduction to her setting.

Organising learning in a classroom with minimal resources, poor furniture, uncertain electricity and demanding learners takes a lot of energy. Powering the computer regularly demands considerable planning, and using one lap-top with large classes is hard work. In the early stages of the project Nomvula was not a prolific user of the lap-top and hand-held compared with some of her colleagues. This changed as she gained in expertise, confidence and practice over the first year of the project.

The project team spent three days of observation at the school (August and November 2002 and March 2003), talking to staff and learners, and also participated in a meeting of governors and students' grandparents.

Doing very well, the educators are using the computers nicely with the learners, who demonstrated how well they know the lap-tops. Unfortunately [Ubulumko] has been without electricity for a few weeks and [Nomvula] has not been able to do all they would have liked. However, this has not disillusioned them and they are still as enthusiastic as ever.

They reported no major problems, but would like to develop using Excel for numeracy activities. [Luli] (cluster leader) joined me for the trip, and we encouraged them to take their time in doing the activities, and not to rush them for the sake of the UFH project.

The principal was available briefly, and thanked DEEP for its help within the classroom and school.

NOT connected to the Internet or e-mail.

(Extract from local team diary. visit to Ubulumko, November 2002)

Nomvula uses the lap-top at home between 3 and 5 hours each week. Since the Internet is not accessible at school she uses the Internet facility of another school and is also now connected at home. She identifies 'learning more about the subject area I teach' as the professional activity she uses ICT for most, together with 'preparing teaching materials and resources'. Both she and her partner Nomsa have used 'Word' to create work sheets, for example on the themes of 'Animals' and 'Energy'. They frequently work together, share ideas and provide colleagues with support. Besides participation in the formal DEEP Professional Development Activities, the lap-top history indicates that Nomvula has used the computer to pursue her own learning by working on home study assignments such as translations from Xhosa to English and word-processed essays on 'Terminology Theory'.

ICT activities are used to improve students' literacy in Xhosa and English in the classroom. Students have used 'Word', for example, to create letters related to the theme 'Me and My School' as well as accounts of 'Home' and 'Myself'. In addition, they have worked in groups to create multimedia poetry and used the scanner to make calendars that feature their own photos. The DEEP CD-ROM, frequently used in literacy lessons, has encouraged the reading and group discussions of multimedia fables; stories studied have been used as a springboard for the students' own writing. Such activities help develop social and communication skills; they also allow a greater depth of subject content to be covered in a shorter time. This type of work has recently been extended to the teaching of numeracy. One activity Nomvula speaks of with great enthusiasm was using the hand-held camera and audio recorder to capture a live lecture by Mark Shuttleworth, the first African in space, during a visit to Butterworth. This has become a permanent classroom resource.

Nomvula reports in her exit questionnaire (March 2003) that 'Science' is the ICT-related activity used most often by her students. The lap-top history confirms this. We can see that she started to use the lap-top a month after the launch workshop (she had initial problems authenticating the new machine) and have been able to track that over a period of several months that same year she began to use the 'Enchanted Learning' website to research scientific topics: vertebrates in March, amphibians in April, energy in July. She has adopted the project's cross-curricular approach, evidenced through the simple schemes of work, illustrated below:

SCIENCE ACTIVITIES: NOTES ON VERTEBRATE ANIMALS:-

1. THE FISH
2. FOCUS ON:- a) HABITAT b) BODY DIVISION c) RESPIRATION
                d) LOCOMOTION e) FERTILISATION
   LEARNER ACTIVITY:-
   DRAWING OF THE FISH STRUCTURE AND LABELLING OF THE STRUCTURE

Literacy Activities:
1. RETRIEVING THE DEEP CD AND READ ABOUT THE AESOP FABLES
2. CHOOSE ONE STORY (THE WOLF IN A SHEEP SKIN)
3. DISCUSS THE STORY WITH THE LEARNERS
   LEARNER ACTIVITY:- WRITE A STORY BASED ON THE MESSAGE FROM THE STORY WRITE
   LETTERS AS THEY HAVE TO SHOW   SCIENCE ACTIVITIES: POWERPOINT PRESENTATION
   NOTES ON AMPHIBIANS

(Extract from teacher planning notes)

The lap-top's history chronicles student work arising from these schemes; they draw on the DEEP websites to access information otherwise unavailable, such as that on animal classification shown in the students' presentation. Use of presentation software prevents students from 'copying and pasting' large chunks of text without consideration; it leads to a more focused reading, appraisal and selection from source material, and encourages 're-presentation' of ideas in students' own words (e.g. no reference source would have used 'etc.' where 'birds' would have completed the list...).

Groups of students have used the resources to extract appropriate information on animal characteristics and used the structure of their presentation to help organise their information about the animals, each 'topic' addressed on a separate slide. Indeed, having access to a 'virtual library' with information on hundreds of animals has allowed the learners to explore similarities and differences between different vertebrates, making some first steps towards comparative biology.

The lap-top evidenced cross-curricular work that integrated animal classification and adaptation, with animal stories and acrostic poetry:

GIRAFFE

- G=Good looking
- I=Innocent
- R=Reserved
- A=Ability to
- F=Fight
- F=Foes
- E=Ever and ever
- BY:Sizipiwe,Zikhona,Lundi ,Onela,Sibongiseni,

T=Terrestrial
O= Of an
A=Amphibian with the
D=Dark.

BY: NOSAZISO, AXOLE, ABONGILE, MISE

DIFFERENCES BETWEEN A FISH AND A FROG

- A frog lives on both land and water
- It is covered by skin
- It is divided into 3 parts, limbs, head and trunk
- It breathes by means of the lungs
- It uses legs for swimming and jumping

- A fish lives in water
- It is covered with scales
- It is divided into 3 parts, head, trunk, tail
- It breathes by means of gills
- It uses fins for swimming

SIMILARITIES BETWEEN A FISH AND A FROG

- They are both aquatic animals
- They are both cold blooded

- They both lay eggs (oviparous)
- Their fertilisation is external

EXTERNAL STRUCTURE OF A TOAD
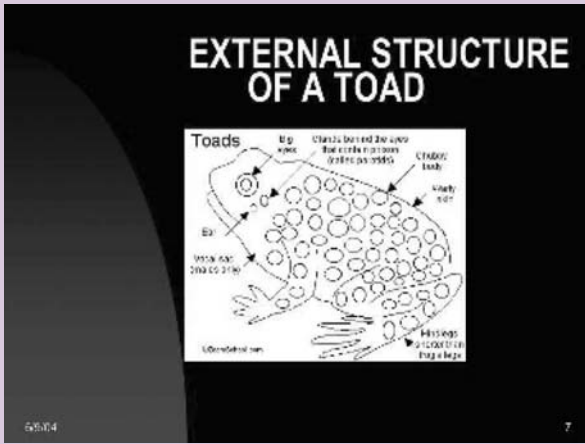
Approaches to numeracy
Numeracy was the least developed element of the programme because the team was unable to locate a suitable numeracy specialist within the constraints of time and project resources. A number of project teachers specialising in maths strongly voiced the need for additional numeracy activities at mid-project evaluation and an additional workshop on *Logo* was provided, although unrelated to the project theme.

The main numeracy activity involved teachers in exploring the use of ICT for data analysis, and comparing population figures for several endangered species from the two project countries.

The approach taken had a number of defining features:

• The work was genuinely open-ended – there was neither a 'right' process or a 'right' answer – the focus was upon developing students' understanding.
• Students were invited to work with real data about real problems – data with 'holes' and ambiguities.
• Students had to explain and discuss their thinking with their peers, working collaboratively.
• The work could bring into play a wide range of numeracy skills, from basic maths (addition, subtraction, multiplication, division), to working with ratio, rate, percentage, bar charts, line graphs, extrapolation.
• The use of spreadsheets facilitated rapid exploration of ideas, providing instant feedback to students.
• The use of presentation required students to make their reasoning explicit, whilst providing opportunity for affirmation.

Many numeracy teachers took one or more of these features and applied them to the particular topics they were teaching at that time.

In many of the classrooms visited in Egypt changes in interaction with students were observed – with teachers 'coming out' from behind their desk, and a more interactive dialogue (between teachers and students, and Saraa's students and students) developing. This new approach is illustrated by classroom (see Case Study 5) where students worked in small groups on mathematical problems, taking turns to work at the single PC.

Case study 5 (continuation of Case Study 2)

'Before DEEP we only used [Ministry of Education] CDs, now we use Powerpoint and Word. Before only the teachers used computers, now the children began to touch and use the computer. One excellent [thing] – learners [are] teachers to others.'

(Teacher interview, 2003)

Saraa was observed teaching part of a lesson in the schools media laboratory. She used presentation software as a basis for a period of whole-class teaching on 'place values'. Presentation slides were used to provide information and questions, which the teacher invited students to respond to. The students were very attentive and motivated to respond – and there was a lot of teacher–student interaction. One student was chosen to 'operate' the computer, moving the slideshow on when invited to by the teacher. Students seemed to enjoy the teachers' use of brightly coloured backgrounds and cartoon characters for decoration.

At this point, only a term after the project launch, the observed student use of ICT was minimal, but the researchers noted that Saraa had 'taken control' of ICT use in her classroom. Although the way in which she was using the computer to 'show' things to her students was similar to her previous practice, – she was no longer 'showing' the prescribed Ministry CD-ROMs, but had begun to author her own educational materials. The project partners also reported that they had begun to do 'basic skills' work with their students, who were becoming more confident.

In addition to classroom uses, both teachers were daily reading the news on the Internet (http://weekly.ahram.org.eg/index.html) and exploring educational resources.

Six months later (April 2003) Saraa had developed her practice considerably. She reports:

'My methods of teaching strategy have completely changed. In the past I was a traditional teacher. Now I think about how I can use my classroom. It made the students more lively and vitality [sic]. It's a live classroom.'

(Teacher interview, 2002)

Together with her partner she had begun to file interesting articles she was finding in the on-line newspaper, and using these in class work. Students sent an e-mail to the Egyptian Minister of Education as part of one project.

'The information of the work [i.e. the traditional school books, or what the teacher brings] is not the only information. The information from the Internet enriches their mind…using the computers drew their attention to the lesson…our text-books are very dry. If we give them more information, this is very good for them.'

(Teacher interview, 2003)

The second observation focused upon a teacher-led presentation, but this activity had become significantly more sophisticated. The teacher had created hyperlinks to enable students to choose answers to questions 'on screen' with the choice leading to a 'right' or 'wrong' image and accompanying sound being presented. In this way, groups of students were able to work their own way through the questions, with feedback provided by the presentation.

Saraa was surprised at how the students wanted to follow her own experiences, from being 'users' to 'creators':

'When I created a presentation for the students, they began to imitate me. One of the students made their own presentation in English language…at first I used the computer alone. Now I encourage the students to use the computer, and we monitor, encourage them….I think there is interaction between the teacher and the students, when the computer is used as an educational aid.'

By creating her own digital learning resources, Saraa also realised that she had previously tried to teach too large a cluster of concepts at one time. Trying to structure and organise this area of the curriculum more successfully, she devised a scheme of work that broke it down into five units of study. The supervisor from the regional maths office was sufficiently impressed with her thinking in this area (teaching fractions), and the use she had made of ICT, that she was invited to present her work to a meeting of 110 maths teachers and supervisors. Having presented the first of the five units, the teachers insisted she come back and present the others too. This has been the first time Saraa has presented anything to her peers in such a context – it has been a significant boost to her professional self-esteem.

Case Study 6 'Now we become a work unit'
El-Nagah is located in the El Sharabia district in northern Cairo, with the second highest population density in Cairo, according to the 1994 census (see Appendix). Hosni is in his late 20s and teaches maths to grades 1–3, whilst his slightly older colleague, Weret, is a female teacher of Arabic. Prior contact with ICT was negligible for both partners and neither had used the Internet. Weret had not previously participated in any other teacher training programme. Hosni had been involved in a professional development scheme related to maths, and also English and Word for Windows; he also had some access to a friend's computer outside of school hours. He was the only teacher to vigorously voice negative comments about the programme and its purposes during the initial launch. He had mistakenly assumed it would focus on development of personal computer skills and was sceptical of the idea of ICT being used by students in the classroom. Neverthless he persisted with the programme; a year later evidence shows him using ICT significantly, both at home and school for the planning and teaching of mathematics and Arabic. He has now purchased his own PC.

Although they work in a relatively small school, Weret and Hosni did not know each other prior to the project. The researchers were surprised to learn that they now meet together weekly to work on the computer, to prepare and evaluate lessons. Weret reported:

'Before the DEEP project we didn't know each other – everyone was separate. Now we become a work unit, and very great friends. Last year we shared a class...Every Thursday we have a fixed meeting...we discuss everything – DEEP, problems of teaching. Mr S (technician) also comes.' [Hosni] 'I need training too!' [Mr S]

The local co-ordinator suggested that this partnership had encouraged Hosni to persist with the programme early on when he might otherwise have given up.

Developing teacher partnerships
The project pairings were envisaged as an element of support; this relationship was structural within the programme as set out in Chapter 3. Lap-tops were configured (using XP) with three discrete password-protected areas: one for each partner plus a shared area for joint working. Interviews and school visits showed that the computer facilitated close joint work on professional tasks, and this has already been illustrated by the work of Peter and Connie. In the Eastern Cape, the fact that partners needed to plan together in order to physically share the single lap-top (both for classroom teaching and out of school use) was shown to increase joint working practices.

These partnerships varied – males and females working together (in both settings); mature colleagues with younger colleagues; an older school principal with a younger teacher; an ebullient character combined with a shy one and so forth. Relationships and expertise also varied; in some instances, for example, a stronger ICT-user worked with a partner with greater pedagogic maturity. In only three cases did pairings break down significantly, due to illness or rivalry over lap-top use etc., situations that over a period of time the local co-ordinator and relevant cluster groups tried to resolve with the teachers concerned.

In both country contexts many peer partnerships appear to have developed as significant working relationships, as illustrated by Case Study 6.

Developing professional networks
The DEEPTALK environment generated a completely new form of professional activity for all the teachers who used it. The project team observed the way in which such activity often entailed a technological battle with frustratingly slow and sporadic Internet connections. Nevertheless many teachers persisted with using e-communication and saw it as a valuable, additional professional tool that they wished to become proficient in using.

Thursday, May 02, 2002 – 03:04 pm

Hi

You cannot believe. We now own our own mini pocket computers.

'I can't use it'.

I'm just teasing.

We promise that we will do our best. Hey, how do other people feel about the use of these computers. I'm with [2 project partners] from King. They have started their fight with the mini computer. Chiau

Thursday, May 02, 2002 – 03:11 pm

Hi GLOW WORMS

I AM NOW DEEP IN THE USE OF ICT. IT IS FUN TO BE INVOVED IN THE EDUCATION TRANSFORMATION.

WITH WARM GREETINGS

After the initial spate of 'here I am' messages, communication mostly focused on problems, or questions, although there was some sharing of work and ideas. Students from some of the project schools were also encouraged by their teachers to use the environment to experiment with e-mail.

Friday, May 24, 2002 - 02:26 pm

Hi

We have not yet received the modems and the photocopiers. By the way we are in a process of learning how to use the jornadas. A's Jornada does not work properly. The problem is the calculator, it does not show any keys.

Now we are in a process of registering the jornadas.

Regards M

Tuesday, June 11, 2002 - 04:30 pm

A : if your Jornada is still not working properly, there is a 'reset' button on the back of the machine: push this to make it start afresh. You will not loose any information when you reset.

Yours, T.

Saturday, November 16, 2002 – 10-11am

Dear DEEP

My name's A_____ .I'm a student in the [El Salaam]. I like the DEEP activities very much. Mrs _____is training us to do very interesting slides. We are using Internet and e-mail. I'm very happy to be a DEEP member

A_____A_____, Primary 4

As reported more fully in Appendix 9, the failure of standard software programmes to support Arabic was a major issue faced by the project. A dedicated Arabic-enabled discussion area linking project teachers in Cairo had to be set up by the local co-ordinator using Yahoo, because it did not prove feasible to create one on the DEEP site in the time frame of the project. This worked successfully for networking, announcing local workshops and the posting of resources.

On the other hand, Xhosa could be spoken on the site, because it utilises Roman script.

Thursday, May 02, 2002 - 03:16 pm

SHWEMZA

HUNTSHU!!!

KWAQAL'UKULUNGA.DEEP,UKHANYISILE

Web-based communication via modems remained so fragile, unreliable and slow in the Eastern Cape context that the website was rarely used when instant contact with a colleague was required. SMS (text messaging) was used most frequently to arrange meetings, or to alert colleagues that a longer message awaited them on e-mail. Nevertheless e-mail became an important form of contact and many of the teachers persisted in its use despite connection difficulties.

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Hi [Tami]

I'm fine thanks and I hope you are doing very well. Listen I don'tknow what to about the video camera at the moment and I'm going to Alice this week. The only alternative is to get it next week onTuesday. I'll be going to East London and I'm starting new activities with my kids.Otherwise, how are you doing with Ace?

See you next week. Bye, [Luli]

Greetings! I also think congratulations are in order! I hope your day went well. I'm trying to check whether you got ivideo from V----- kuba wayethe uyakuza nayo this past weekend nikwazi ukuyifumana kuba uN------- ubusy yichoral music at the moment, akakwazi ukuyisebenzisa. Ubulise kuA------ and find out from him whether laclaim wayeyifakile for travel yabhatalwa kuba u V---- uthi eyakhe zange ingene. I need to know so that I can follow up. You also need to claim for the aborted meeting you came to a few weeks ago.

Hi Welcome to the club yokuphelelwa yimali. I'm glad niconnectile noV`----- -I'm now worried about iV----- kuba their stuff got wiped out phayakooV-------.

E-mails between participants, 2002

Text message sent from a teacher to a project co-ordinator, 2003

'The knowledge and experience of poor people and their perspectives on their needs and own solutions to their problems are often ignored.'

(Marker et al, 2002)

'Understanding and coming to a realisation of the validity of one's culture and one's voice…through a strong sense of one's own creative input into the world; to take increasing power over oppressive conditions…that can be dealt with in a lot of different ways...In terms of the very, very strong sense of everyday culture, the very, very strong sense of images of…oneself. It is a whole way of transforming the material, the style, the context, the very definition of what is worth learning.'

(Interview with Herbert Kohl on Paulo Freire's approach to literacy).

'It's changed; we learn things in our region, before we didn't understand.'

'I did not know how to dream but now I know.'

(DEEP student questionnaires, 2003)

Still and moving image production
Activities that utilised digital cameras, photography and the making of movies came to play an important role in the programme for all project schools in both contexts. Initially the research team had seen the digitisation of project activity as a means of documenting programme development in real settings. Images of teachers, students, schools, classroom activity, social events, field trips, drama, indigenous plants, music making, interviews, poetry readings and story telling were cumulatively captured by the project team and participants (including students) and shared with teachers, parents, students, governors, members of UFH and PPMU on any group occasion: on pitted whitewashed walls or expensive screens, at training sessions, in schools, at cluster meetings, on lap-tops and on hand-helds.

Once teachers were assigned their own cameras, media production was observed to be ceaseless in school communities, especially those that had never before had the opportunity to frame, capture and critically observe themselves, their neighbours, friends, community.

Such activity included:

(i)   Teacher use:
• creating images and movies for use as ongoing classroom resource;
• capturing classroom activity to document student progress;
• recording programme activity for self-assessment/portfolio;
• photographing friends, children and other relatives;
• documenting special events (school play, visit of a dignitary, graduation ceremony etc.);
• fun;
• making school displays for colleagues, school principals, governors and inspectors about the school and its work
(especially important where adult illiteracy is high).

(ii)   Student use:
• photographing the environment for presentation or critical assessment (e.g. conservation issues);
• scientific and social sciences project work;
• field-work;
• fun.

Such activity was seen to create new forms of knowledge. Still and moving images gave a new status and importance to everyday activity, local events, indigenous natural and human resources. They were also seen to facilitate a strong sense of personal and group identity. 'This is us'; 'This is our place'; 'We are here'; 'This is what we do.' Many teachers and students used cameras to create or capture their own products, capturing, scrutinising and sometimes critically analysing their own settings.

In discussing project findings, the research team sometimes encountered the view that digital cameras and associated software were a luxury item for resource-challenged settings. Yet the research showed that media production played a distinctive and significant role in learning within the project. Media production was seen to enable:

• learning based on the familiar and what was of value to the community;
• validation of students' and teachers' own communities and settings as subjects of investigation;
• curriculum and domain-related development;
• creativity;
• documentation of learning (for both students and teachers);
• communication of student activity to parents with little if any literacy skills.
• reflection;
• critical analysis;
• social skills;
• the digitisation of the cultural heritage, indigenous knowledge and traditions;
• fun and enjoyment;
• affirmation of success;
• a sense of agency.

Approaches to team learning

Within the Eastern Cape a common approach was developed by project teachers that allowed all students within a class to develop fluency and confidence in using ICT within a very short time frame. They worked with a group of 5 or 6 of their most confident students for an hour or so daily over a period of one or two weeks. Each student then became a group leader whose task it was to share their expertise with peers. This was sometimes done during lessons, sometimes after school; students were keen to stay on to use the computers, cameras and scanners.

The research team noted a range of related outcomes:

• Student leaders took seriously the responsibility of ensuring each member of their group had an equal turn in practice and instruction; an almost balletic routine in the sharing of touch pad or stylus was observed.

• The approach was efficient in ensuring that students learned basic skills quickly.

• New social skills were developed.

• Peer teaching and learning enabled students to be relaxed; they felt free to explore. Many developed exceptional fluency in a range of softwares through experimentation, quickly outstripping their teachers.

• This collaborative approach of 'expert' leaders permeated classroom organisation more generally.

• Students' literacy and oral competence were increased.

DFID

Chapter 5: **Discussion of findings**

This chapter will focus on the study's anticipated outcomes: that student achievement and motivation can be enhanced by the effective use of ICT and that teachers' professional knowledge can be developed to ensure such improvements. In presenting the findings of the research, the three main research questions will be addressed in turn:

• What is the impact of ICT use on the pedagogic knowledge and practice of teachers and the communities in which they live and work?
• What is the impact of ICT-enhanced teaching on student achievement and motivation?
• How can teacher education and training be developed to ensure teacher capacity to exploit the potential for ICT?

The findings relating to the research questions on the benefits and limitations of using the hand-held computer in a professional development context will also be set out, together with additional issues raised by the research study.

Research question 1

What is the impact of ICT use on the pedagogic knowledge and practice of teachers and the communities in which they live and work?

Key finding 1

Project teachers in both contexts quickly developed confidence in using desktop/ lap-top and hand-held computers for a range of purposes:

• development of basic computer skills was largely unproblematic;
• the majority learnt to use a variety of digital softwares and other peripherals (e.g. Word, Calculator, Powerpoint, Internet, E-mail, Games, Scanner, Printer, Photocopier, Camera) in a short time frame.

Teacher confidence

'One of the main barriers to further integration of ICT throughout the curriculum is teachers' fear of using computers: some are frightened that they will explode if they press the wrong key.'

(Cawthera, 2001)

'I love to use the computer, I use with no fear'
(Cairo teacher, end of project interview).

'The [hand-held] is my companion'
(Eastern Cape teacher, end of project interview).

Teachers in both contexts quickly learned to use ICT for a range of personal, professional and pedagogic purposes and during the lifetime of the project teachers grew significantly in their confidence to use ICT. In interim questionnaires (August and November 2002) almost a third of teachers indicated that they had begun to feel 'somewhat confident' in the use of computers; two-thirds reported 'medium' to 'high' confidence.

In exit questionnaires all respondents reported 'medium' or 'high' confidence, and offered extensive additional commentary which included: 'The project has removed my fear in using various communication and information

resources'; 'using computers gave me high confidence to release hidden abilities inside me and teach students using modern methods'; 'I have medium confidence to use a computer because we have only one and it's not an easy task to use it with the learners'; 'I think I have high confidence to use a computer because I am more computer literate than other staff'; 'my use of computers gave me full confidence to produce educational materials that serve our curricula and to leave traditional methods of teaching behind'.

Fig. 15a: Confidence in using ICT – Cairo teachers, 2002   **Fig. 15b: Confidence in using ICT – Cairo teachers, 2003**
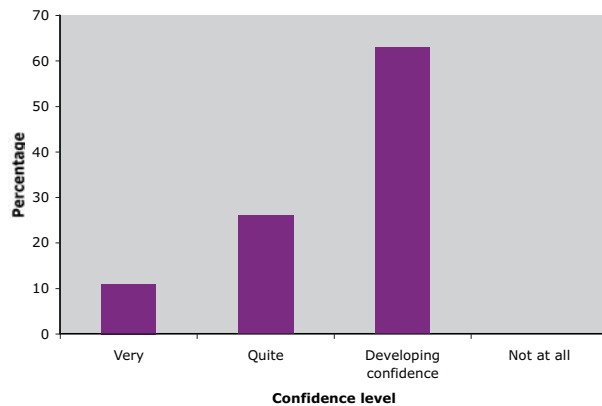
These reported experiences were borne out by observations of all project teachers using ICT in a range of settings (workshops, classrooms, affirmation ceremonies) and confirmed by the range of teacher and student products and ICT activity (such as website use) tracked on PCs and lap-tops, as illustrated in Chapter 4.

It would be easy to gloss over the significance of teachers' developing confidence in 'using ICT for teaching'. In the process of confidence building, teachers are learning something that is not yet there in their experience; they are 'acquiring their future activity while creating it' (Engestrom and Middleton, 1998); this is a challenging process involving experimenting, modelling, and then generalising. First steps are often the hardest, because they reveal personal vulnerability, lack of know-how, as well as fear of what is not known. Project planning can often underestimate the importance of the process of confidence building: the elation–anxiety accompanying 'first time' activity such as a laboriously constructed first e-mail, use of a software program such as Word for the first time with thirty or more children in a classroom; first use of a hand-held to exchange a document with a peer. The programme explicitly set out to encourage teachers to name and discuss their ICT needs; reflect on when and how they might usefully and appropriately choose to use ICT in the demanding circumstances in which they live and work; document their own and their students' and peers' progress, however small, in diaries and questionnaires; and publicly affirm and celebrate achievements.

Teachers' awareness that they were participants in a research project supported reflectivity. The value and high status accorded to their ongoing evaluations of the ICT activity – and the self-esteem such activity afforded project participants – provides important general lessons for similar CPD programmes.

The following aspects of programme design and implementation were seen to be important factors in the key process of confidence building:

- personal access to ICT;
- project partner;
- joint evaluative activities;
- strong initial IT and pedagogic training;
- curriculum activities progressively building ICT skills and knowledge;
- few prior expectations (including ICT-literate peers) to live up to;
- commitment by school, students and community to support project partners in their efforts;
- clear overall programme management structures to ensure ongoing support;
- affirmative feedback from peers, school principals, students, parents and project team.

Key finding 2

ICT use enhanced teachers' professional knowledge and capability by extending subject knowledge.

Developing subject knowledge

'In poor communities, the scarcity of trained local personnel and the impediments they face in accessing vital information and enhancing their skills, perpetuate the low educational attainment and poor health of these communities and makes them less able to cope with new challenges.'

(Marker et al., 2002, p. 7)

Hello,

I used the camera when Mark Shuttleworth visited Butterworth. You know him, the first African to go into space. I also recorded his speech while making a lecture about his journey into space. How wonderful!…its now that I can feel myself as a professional. Warm greetings. Bye'

(E-mail from Nomvula, project teacher, 2002)

The development of 'subject' knowledge, as set out in the model of professional knowledge, in Chapter 2, was the most frequently cited purpose for teachers' own professional use of ICT, both in interviews and questionnaires (29 (82%), exit questionnaire). Subject knowledge was also the aspect of professional knowledge that teachers deemed the project to have had the highest impact on: 'The DEEP had a great effect on my abilities in teaching my subject and made me enjoy it more'; I have started to use computers in a way that is related to my speciality'(exit questionnaires, 2003).

Research suggests that teachers' subject knowledge is an essential component of effective teaching, yet it is an element of continuing professional development often overlooked, or taught in isolation from other aspects of professional knowledge. The approach taken in the DEEP programme, integrating subject matter development in tandem with new pedagogic knowledge through classroom-based activity, was welcomed by teachers. Teachers requested that additional cross-curricular themes such as health and citizenship should also be developed within the programme; that could in turn support literacy, numeracy and science teaching in much the same way as the environmental theme has done.

Fig. 16: Teacher use of project resources for subject knowledge development
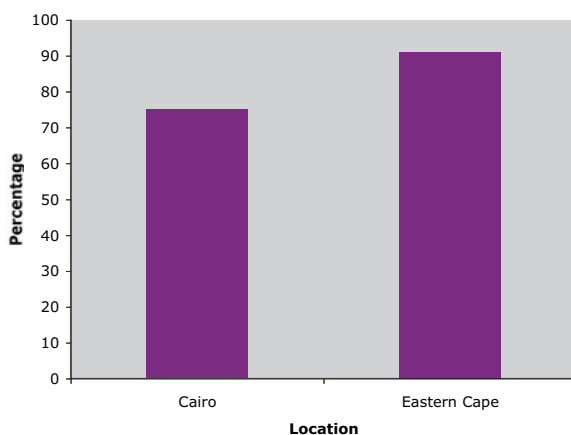
Evidence from several recent studies (see Cox et al., 2004, for example) also shows that when teachers use their knowledge of their subject, their use of ICT has a more direct effect on student attainment. Project data confirms this, illustrating the way in which ICT served concurrently as a means of developing teachers' subject knowledge, and as a pedagogic tool for enhancing students' scientific and information literacy. Case Study 3, above, focusing on the development of teachers' scientific knowledge in a remote, information-poor environment, also illustrates, through analysis of practice over time, that use of ICT can raise the quality of teaching and learning in schools and communities which are starved of resources and information. In cost-effectiveness terms such a school derives a much greater incremental benefit from one functional computer than schools already saturated with resources (see Cawthera, 2001, p. 30).

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Key finding 3

ICT use enhanced teachers' professional knowledge and capability by enabling planning and preparation for teaching to be more efficient.

Developing school knowledge

'The poor have information, knowledge and communication needs, as do all people, yet they are often unable to address them… given the multiple constraints they face, the poor are either unable to meet their needs or must do so in costly ways that may perpetuate their disadvantaged position'.

(Marker et al., 2002)

'I can't go into a class now without having planned activities thoroughly'

(Teacher interview, South Africa, March 2003)

The category 'school knowledge' is used in our model of professional knowledge to gain a hold on the complex processes a teacher must carry out to transform subject matter of any kind into teachable form, taking account, for example, of age groups, interests and prior experience. 'School knowledge' includes knowledge of national curricula; the discourse, vocabularies and models of school subjects; understanding of national examination criteria, as well as how to translate all these into meaningful, progressive schemes of work and lesson plans and thence into practice. The daily task of planning for teaching is arguably the most demanding and often most underrated professional task of all, involving teachers in a wide range of roles – for example as researchers, planners, project managers and resource providers. This study revealed just how exhausting and de-motivating it can be for teachers to maintain such intellectually demanding activity day after day with the minimum of resources and only rudimentary planning tools and lack the associated professional artefacts that many teachers in the global north take for granted (e.g. planning templates; curriculum documents; example lesson approaches; dictionaries; thesaurus, etc.). It also unexpectedly revealed the key role ICT can play in supporting the development of school knowledge and hence a new sense of professionalism. In both contexts teachers reported that use of ICT had impacted on their ability to plan lessons; a majority (27 [77%]) reported 'high' impact.

The most frequent uses of ICT for the development of school knowledge were:

• to obtain resources (27 [77%]);
• to prepare teaching materials (22 [62%]);
• to prepare lessons (22 [62%]);
• to produce teaching resources (18 [51.5%]);
• for administration (12 [34%]).

(Exit questionnaires, 2003)

Teachers particularly reported on the expansion of their professional capabilities as they used and got used to the lap-top and/or hand-held computer. Many considered that there was something unique about the opportunities provided by such flexible devices in their particular context. Portable computing offered new possibilities in terms of access to 'anytime, anywhere' professional activity. The hand-held in particular could be used at home, in the classroom, in friends' homes, on field-trips or at a special event. This finding was most marked in the Eastern Cape where project partners shared a lap-top and two hand-held computers. In Cairo teachers had been hampered by the English-only interface of the hand-held; if they wished to use the desktop PC they needed to do so in situ, out of school hours. Nonetheless, increased planning and preparation for lessons was visible in the Egyptian context too and the experience of Cairo teacher Saraa (Case Study 2) is evidence of this.

In both contexts the use of the word 'creative' was frequently chosen by teachers to describe how they felt about the way ICT had changed their day-to-day classroom organisation and planning activity. Through new opportunities to practice the planning process, amend model lesson templates, explore video and case studies of collaborative learning, and access and develop fresh resources, many teachers in the project felt motivated and confident enough to try out new teaching strategies.

Initially, the media lab arrangements inhibited teachers in Egypt from trying out activities that required planning for group and paired work. As the project progressed, researchers observed both teachers and learners leading more interactive whole-class sessions using ICT. By project end, significant numbers of school students in the Cairo project schools were successfully participating in small-group literacy, numeracy and science activities at work-stations. In some of the schools teachers rearranged furniture in the media labs in order to accommodate the new way of working.

Such findings challenge current orthodoxy that ICT relegates the teachers' role to that of 'facilitator', confirming research that shows teachers' expertise and creativity in planning for pedagogy to be a central dimension of effective practice. More broadly they highlight the importance of school knowledge for effective teaching and the key role ICT can play in its development, enabling teachers to plan and develop resources and teaching strategies effectively and efficiently. It might well be argued that in circumstances where teachers struggle without an adequate professional toolkit to support school knowledge, education is destined to remain an impoverished experience for teachers and students alike. Certainly there is little evidence that basic education as currently practised in many parts of sub- Saharan Africa is increasing access or quality (Cawthera, 2001). A recent study by Dembélé and Miaro-II (2003) indicates that unhelpful teaching practices and rigid, chalk-and-talk, teacher-centred/dominated pedagogy remain the norm in sub-Saharan Africa. 'Such pedagogy places students in a passive role, limits their activity in class to memorising facts and reciting them back to the teacher' and is also 'reflected in classroom assessment practices'. Teacher development stands as a cornerstone for change, but professional work, as this study shows, demands complex knowledge. Such knowledge, we propose, can be significantly enhanced by access to an up to date, professional toolkit of practice such as that used by project teachers and as set out in Chapter 2, principle 2. ICT can enable teachers wherever they are situated to access, use, develop and improve some of the essential artefacts of their practice: planning tools, case studies of effective subject teaching; model schemes of work; approaches to classroom organisation with large class sizes, and so forth.

Key finding 4

ICT use extended the range of teachers' existing pedagogic practices: all teachers introduced ICT into planned lessons with their classes; there was evidence of students' outcomes from these lessons.

Developing pedagogic knowledge

'We are writing our own African story.'

'…We even made drawings…I've learnt how to sketch…'

'I learnt to scan. I have learnt how to improve a picture on the computer…'

'I find it very interesting to work with a computer…I've learnt how to print and type on the computer…The story is about how the giraffe got its long neck. We will share the story with all of you when it is done…'

(E-mail from Grade 7 students, Uxolo School)

Fig. 17: Importance of ICT for learning, Eastern Cape
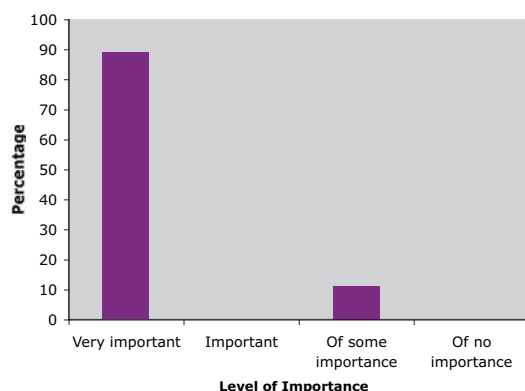
The majority of teachers reported that they considered ICT to be 'important' or 'very important' for teaching and learning; 88% of teachers in the Eastern Cape considered it to be 'very important' (mid- and end of project questionnaires).

Although the research team expected that the DEEP Professional Activities would stimulate some new classroom practice, classroom application was not expected until the second term of the project. Project pairs were encouraged, as discussed in Chapter 4, to spend time

initially becoming personally confident with the kind of tasks they might in the future get students to carry out in the classroom. Even then the researchers assumed practice would develop slowly – if at all – in those circumstances where teachers were struggling with large classes, limited ICT access and negligible ICT support. It was an unexpected finding that all project teachers were using ICT in the classroom by mid-project review. In the Eastern Cape, most teachers had been integrating ICT into some lessons some two months after project launch. Fig. 18 enumerates products gathered from lap-tops. These have been categorised according to the type of teacher knowledge (i.e. school/subject/pedagogic/personal) that seemed to the research team to be most drawn on in their production. Documents produced by the whole school/community are also indicated. In all but one project school the number of products associated with classroom teaching (pedagogic) was in the majority.

Project teachers identified their own most frequent use of ICT within the classroom as:

- to facilitate collaborative working (74%);
- to present material (54%);
- to enable independent learning (31%).

(Exit questionnaires, 2003)

Such use varied between countries. For example, all except one Eastern Cape respondent said they used ICT to facilitate collaboration; only a third said they used ICT to present material to students. Whole-class presentations by teachers were frequently observed in Egypt, but none were observed in Eastern Cape. It is important to note that no electronic displays were available in any project school in the South African context.

Teacher reports on student use of ICT within their classroom were extremely varied. The majority of teachers in both countries (70% SA; 72% Egypt) stated that students used computers to 'access information'. Other uses fell into the following categories, arising from qualitative responses to the end of project questionnaire:

Individual and group use:
- 'individual investigation';
- 'group investigations';

Generic skills and processes:
- 'research';
- 'to practise ICT skills';
- 'working on spreadsheets';
- 'to present material';
- 'for problem solving';
- 'photography';
- 'using the Internet'.

Curriculum-related uses:
- 'research of different mammals';
- 'the skilful scientific activities which improve students' minds and fulfil their artistic and cultural inclination such as artistic activities';
- 'story writing';
- 'poetry writing'.

It was noticeable how greatly many teachers digressed from DEEP classroom tasks, or modified them according to their own context and also how use of the computer led to new forms of activity. Several types of classroom activity were unexpected, such as use of the hand-held voice recorder by students to support language development; use of the scanner to record local herbs and plant species; use of the camera to document student work for display at parents' meetings. In Cairo the final field-work took place during the Iraq war: in one school students were following and responding to events using news reports from the Internet. Such uses had never been discussed with participants.

Teachers often significantly developed the DEEP Classroom Tasks, as illustrated by the work of Peter and Connie in Case Study 3. Table 3, below, presents an analysis of the ICT-related activities this pair developed within the sequence of lessons described in Case Study 3. It summarises (a) the aspects of teacher knowledge being drawn on and developed; (b) the learning outcomes evidenced; and (c) the range of roles played by teachers and students at different points in the sequence. It also indicates the levels of ICT use (efficiency, extension, transformation) observed in this pedagogic practice.

Fig. 18: Purpose of lap-top use, Eastern Cape
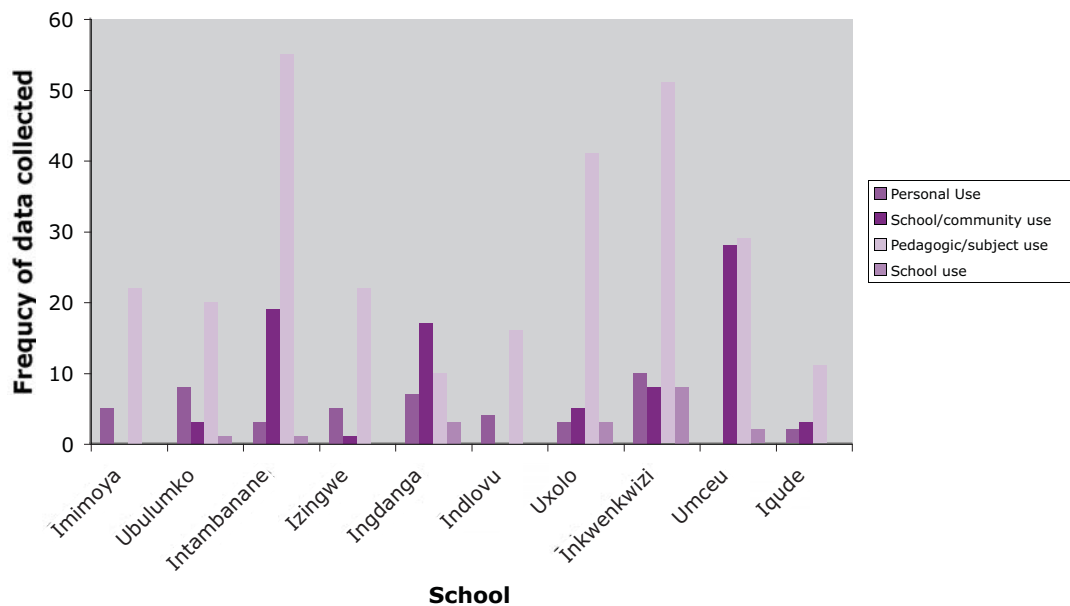
Table 2: Uxolo lap-top data snapshot, August 2002

Uxolo School	Whole-school/community use		Personal use			Categories overlap in these products		
						Pedagogic	Subject	School knowledge
No. of products	Funding and business plan proposal for Graham Farms Community Club.		CV of project teacher	WP		Acrostic poetry:	L/C/M	Economic and Management Science
3 Personal			Friends application for promotion	WP		1. Nellie	M/Sc/	Assessment Task including group assessment
5 School/ community		WP				2. Tortoise	Lit/R	
	Principal's letter to Parents.	WP	Research proposal for personal study	MM		3. Porpoise		
				R		4. Lion	L/C/E/	Worksheet on whales
38 Pedagogic/ subject	Sports coaching and selection of team prompt sheet.					5. Zebra	Sc	
		WP				6. Student Survey		Poetry lesson plan
10 School	Financial Report to Governors	WP				7–34. Personal writing (individual students)	WP/L/I /BS/Lit	Lesson plan for introducing vertebrates
56 Total	Staff meeting minutes	WP				35. Jointly produced play script (later acted)		
						36. Teacher's lay-out of classroom groups.	WP/L/ C/Lit	Lesson plan on animal characteristics
						37. Worksheet	D/T/I	Lesson plan multimedia story
						38. Giraffe Story – whole-class collaboration.	MM/Sc /Lit/L/ C	3 lesson plans
								(All used WP including tables – all teacher work)

Coding of products:

WP = word processing

MM = multimedia

L = learner work

T = teacher work

Sc = science focus

Lit = literacy focus

C = collaborative task

I = individual task

BS = basic skills

R = research

D = drawing

Table 3: How The Giraffe Got Its Long Neck – an analysis of ICT activities.

Learning/assessment activity	Teacher/student role	Teacher knowledge	ICT used	ICT level: Efficiency Extending Transforming	Learning outcome/benefit
Lesson plans for the literacy sequence 'How The Giraffe Got Its Long Neck' & linked science activities.	Teacher as researcher, planner and manager.	School Subject Pedagogic	Lap-top; Internet; word processor; spreadsheet.	**Efficiency gain** – this could have been done on paper. **Extending** – electronic format allows it to be shared by project partners and at cluster meetings. It can easily be adapted for other uses and stored electronically for future.	Thorough care to objectives and planning sequence. Enables forward planning to be more effective.
Development of resources – identifying fables from a website; student self-assessment sheet.	Teacher as researcher and assessor.	School Pedagogic Subject	Internet use; Excel; word processor	**Extending** – teacher used Internet to find new curriculum-related story. Without ICT the teacher could not have provided multiple copies of new story for learners. These can be saved and re-used. **Transforming** – physically unrealistic to have provided the sophisticated self-assessment sheet for every learner unless they had copied it out (this would have taken 15 hours minimum student time in total).	Motivational choice of text for students. High-quality assessment for learning activity.
E-mail. Students compose and send message to the project website.	Teacher as facilitator. Student as communicator and IT expert.	Pedagogic	E-mail	**Transforming** – students aware of being able to contact quickly and easily a real audience of peers and others beyond the school as an audience for their work.	Many gains as a literacy task. Authentic writing task; extends motivation; encourages sense of audience. New form of communication skill; encourages group skills.
Scanning images.	Teacher as coach and manager. Student as ICT expert.	Pedagogic	Scanner;lap-top	**Extending** – could have been done with glue/crayons/paper. Capturing story digitally means it can be stored; read as part of a school library; shared with others beyond school and with parents; placed into students' individual electronic files.	As above – also encourages sustained collaboration on an authentic task.

Learning/assessment activity	Teacher/student role	Teacher knowledge	ICT used	ICT level: Efficiency Extending Transforming	Learning outcome/benefit
Creating narrative text and dialogue/speech bubbles.	Teacher as modeller. Student as author and IT expert.	Pedagogic Subject	Word processing; Powerpoint.	**Extending** – could have been done by hand. Creating digitally means that students are aware of a real audience and quality end products. Visual use and 'creation' of speech bubbles helps students conceptualise distinction between narrative and dialogue.	Develops knowledge of distinction between narrative and dialogue. Motivating literacy activity that enhances student achievement and 'memory' of literacy process.
E-mail for external audience with final product sent as attachment.	Teacher as facilitator. Student as authors sharing their work 'Now I become a young author of tomorrow'.		E-mail	**Transforming** – students aware of being able to contact quickly and easily peers and others beyond the school as a real audience for their work.	No other possibility of sending illustrated story simultaneously to several different sites for feedback and sharing of approach. Widens view of possibilities beyond immediate home environment. Sense of self-esteem and pride for all involved because of 'professional' quality of product.

Developing personal and professional identity

'I am now constantly finding things that extend my knowledge as a teacher – making me really grow professionally. There is change. In the past, for example, we did planning, but we have to come think differently now, learning is now challenging us and we are exploring more. This year we are going to do even better, as teachers we are really learning.'

(Teacher, interview, March 2003)

Analysis of project teachers' concept maps on the subject of 'Teaching and learning with ICT' suggest that project teachers' knowledge developed significantly during the lifetime of the project from procedural knowledge of ICT and its general application to teaching and learning, to knowledge of how ICT could be appropriated for a range of personal, professional and classroom practices. The examples of pre- and post- project maps shown in Figs. 19a–d illustrate this shift in understanding.

In pre-project maps teachers mostly named discrete technologies and linked these conceptually to what they knew they could do in a general sense: 'communication – learners can communicate with people far far away' (Fig. 19a); 'information – world news – latest events – newspapers' (Fig. 19b). In post-project maps, by contrast, teachers introduced personal pronouns ('I' and 'we') and represented personal experiences and/or uses of ICT rather than ICT devices, e.g. 'personal – confidence – own ICT competence'; 'activities – classroom-based acrostics – fables/*intsomi* – endangered animals' (Fig. 19d) 'it helps especially when I was doing environment animals at the zoo and those at home Learners saw them and the lesson became real' (Fig. 19c).

Some teachers integrated personal use of the hand-held devices into concept maps. Nolundi (Imimoya), for example, gave her map four equally weighted branches entitled: Learning; Resources; Research; Jornada. This fourth branch was annotated: 'I record, take photographs, write, read stories.'

During interviews personal appropriation/ownership of the technology was a strong theme: 'I use it everywhere'; 'the jornada is my companion'. The study, we suggest, shows how ICT is shaped by the social and cultural meanings the teachers and students bring to it. The affordances of lap-top or hand-held were shaped by the purposes, activities, needs and imaginations of teachers and students, just as much as what they were able to do was shaped, extended and transformed by the technology.

Computers uniquely document histories of use. The research team had seen such functionality as one mode of data collection that would help document electronic products and teacher and student 'ICT outcomes'. What such data also taught us was that if tools really are to serve day-to-day practices, then user and tool need to literally share and develop a common history. Lap-top data showed us a teacher in the early stages of the project, clearly working with difficulty, tapping out simple sentences or abandoning a Powerpoint file gone wrong; a work colleague painstakingly creating a CV and job application over a several-day period; a mourning sister, expressing grief through poetry; a school principal writing to the District Council on behalf of the local community. Most often we could see that teachers and students had worked with increasing competence on a range of classroom activities. As device and user(s)' everyday histories developed together over time, so ICT became part of day-to-day 'thinking as usual'. Once such a point was reached, the research suggests, there is potential for significant classroom change.

At this point the ICT became embedded into personal knowledge and integral to the user's identity: 'I have changed. It has made me proud because I know how to use ICT. At first I didn't know anything…it has changed us really.' 'I am proud of myself really...the people as well – always congratulating us. The [project] teachers are good now, I think everyone is longing to study.'

ICT use seemed to help teachers construct, at one and the same time, a secure sense of identity and belonging and the sense of a wider collectivity.
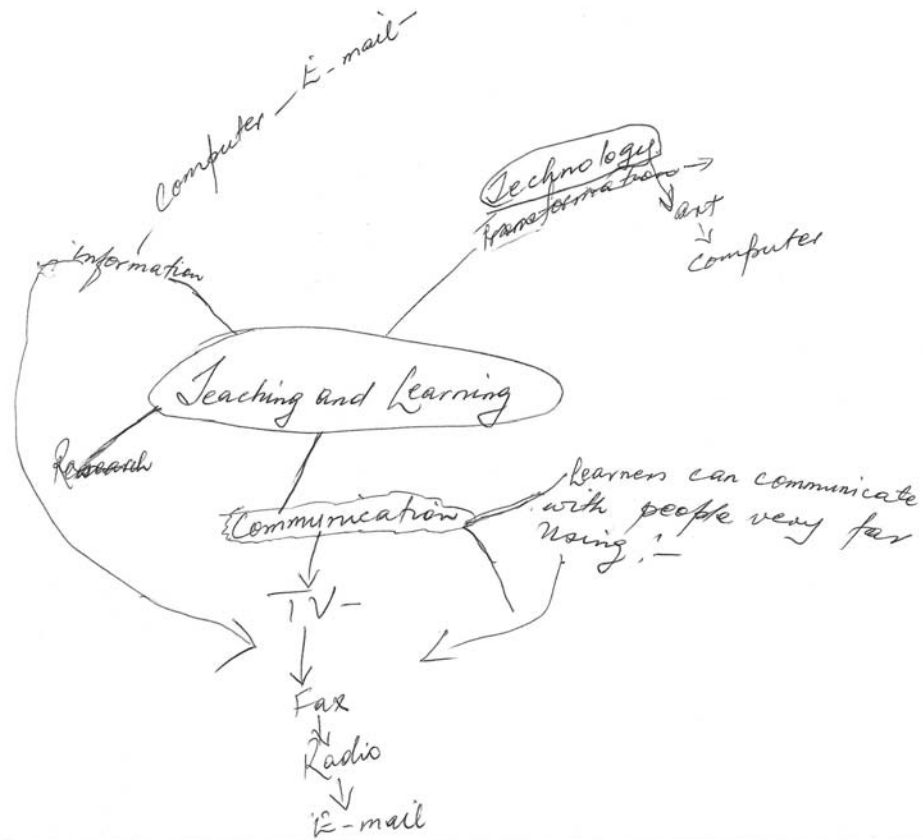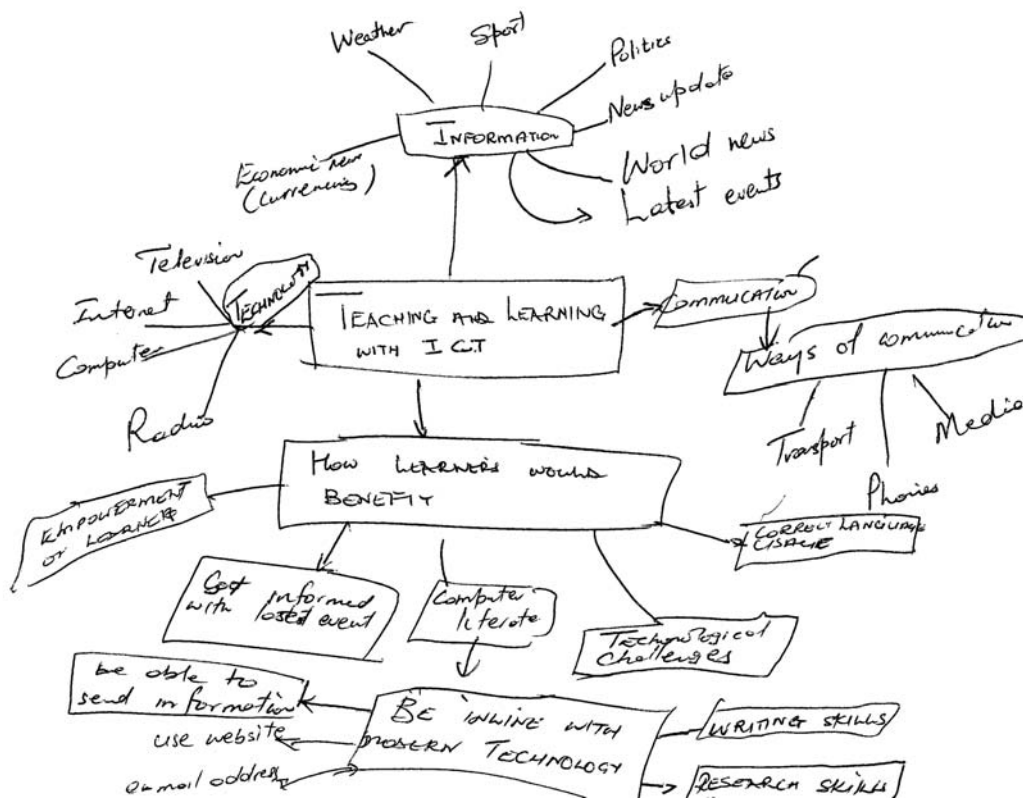
Fig. 19a
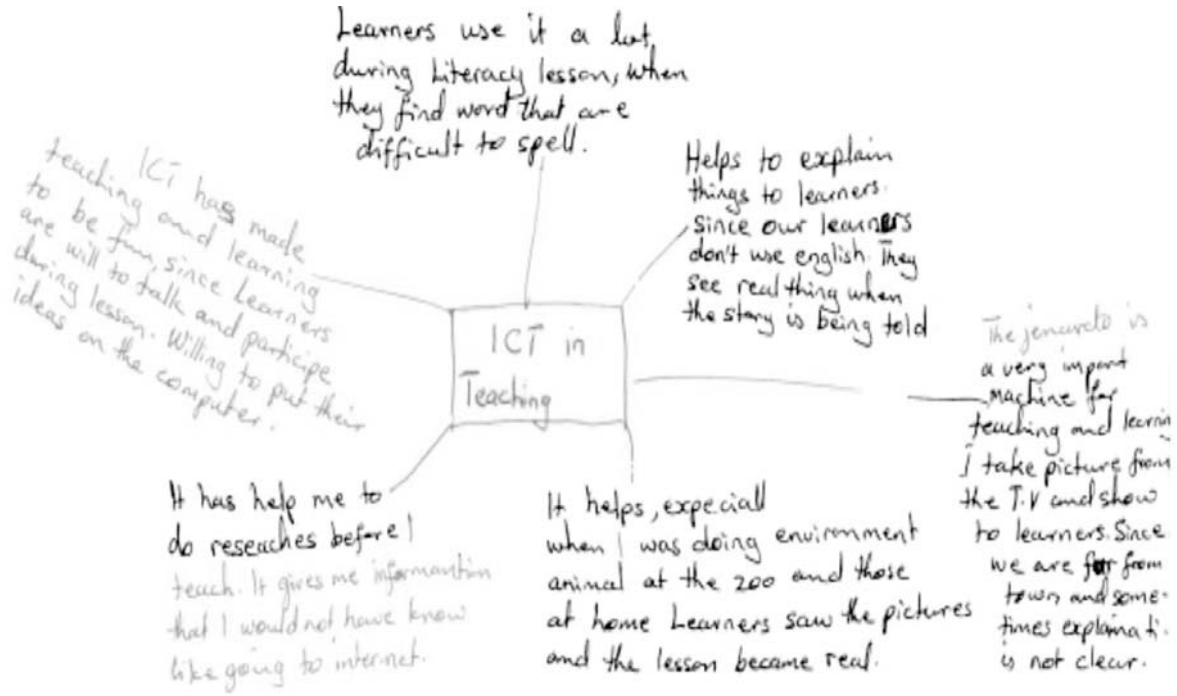
Fig. 19b

Fig. 19c

Fig. 19d

Key finding 5

ICT use enhanced teachers' professional knowledge and capability by permitting new forms of teacher-to-teacher cooperation.

Teacher-to-teacher co-operation

Hello!

You cannot believe how excited am I when I retrieved your message. I screamed and disturbed everyone in the Lab. You know what, it is because it is my first time to receive a message from a computer and as a result I'M CRAZZZZZY! HOPE TO SEE U AGAIN! I am now trying 2 get2 DEEP WEBSITE.BYE WITH LOVE GOD BLESS

(E-mail from teacher, Eastern Cape)

The support model within the project was constructed around the potential ICT offered for teacher-to-teacher collaboration. Several new forms of teacher-to-teacher co-operation developed during the project facilitated by ICT:
• teacher partnerships;
• cluster groups;
• local, national and international professional networks.

Teacher partnerships
The paired approach, together with 'school visits', were the most highly valued element of support within the programme: the majority (81%) rated it 'very helpful'. Teachers often worked together at school or home as well as extensively on an individual basis (see Fig. 20).

Fig. 20: Lap-top use
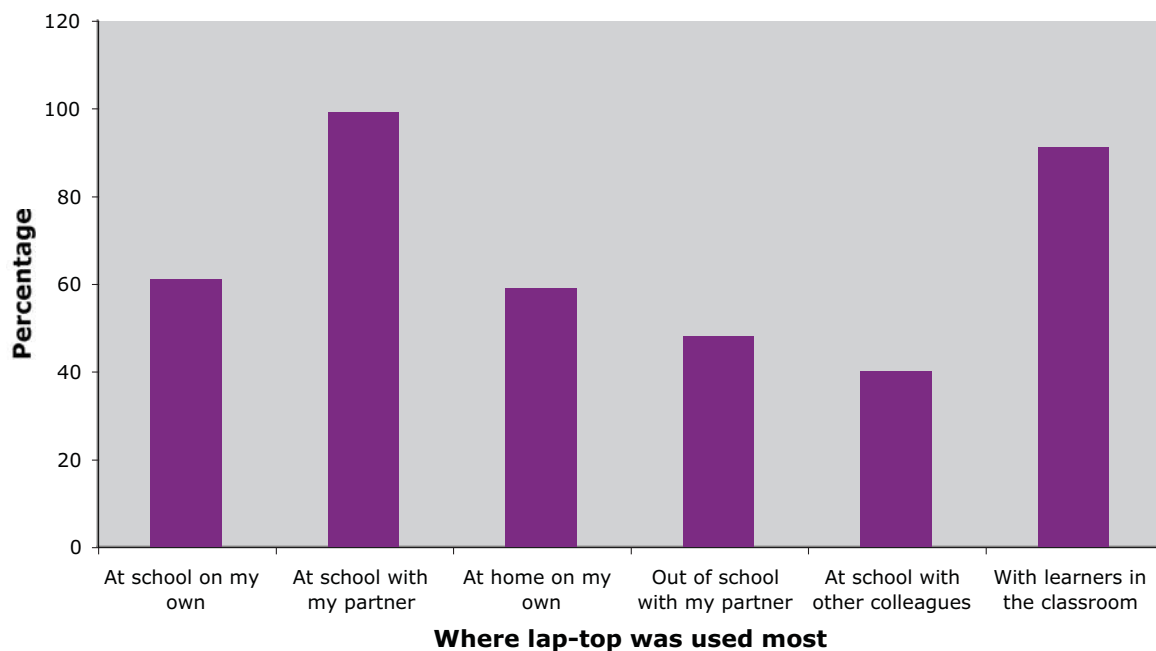
The approach, facilitated by shared ICT activity, confirms the first principle outlined in Chapter 2, that learning is a process of joint knowledge building. Collaborative activity modelled and allowed teachers to practise new approaches to learning, as well as to experience the quality of outcomes from peer working. This model also generated high levels of lap-top usage:

• teachers used the lap-top out of school hours to discuss and develop opportunities for integrating ICT into lessons;
• pairs of teachers using the machines doubled the number of opportunities for equipment use;
• the portability of the device meant it was used in the evenings and weekends, for ongoing professional development, personal learning and community activity.

Within the classroom, pairs or groups tended to use the computer in rotation. This meant that rather than 'a single computer lesson' occurring at occasional intervals during the week, ICT activities spanned several days of continuous use. In ensuring a high level of usage for project equipment, the multi-user approach illustrates several of the proposals made by Cawthera (2001) for optimising the cost-benefit balance in providing ICT to schools.

Cluster groups
Cluster group communication was also facilitated by a combination of SMS, mobile phone, fax and e-mail. ICT also facilitated teacher-to-teacher co-operation between, as well as within, local schools in a number of other ways. For example, the hand-held in particular facilitated the sharing of resources: teachers were observed handing the devices to each other in order to share materials during cluster meetings. Once the 'beaming' facility (also available on the lap-tops) was fully understood, teachers were observed exchanging notes and photos, lesson plans and student work during cluster meetings and training workshops.

Professional networks
The DEEPTALK arena facilitated around 100 message postings over the lifetime of the project. Despite the research team's wide experience of novice users of e-communication, it was impossible for them not to be impressed by the elation of first messages independently sent or received within the DEEPTALK environment. A single-sentence e-mail represented a significant professional step towards a new form of working.

The environment was used for contact between local peers and project co-ordinators, as well as to link teachers in both country programmes and engage in discussion with members of the project regardless of where in the world they were located.

In end of project questionnaires a quarter of respondents specifically singled out 'communication with other professionals' as a mode of ICT use and over half considered 'e-support' to have been 'helpful'. This was unexpected given the difficulties of networking that many faced and the fact that this was a completely new mode of professional activity. Many teachers reported that they had started to make regular use of teacher e-networks (e.g. SchoolNet) as a result of the programme. They reported that off-line readers, for the reading and composing of messages, were essential for e-environments to be useable and affordable.

Key finding 6

There was no significant correlation between teachers' prior use of ICT and the ability to successfully develop ICT-enhanced classroom practices.

There was no necessary link between the ICT access and infrastructures of project schools/communities and successful teacher outcomes.

Prior experience and provision of ICT
Teachers with no previous experience of ICT and/or no prior experience of using ICT for teaching were observed to have developed sustained and effective classroom practices. Few of the participants focused on in the case studies, for example, had prior experience of using ICT in the classroom; many, such as Nomvula, Nomsa and Weret, had little or no prior experience of ICT.

The data indicates that successful outcomes in terms of the development of teachers' personal and classroom use of ICT were not dependent on either the size or the nature of their school's ICT provision and infrastructure. Two rural schools (Intambanane and Inqgana) became lead schools and displayed highly productive outcomes, despite having had no ICT resource prior to the programme and with negligible infrastructure (neither had phone lines and electricity in both contexts was fragile). Across the project overall the only two schools that had sizeable ICT computer suites, Ufudo (25 refurbished computers) and Elintla (18 computers), were the least successful in achieving project outcomes, though for different reasons. Ufudo was the only project school not to complete the programme. Elintla was the most northerly school in the Eastern Cape group, situated a considerable distance from the others. The project partners made slow progress, in part because of the serious illness of one. The local team, however, judged the school's distance from ongoing peer support, including difficulty in attending cluster meetings, to be the major reason for lack of progress and impetus to continue.

This finding is illustrated by notes made by one of the local team on visits in the same week to Izingwe, a remote farm school with negligible resources, and Elintla:

Week 4th November – 8th November 2002

Izingwe, Zwartwater

Must admit that the educators are more advanced to what I'd seen in the past. They seem quite comfortable with using the lap-top and producing some nice work with the learners. It was interesting to see that the school has used the scanner and other resources to produce slides on cattle and other animals within the Zwartwater area. It was also wonderful to see that they have used the lap-top for other subjects like mathematics and science, and produced some activity sheets themselves.

I think the learners have found it difficult to work on the computer, as their English is not good and spoken little within the school and the community. Some of the learners have enjoyed and love using the computer, as it has helped them improve their English.

The community too have been using the lap-top and printer/copier to their benefit. They have produced posters, invites, etc by using the lap-top and printing out, and then copying them. 'The community as a whole', said one member, 'has benefitted'.

Elintla, Qumbu

Helped Nkuli load the DEEP website onto the server within their computer lab/resource room. They have 16 computers, which are used by grades 5 and 6 only, but not used to their full potential, which is a shame. However, they are looking at ways to improve the use of the computer lab for next year. Nothing much has been done towards the DEEP activities, but Nkuli is making a start, which is better than nothing. They only have four weeks of schooling left before the summer holidays. If anything, they will complete two activities.

Key finding 7

More women participated in the project overall than men. Successful outcomes were achieved by both men and women.

Gender issues
Both UFH and PPMU have a commitment to gender equality. In the project overall project partners ensured that there was a balance between men and women participants. In the Eastern Cape there were more women overall in the project and the local co-ordinator was a woman. The case studies illustrate the successful outcomes of both male and female participants. The women in the project offer strong new role models for their peers and for female learners, both in rural communities and in Cairo.

In the time frame of the project it was not possible to explore gender issues to any degree. It was anecdotally noted that strong networks of support developed between the women. In some of the mixed gender pairings there was some concern on the part of the project team that the women were not flourishing as well as their counterparts in women-only pairings.

Gender inequalities in relation to ICT use are well documented in widely different countries and contexts. The DEEP programme explicity incorporated exploration of these issues within the face-to-face training, as well as in the resource materials. Field-work suggested that boys and girls within the project gained equal access to the technology and that project teachers were largely aware of this as an important issue. However, more research needs to be carried out focusing specifically on gender and technology issues in both contexts.

Key finding 8

In some instances, the use of ICT impacted on the work of project teachers' wider community. ICT was used in significant ways by schools as a whole, as well as by many of the communities in which project teachers lived and worked.

Mobilising the community

'We spoke to the parents at the parents meeting…and they were so interested. They were all really happy and praised the principal, because it was her that introduced this project. They even praised her over the radio too.'

Whilst the data formally records the activities and experiences of some 48 teachers and 23 schools, in practice in both contexts a far larger number of teachers became involved in the programme. Project teachers reported helping colleagues with basic IT skills, showing them how to produce CVs, working collegially to plan lessons and use ICT in their classrooms – and for recreation. Use of the computer with family, especially children, was common and evidenced by lap-top data. 'I've helped other teachers, made certificates with borders; school sports timetable, made agendas for meetings and even typed an assignment for a colleague; we had to ask my 6 year old son's friends what word he might have used as a password to lock us out of the computer [laughter], of course we use solitaire, we want to get more games, everyone likes them.'

Whilst this pattern was constrained in Cairo, because of fixed PCs within the media lab, a strong sense of collegiality and interest around the use of ICT for new kinds of activities developed in many of the schools. Tiba in Bab-El Sharia, for example, set up an after school club for staff and students interested in computer use. In this urban context the most striking development was project leaders' relationship with IT technicians. In several project schools technicians became actively involved in supporting teachers and students both in out of lesson time in project activity, especially Internet and e-mail use. In three schools project teachers were observed planning and teaching lessons jointly with the technician; several technicians attended workshops with their colleagues. In both settings project activities encouraged teachers to introduce parents and the local community to the project. The research tools were not designed to explore community reaction to or involvement in the project, however, and this dimension was not explored further in urban Cairo.

In the Eastern Cape it had seemed impractical for one small lap-top to be shared much beyond teacher partners and their classes. Yet community response and activity was so consistently reported at interview and within questionnaires, that impact on several of the local communities within the project has to be judged as significant. The degree to which members of school and the local community had shared and used the lap-tops was unexpected. Fig. 21 suggests that school and community lap-top use across all settings in the Eastern Cape was greater than teachers' personal use. Uses ranged from an application for a wool shearing shed for Zwartwater's community woolgrowers association (Izingwe), the constitution of a local sewing project (Ingqanga), enquiry on an unpaid death claim (Inkankwezi) to an obituary of a local resident (Ubulumko). Table 4 exemplifies ICT use in a rural (Ingqanga) and a peri urban setting (Umceo) in the first few months of the project.

Community activities included:

A computer literacy class for parents, and involvement in decision making about ICT use:

'We had a parents' evening – there was a proposal from the parents that we use it with Grade 7, as they are going to leave school soon, as a resource for their learning. Eight learners have been trained first to use the computers. They will facilitate small groups of peers.'

(Uxolo)

A local hospital making use of the computer in exchange for powering up the battery:

'We have no electricity so we walk together to the neighbouring hospital down the road to charge the battery. The hospital staff are very interested in the computer and some have used it.'

(Iqhude)

Evening classes for teenage students who had been involved in the first year of the project (Intambanane)

(Mid-project interviews, 2002)

School principals and teachers consistently reported on parental and community involvement and interest:

'We are working to develop our school – everyone wants to know more.'; 'This computer promotes the school – the community know about it'; 'We have called the community…we explained how the educators gave up their time in their holidays, they sacrificed. We do it for the learners'; 'It has raised my standards and dignity. Our school enrolment has increased'; 'My family were very happy, they knew it was a great achievement. They honoured what I did.'

(Principal and teacher interviews)

Table 4: Whole-school and community products

School	
Imceu (peri-urban)	Ingqanga (rural)
School principal letter (Xhosa).	Request for room for Queenstown for cluster group.
Invitation to urgent parents' meeting.	School report template.
Principal report to Department of Education about staff member.	Letter about baptismal certificate (Church).
Letter to managing director of Bisho Hospital requesting mobile clinic and ambulance.	Builders' invoice (relative).
Letter to police to ask for security for community event.	Letter about baptismal certificate (Church).
Central region festival 'Lovelife' Programme.*	Builders' construction and lease agreement.
School registration form for local games team.	Letter about postponement of materials.
Soccer fixture list.	Queenstown district SGB constitution.
Teams list for county games.	Siya phila sewing project constitution.
General registration form.	Request for accommodation and storage of learner and teacher support material.
Soccer registration form.	Letter requesting accommodation for local maths workshop.
Fixture and results form.	Year budget.
Post-primaries fixture.	Year planner.
Events checklist.	Letter about postponement of materials development.
Quotation for D.K. services.	Request for tuition time for materials. development workshop.
Group rota.	Poster for maths teaching workshop.
Ticket template for 'Lovelife' community event.	Narrative report for the school.
District principal meeting agenda.	Letter of thanks to the Board of Directors for supporting open day.
Regional code requisition form.	
A teachers' prayer (for the Staff Room).	

* Lovelife is a charity to encourage positive sexuality.

Fig. 21: Lap-top use by purpose
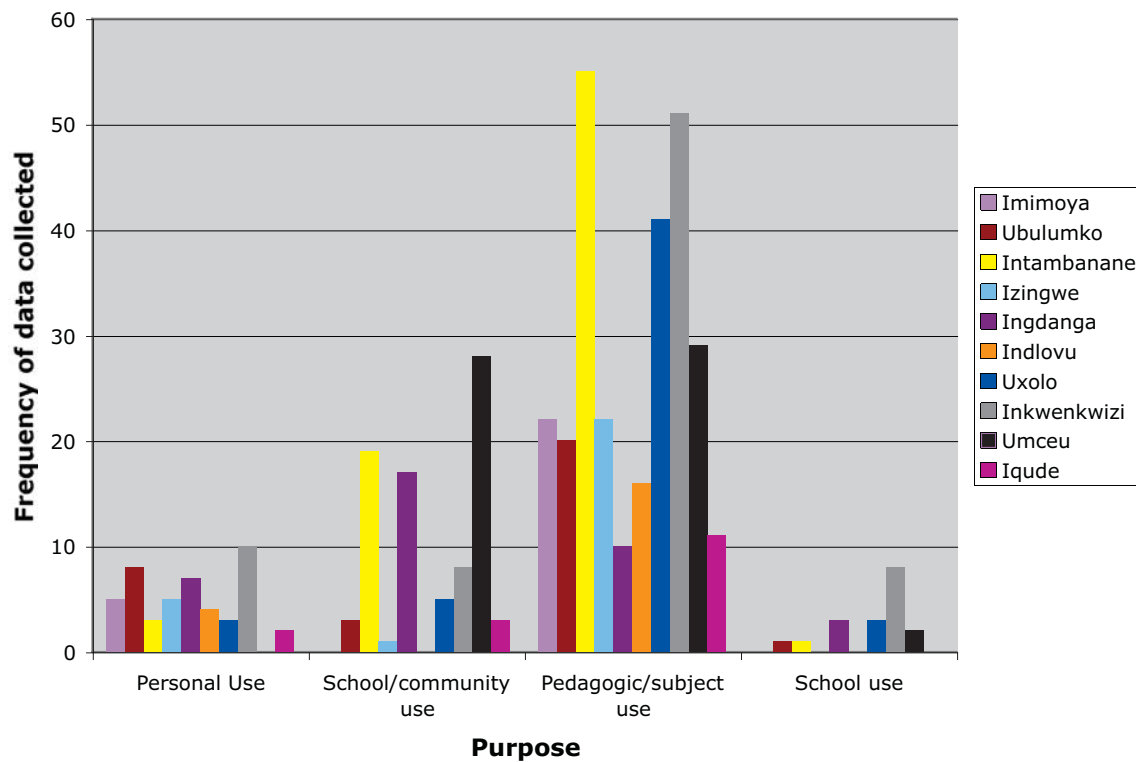
Research question 2

What is the impact of ICT upon student achievements and motivation?

Key finding 9

Students in both contexts quickly developed confidence in using desktop/ lap-top and hand-held computers for a range of purposes:

- development of basic computer skills was unproblematic;
- the majority learnt to use a variety of digital softwares and other peripherals (e.g. Word, Calculator, Powerpoint, Internet, E-mail, Games, Scanner–Printer– Photocopier, Camera) in a very short time frame;
- students used ICT to carry out a range of literacy, numeracy and scientific activities and there were outcomes;
- students showed high levels of motivation in using ICT both within and out of lessons.

Key finding 10

Teachers, school principals, parents – and students themselves – reported on a range of achievements including enhanced learning, improvements in literacy and scientific literacy. Increase in school attendance was also reported in both country contexts.

Student confidence, motivation and achievement
The data on student achievement and motivation discussed in this section of the report were drawn from a variety of sources: teachers, school principals, others in the community, students themselves, observations and informal discussions with students, student diaries and e-mails and student products including public presentations.

Student perspectives
Students, aged between 8 and 13, completed 93 questionnaires on their experiences in the project – mostly in Arabic and Xhosa. Since these questionnaires were often completed in pairs or small groups in the Eastern Cape context, around 300 students overall were involved in this mode of feedback. The majority estimated they spent between 1 and 3 hours every week using the computer; all reported that 'my teacher(s)' had taught them to use the computer. None of the students completing questionnaires in the Eastern Cape had access to a computer at home, although some students in Cairo mentioned that members of their wider family had a computer which they occasionally used.

Since project activity was so strongly classroom-focused, teacher and student outcomes were closely interlinked; many examples of student activity and associated products have been discussed in earlier sections. Examples of student products from every school in the project can also be found at http://www.open.ac.uk/Deep/participants; students' spoken presentations of their experiences in the project are at http://www.open.ac.uk/DEEP/iau.

The uses that ICT students said they 'most enjoyed', ranked in order of preference, were:

    Games (86%)
    Projects (82%)
    Watching video (86%)
    Making Powerpoint presentations (76%)
    Listening to music (63%).

All students reported they had used the computer both individually and in groups.

Across the wide range of school settings, students said the use of ICT had *changed lessons* 'a little' (15.8%) or 'a lot' (82.5%). Examples given of such change were varied, particularly given the range of age groups; however, enjoyment, interest and fun figured strongly, implicitly or explicitly, in many reponses:

'Because we learn new words'; 'It is enjoyable and exciting'; 'I enjoy making stories'; 'I did not know how to dream but now I know'; 'I've explored different programmes and now I can go and try them out'; 'I can count using it'; 'Because I did not know endangered animals and now I have seen them'; 'I can play games'; 'I learnt about animals and stopped beating and kicking them. I love them and I give them food'; 'It's very nice and interesting'; 'It's changed how we learn things in our region, before we didn't understand'; 'We also wrote a short story it was fun and enjoyable; 'We see the things we didn't see face-to-face: an elephant, lions, giraffe' ; 'I love a dog because it tells you about people who are coming.'

Many students articulated in one way or another a sense of increased confidence, as well as enjoyment in learning generally. Reponses to the question 'Has the project made any changes to you?' indicated a general sense of the increased quality of the learning experience. Although some replies may well have echoed views voiced by teachers, parents or other adults, most referred directly to personal experiences:

'Things that we learn have changed us because we are getting a good education';

'Learning how to explain to other children';

'I did not know by using my fingers I could be where I am today, it was hard using a computer but now it's easy and enjoyable';

'It has changed me a lot and I am proud. Yes everything that is in the computer I understand it although I don't know it all';

'My spelling used to be very wrong but now the computer gives me the correct spelling';

'We now have a computer, lessons and school isn't boring anymore. It's opened a door for me.'

Some students completed concepts maps at the end of the project on their views of ICT and learning. Words like 'enjoyable', 'exciting' recurred in these (e.g. Fig. 22a). In contrast with the teachers' concept maps, which mostly incorporated reference to ICT hardware and software, students focused directly on curriculum activities, e.g. 'learning science – plants – root system; animals – invertebrates – silkworm – earthworm' (Fig. 22b). 'it is enjoyable and exciting- play games – watch movies; write stories – fox and crow – baba yaga's daughter; we get new English words – we write sentences – giraffe – we make powerpoint presentations - camel', (Fig. 22a and b). This confirmed evidence from diaries, observations and student products that teachers had primarily focused on ICT for curriculum activities within the curriculum and not on IT skills.

Considerable literature now exists in the UK, US and other countries of the global north on the sharp distinction that has emerged in many communities between students' home and school use of ICT. Some accounts are given of a form of 'digital divide' that has developed between students with and without ICT access. Other accounts focus on the differential uses of ICT by students at home and school. In project settings home use is virtually unknown. No such differential uses exist. No distinction was made between fun, play and learning. Teachers in both settings enjoyed using the hand-helds and lap-tops to play games such as solitaire, to listen to music, and to take photos and they encouraged learners to have fun with the computer too. Playing of games, for example, was viewed by most of the teachers as one form of learning; often teachers and students played games together. In Fig. 22a a nine year old incorporates 'playing games' and 'watching movies', under the heading 'what we have learnt'.

DEEP IMPACT: *an investigation of the use of information and communication technologies for teacher education in the global south*

Figs. 22a and 22b: Concept maps by Grade 7 students, El Nile and Intambanane Schools

Teacher and school principal perspectives

At the close of the project, the majority of teachers (90%) considered that project activity had been useful 'for improving student achievement and motivation'. When they were invited to say 'What aspect of student learning has most improved?' answers varied considerably. Example responses drawn from questionnaires, shown below, largely clustered around the following areas of development: communication; curriculum related learning; IT skills; social learning; approaches to learning; confidence and motivation:

Communication

'To be able to select the important points in a presentation';
'language skills';
'communication skills'.

Curriculum-related learning

'Narrating a story and making a summary' (literacy);
'Reading, spelling, and writing skills have dramatically improved for most of my learners' (literacy);
'Improved reading and spelling' (literacy);
'Improved vocabulary' (literacy);
'Reading and writing skills' (literacy);
'Reading, spelling and typing';
'Poetry writing';
'Improved science knowledge';
'Expanding of students' knowledge on the scientific side'.

Social learning

'Social skills – group work';
'Increase of collaboration and exchange of information between themselves'.

IT skills

'They are also used to the computer terms e.g. click, double click, scroll';
'How to handle computers and use them';

Learning to learn

'Researching skills';
'Presentation and problem solving';
'They are more free to choose things/topics that are of interest (e.g. research of different mammals)';
'Brain and knowledge skills as well as the concentration skills';
'New methods of searching for information';
'Learning without the teacher';
'Student bringing additional information to the lesson outside the curricula';
'Concentration in learning has increased';
'High speed of understanding information'.

Confidence/motivation

'Students became more confident and pay more attention.'

(Teacher exit questionnaires, 2003)

Feedback from school principals focused particularly on students' increased motivation towards learning. 'Learners are inquisitive' was a frequent response, 'learners have become more curious', 'they ask about the computer when it is not there', 'it attracts students', ' the students will even sacrifice not going to physical education.' Some remarked on the development of specific skills: 'it encourages learners to know spelling, sentence building, science awareness'; 'parents are pleased that their children are taking literacy seriously', as well as a sense of personal development and self-confidence: 'my learners have had an opportunity to see, touch and use the computer for the first time in their lives; it widens their knowledge, they are willing to speak and willing to attend the classes, it widens their knowledge.'

(School principal, 2003).

Where rote learning had previously been the norm it was clear that many project teachers had been struck by a change in the quality of learning and student engagement facilitated by ICT activity. Principals and teachers in Cairo, in particular, emphasised that computer activities enhanced the learning process because 'what they have learnt sticks in their minds', "hands on" tasks have led learners to think, observe and record accurately for themselves', 'learners are free to speak' (teacher and principal interviews).
Formal tests were not carried out with students; however, more than half of project teachers and school principals volunteered during interviews that student test scores had increased in end-of-year tests: 'those learners [in the DEEP classes] are more advanced'; 'Those learners who are exposed to this project are more advanced, this edge helps them move more quickly'; 'I witnessed that the exams began to increase for maths; I will photocopy one of the improvements in grades for you to see.'

Dimensions of classroom change

In Chapter 2, six dimensions were identifed that are common to any pedagogic setting: goals and purposes, views of knowledge and learning, learning and assessment activities, tools and artefacts, discourse, and roles and relationships. We suggested that if one dimension changed, then other dimensions would alter also. In students' accounts of their experiences, together with observation of practice, a number of dimensions of change were evident in the majority of pedagogic settings that impacted on students' learning experiences and achievements:

Tools and artefacts

The range of new tools and artefacts introduced by the project excited students; in every setting ICT was appropriated for a range of school and classroom activities. Most students had no preconceptions of ICT use; it was noticeable that students were adventurous with the technologies, particularly when working in groups, 'swopping' techniques and tips, teaching each other, as well as experimenting without anxiety.

Learning and assessment activities

New activities, previously little used (if at all) were discussed and observed including: individual and group research ('we get information from websites, but we only take what we are interested in'), peer tutoring ('learning how to explain to other children'), presentations to the whole class by peers (Cairo); team working ('We also wrote a short story'). Some classroom boundaries were significantly widened: students used e-mail; entered web competitions; took hand-helds into the local environment for field-work. In some cases parents and grandparents and other experts were invited into the classroom; other teachers came to see students at work. Teachers and school principals reported that students persistently requested ICT activities, asking 'Where is the computer today?' or 'Can we use the jornada?' Such persistence, even lobbying, on students' part, it is proposed, helped to ensure that these new activities were sustained, perhaps less likely with other new approaches to classroom development.
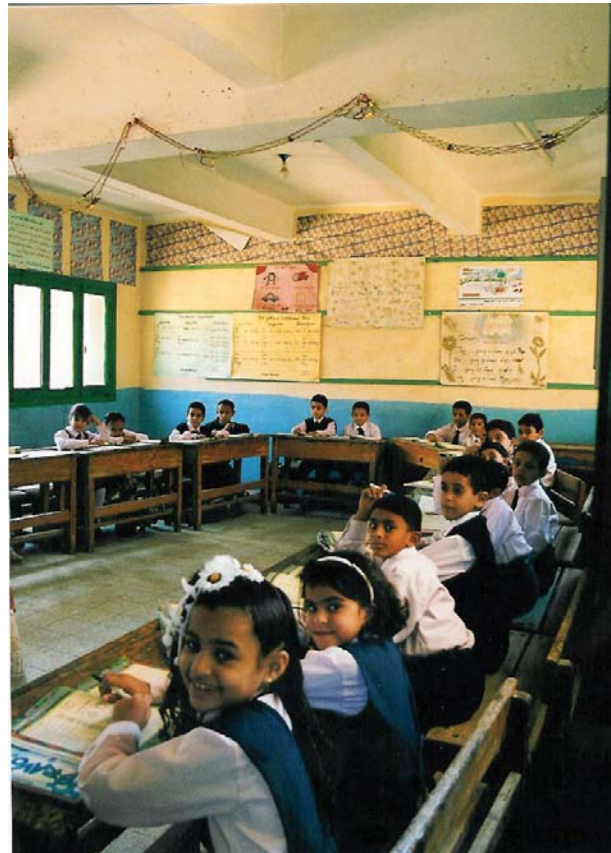
Roles and relationships

Students were observed taking on a variety of new roles in the classroom, e.g. group leader, peer tutor, presenter, researcher, photographer, evaluator. Many students suggested in interviews and questionnaires that relationships with each other and with their teachers had also changed: 84% reported their 'teachers had changed' : 'my teachers have changed a lot', 'they don't become tired when I ask them questions'; 'my teachers write short stories and listen to music'; 'they can explain for us when we don't understand'; 'It's because Miss ___ for example, my MLMMS teachers has changed, she is not that strict'; 'it helps the teachers to work with the learners easier and gave them less stress because the computers make the work a lot easier for the students as well'; teachers also did not know how to use a computer and now it helps them to teach us'; 'the teacher made the computer fun'; 'they came up with the thing I was dreaming about'; 'they have shown me something which has changed my life'; 'they work for a long time with us and they do not shout at us'

(end-of-project student questionnaires).

Teachers in turn reported on changes in their relationships with students: 'I have a more friendly relationship with my learners'; 'lessons now always encourage active involvement of both learners and teachers'; 'Our interpersonal relations with other teachers and the atmosphere in the classroom is relaxed and fun'

(interviews, 2003).

Discourse

Discourse developed significantly in many classrooms. New vocabulary related to ICT (copy, paste, drag, drop, minimise, scroll, mouse, focus, print, multimedia) became part of the daily language of the classroom. More subtle changes were also observed such as the language of collaboration ('in your groups'; 'peer tutor'; 'team leader'; 'expert group') and the discourse of subject disciplines ('vertebrate', 'amphibian', 'carnivore', 'data', 'pie chart', 'table', 'e- mail', 'dialogue', 'fable', 'narrative'). The use of locally, computer-generated Xhosa and bi-lingual resources was newly evident in some of the classrooms that hitherto had to rely primarily on English-only published resources. Much of this discourse is evidenced in the teacher diary below (see Fig. 23).

Views of learning and knowledge

Team learning became highly valued and in many classrooms helped to modify teacher ideas about how learning happens. Many students were supported in learning independently using the computer and interactive, 'hands-on' tasks were perceived by teachers to improve the quality of learning. Experts from beyond the classroom were drawn on by some teachers and in some cases the local environment and members of the local community became the subject of classroom study and investigation. In many settings changes in approaches to learning were evidenced in the physical classroom, as well as in the extension of the boundaries of the classroom:

- student work displayed;
- furniture moved to facilitate group learning;
- notices listing group members and team leaders prominent on classroom walls;
- students' shared portfolios, including floppy discs for storing work, in evidence.

Fig. 23: Extract from teacher diary, 2002

PLANNING. What steps did you take to plan this Activity? (e.g. which resources did you use? Did you work with your partner? How did you prepare the classroom? etc)

As a starting point I decided to pilot the first activity with a small group of learners. I made use of worksheets, Laptop - CD Rom - Fable Hare and Tortoise. Prior to this I introduce the lap-top to a "expert" group of learners who would serve as "facilitators" around the use of laptop in their groups. I made use of the chalk board to write down reports and verbal contributions of learners. My project partner and I worked cooperatively supporting each other in making sense of our own learning in the use of ICT and its link in learning and teaching The classroom was set up/out in groups.

TEACHING. What classroom tasks did you carry out within the classroom and with the learners?

I started off with a letter writing task - Learners explaining to parents how come they use laptop in classroom. Use of the laptop basic skill switch on, open up save documents, reading following instructions on computer. Engage in multimedia activity of Hare & Tortoise. Read and retell story. Find meaning of difficult words in text. Writing of story in own words.

Additional research questions

What are the benefits and limitations of using the hand-held computer in a professional development context?

> **Key finding 11**
>
> The majority of teachers reported using the hand-held on a regular basis for a variety of functions, including classroom activities. The hand-held's small size and weight meant teachers could have the device with them wherever and whenever they wished, facilitating 'anywhere, anytime professional learning'.

Hand-held computer use

Using a hand-held computer was a completely new experience for every teacher in the project. The majority of respondents to the hand-held questionnaire reported that they use the devices on a regular basis:
- 7 (21%) 'once a week';
- 16 (48%) 'a few days a week' ;
- 6 (18%) 'daily'.

Only one of the teachers said the device was 'not useful'. Observation showed that they were used far more extensively in the rural context.

Size and weight
Size and weight was viewed as a very important aspect of the hand-held, particularly in the Eastern Cape context, and this was usually linked to the sense of its portability. This view surfaced strongly in the qualitative data: 'It is useful because you can carry it everywhere you need it'; 'Since the Jornada is always in my bag it is easy to reach'; '[The] Jornada is user friendly because it is not too heavy.' The majority thought the weight and size 'just right'.

Professional uses
The diary, calculator, camera and games were the most popular functions, used both at home and in school. Every teacher mentioned taking photographs when describing their use of the device; 17 (51%) of the teachers reported using the hand-held to access the DEEP professional development resources including the e-books; 11 (33%) made use of the multimedia resources. In interviews teachers reported using the devices for a different type and range of activities than the lap-top and desktop, in particular to prepare lessons; make notes on student progress; record appointments; take pictures of students; summarise lessons; note take during lessons; take photographs for curriculum use; make calculations; set reminders for tasks; record events to use as the focus of a lesson; record and photograph student work, record presentations and music to show parents; teach peers basic ICT skills and concepts (e.g. 'terminology, handling the stylus, moving between programs'; teacher questionnaires, 2003). Project teachers were observed using the hand-held for many of these professional purposes within the classroom.

Classroom use
Although some teachers did not consider the device suitable for using with students ('it's limitation is it being small and unable to show it to the learners', hand-held questionnaire), a surprisingly high number of teachers reported using the hand-helds with students in the classroom. Researchers observed classroom use in 10 of the 20 schools for a variety of activities including research, literacy, mathematical games, voice recording/language practice, viewing of video clips, photography

Summary of use: Egypt
Overall the hand-held was seen as 'somewhat' or 'very useful' (21, or 91%) by the Egyptian teachers. Specific benefits reported included: 'the enjoyment in using state of the art instruments'; 'fun'; 'research and knowledge'; 'learning some English language' (hand-held questionnaire). Over half of the respondents considered that the hand-held 'helped their ICT skills'. The majority thought it helped their 'understanding of the language and concepts of ICT'. Four of the teachers thought that it was 'of more value' than other computers they had used. These findings were confirmed in end of project interviews. Home use was the most common: 'using it was very helpful to facilitate preparing for lessons at home because it is easier than writing by

hand' (teacher interview). Researchers observed the hand-helds being used by students in 5 of 11 schools visited, for a variety of activities including a lesson focusing on 'our local environment', in which students were observed taking turns to work in small groups outside the school environment, using the hand-held to make notes and take pictures.

Summary of use: Eastern Cape
The hand-held was highly popular in the Eastern Cape and has been used for a broader range of activities than in Cairo. Fewer hand-held questionnaires were completed because interviews and observations were seen as priorities during field visits to isolated schools; however, the data was confirmed particularly through observation of hand-held use. All respondents said they used the device both at home and in the classroom. Five stated that they use the device whilst travelling. The majority reported that the hand-held has 'helped my ICT skills' and 'understanding of the language and concepts of ICT'. These findings were confirmed by end of project interviews.

Overall the device was seen as 'very useful'; Seven viewed it as being of 'equal' or 'more value' than other computers, '[I] can do anything I may do with the other computer.' This is in a context where 56% of teachers and 75% of the school communities had no prior experience of any form of computer technology (e.g. both hand-held and shared lap-top PC were being used for the first time). The hand-helds were so popular that many of the teachers said they would buy one with their own funds should the price be affordable.

Uses of the device were wide-ranging and creative. *Word* was well used by a significant number of teachers, particularly for lesson preparation. Five teachers had 'frequently' made use of the voice recorder for curriculum purposes. Other uses included: 'Word for writing and I left the device to the students'; 'I used the camera many times to take photos related to the lesson I'm teaching and also to write some information'; 'during the monthly exam'; 'writing and recording appointments'; 'listening to songs and watching song clips'; 'making various slides on some animal and its various characteristics' (hand-held questionnaire). 'We have used the jornada for sports days, for cultural days, for all the activities...in the classroom situation, we've taken pictures of our learners' (teacher interview, 2003).

It was only as a result of teachers' exploratory use of the hand-held in field-work that the research team realised the extensive possibilities of the devices to support curriculum learning. In end of project workshops, additional hand-held activities and uses of software to support field-work were introduced by curriculum specialists, such as quadratting, local history and community story telling. Teachers will be invited to re-apply to work on a further year of research into how hand-helds can support curriculum development in rural classrooms.

Key finding 12

Where mother tongue interfaces or software were not available this limited the effective uses of ICT for both personal and professional purposes.

Limitations of the hand-held
The hand-held was not as popular with teachers in Cairo as in the Eastern Cape. The functions most frequently used for personal purposes were those least language-dependent, for instance the calculator and games – and of course the camera.

At the time of writing an Arabic version of the Operating System (OS), in this case *Windows for pocket PC*, is still not available, though there is some possibility that the project teachers may become 'beta-testers' for an Arabic version of the OS later in 2004.

Findings suggest that this proved a major disincentive for the Cairo teachers to make full use of the hand-helds in written practices. This constraint was mentioned in questionnaires, or at interview, by all project teachers. Kawther, for example, reported 'being not proficient in English language makes me find difficulty in using the Jornada'. She also noted, however: 'Every advanced scientific device has a use for an increase in knowledge' and 'the Jornada is very useful in making pictures'. She reports that she uses the camera 'where students produce class-related pictures' (literal translation of questionnaire from Arabic). In a visit to Kawther's school in Al-Khaliifa, southern Cairo, researchers observed her students using the hand-held fluently for photography – but also for note making and literacy work.

Technical limitations of the hand-held are set out in the Technical Annexe (Appendix 13) and in Table 1.

Key finding 13

The majority of teachers were highly motivated to succeed in using ICT for their own and for their students' learning despite numerous challenges. Where technical support was scarce, teachers worked to solve the problems. Security issues were successfully and pragmatically addressed in a variety of ways depending on context. Equipment 'survival rate' was high.

Technical support, infrastructure, security and equipment survival

Technical support – Cairo

Although all the computers in the Egyptian schools' media labs were quite old, there were relatively few technical problems, which can be attributed to the high level of technical support afforded as part of schools' multimedia provision. As discussed above, one of the project outcomes has been the increased degree of co-operation between teachers and, in Egypt, between teachers and technicians.

Technical support – the Eastern Cape

The UFH team recognised the importance of having high-quality technical support for teachers and schools; however, the university finds it difficult and expensive to sustain IT specialists, since they quickly find higher-paid jobs, in the city. As set out earlier, a local ICT/ISP service was brought in to provide Internet services and technical support for the teachers at the outset of the project. With only one technical specialist, together with the unreliability of telephone access on the UFH campus, one-quarter of the teachers' lap-tops remained unconfigured for Internet use before they returned to their schools. Technical support had to be arranged for these schools as a matter of priority. In this context the utility of mobile phones and SMS instant messaging became immediately apparent. Many teachers who had not had their machines fully configured sent software details using SMS; these were then used to obtain activation keys. Mobile phone calls were subsequently used to support teachers in the activation process.

Use of e-communication for technical support

Teachers used SMS messages to flag up problems, using other lines of communication to follow up on support. In the example below, teachers from Ingqanga initially called for help via SMS:

> *[DEEP] OUR COMPUTER CAN'T LOG US IN.IT SAYS OUR ACCOUNT HAS BEEN LOCKED OUT AND WE SHOULD CONSULT OUR ADMINISTRATOR. [Tami]*
> --

This was followed up via e-mail and the discussion area (from an Internet cafe) as shown in the thread below:

> *Dear [DEEP]*
> *There is a slight problem when trying to logon. The user name is DEEP and the password is _____. You logon once, and then the second time a logon message is shown. It goes like this; ?UNABLE TO LOG YOU ON BECAUSE YOUR ACCOUNT HAS BEEN LOCKED OUT, PLEASE CONTACT YOUR ADMINISTRATOR?. This makes things difficult and it makes people unable to use the lap-tops. Do you know how to sort out this problem?*
> *Thank you [Zama]*
> --
> *Hi, sorry to hear about the problems you have been having with the new computers. The cause is probably simply that someone has tried to log on incorrectly (not getting the username and password exactly correct) too many times; this makes the machine think you are someone other than the proper user, who is trying to guess the password...*
> *...Try what I have suggested above, but if that does not work, you will have to send the machine in to technical support.*
> -------------------------------------
> *Dear [DEEP]*
> *You know what? You are a genious and you have technological powers. Our new computer is now working and that of [Tami]. Let me say this once again, Thank you.*
> *Regards, [Zama]*
> --
> *Hi [DEEP]*
> *This serves to inform you that our lap-top has been fixed. We have already informed [project leader] about this and she is aware. The guy who was fixing it charged ONLY R300 and it works perfectly. I paid it out of my pocket and I received the invoice slip. Thank you.*
> ------------------------------------

Frustration with the low level of support some were receiving from the initial service provider in the Eastern Cape led to some teachers seeking support independently from people closer to their locality, keeping the project team informed of progress through e-mail and conferencing.

Thus the project teachers in isolated settings used SMS to gain technical help from both the project team at their local university and the UK. This approach went some way to overcoming teachers' sense of isolation as well as being a source of practical help. The following SMS to the UK project team was sent by one teacher in a remote location, celebrating the return of her computer from technical support:

> *Congra!! U have won the w/cup, we have received the compts, thanks for that, we will push by Jan very hard. Regards*
> -----------------------

Equipment survival and security

Of the 149 digital devices dedicated to the project (18 lap-tops; 52 hand-helds; 24 all-in-one printer/scanners; 52 add-on cameras; 3 digital cameras) 143 remained in working order at project close. Four of the new lap-tops had to be replaced because of non- functionality (unconnected to damage or misuse by project teachers); two of the hand-held devices were stolen (one during a domestic house robbery in Berlin, Eastern Cape and one from an OU researcher's car in Sussex, UK).

Security issues were solved in a variety of ways:

- *'We keep the lap-top at home – at the weekends when we go back to our families we store it at the principal's house';*
- *'There is a lot of vandalism generally- we have used the new computers to argue the case for good security, which we need regardless of the lap-top. Communities need to take this issue seriously'.*
- *'We lock the lap-top in the strong room at school'.*
- *'We take the lap-top home but we regularly change the container that we carry it in, so as not to draw attention to the fact that we have a computer'.*

It is not possible to quantify precisely, but the data suggest that the 'survival' rate of project equipment was no worse than one might reasonably expect in schools anywhere in the developed world – despite harsh working environments, inexperienced users, a lack of direct technical support, and use by often very large numbers of students. The fact that equipment survival was no worse than and, after factoring in levels of usage, may even be better than, that for schools in more developed contexts challenges the view that ICT is an inappropriate technology for rural contexts. It also illustrates the care teachers and students took with the equipment, and their determination to keep their highly valuable toolkit in good working order.

Key finding 14

Existing cost analyses of ICT use in the development context have been based on outmoded forms and uses of ICT and need reappraisal.

Cost issues

The remit of this research was exploration of pedagogy and ICT. Cost issues were not encompassed by the research questions and they have in any case been the focus of other studies (e.g. Cawthera, 2001). The findings of this study, nevertheless, suggest that existing cost analyses have focused on forms and uses of ICT in the global south that do not take into account a number of important factors, not least significant developments in increasingly cost-effective, powerful mobile technologies.

DEEP explored the provision of state-of-the-art multimedia mobile devices (see p. 42) for a range of curriculum, classroom and teacher training uses (see also Table 1, p. 45). However, the most common model of ICT provision in schools and teacher training institutions in the global south is the computer suite, usually based on the use of basic, often refurbished desktop PCs. This latter 'thinking as usual' model is frequently assumed to be less costly than the 'DEEP' model. Our research suggests this is a false assumption.

We asked two cost-related questions of the DEEP model compared with the computer suite model:
- Does the model cost less (or no more)?
- Does the model achieve more (or at least as much)?

Appendix 10 uses a 'Total Cost of Ownership' framework provided by Moses (2004) to demonstrate that the DEEP model is likely to be significantly less costly than maintaining and running even a donated suite of desktop computers (Power, 2004). Table 1 (p. 45) compares the strengths and weaknesses of different forms of ICT for teacher development. Many of the strengths identified are a function of either the mobility, or the multimedia capability, of the device used. Most refurbished PCs lack multimedia features, nor do they have the mobility of smaller devices; therefore they do not afford many of the pedagogic opportunities detailed in Chapter 5. The DEEP concept of an ICT Toolkit suggests some thinking outside the box is important in exploring further cost-effective, as well as pedagogically sound, solutions for the use of ICT in rural school communities. This study raises a prior set of questions that need to inform any cost analyses: What forms of ICT?; for what purposes?; used by whom? how? and where? The use of powerful, mobile ICTs, we suggest, may be at least as cost-efficient as more traditional models; yet for a similar investment they may be capable of achieving more effective outcomes. Large-scale investment in ICT suites (and the widespread installation of refurbished computers) in the development context, we argue, needs to be re-assessed both on financial and on educational grounds.

Research question 3

How can teacher education and training be developed to ensure teacher capacity to exploit the potential for ICT?

Key finding 15

Educational uses of ICT must be strongly grounded in educational and pedagogic principles, employ quality resources and ensure that professional support is paramount.

Teacher evaluations of the programme were positive. The majority of respondents reported that its impact on their ability to use ICT in their teaching had been 'high'. Feedback on the professional materials and the programme's support structures rated the Classroom Tasks, the Activity Cards and Project Pair support more highly than any other elements of the programme. The Case Studies were also well received: 'they enabled me to understand the plans set out'. This data, together with the findings reported in previous sections of this chapter, indicate that project participants were primarily concerned with their own day-to-day working practices: specifically, how their developing expertise in ICT could be used to improve classroom practice. Positive feedback was given by the Eastern Cape teachers on the use of cluster groups to combine 'well resourced schools with schools that have nothing'. School visits were also welcomed; they are rare, especially in rural environments, and were seen to be helpful in initially raising the status of the project in the community.

The main barriers within the programme were identified as lack of time (Cairo, 15 (62%); Eastern Cape, 6 (54.5%)) and too few computers: (Cairo, 16 (66.7%); Eastern Cape, 11 (100%)). Eight teachers overall said that 'technical problems' presented a barrier (three in Cairo and five in Eastern Cape). Only five of the respondents (four in Cairo and one in the Eastern Cape) cited 'poor' or 'no access' as an impediment to their work, despite the difficulties they had faced and the fragility in many cases of Internet access. Many teachers voiced the view that there needed to be stronger links in the resources to local curriculum requirements and numerous requests were made for materials covering 'all learning areas if possible. It must be highlighted that this natural science activity can be integrated with LLC and LOs [learning outcomes].' All of the teachers reported that they wished 'to develop the use of ICT in my teaching'; 100% reported they had found the programme 'very useful' for 'developing my professional knowledge and practice' and 100% had found the programme 'very useful' for 'improving student motivation' and 'improving student achievement'.

Programme attrition was low: only one of the 24 schools dropped out of the project; 46 of the 48 project teachers remain active and are being invited to participate in a further year of research on curriculum uses of the hand-held devices, as well as to support the training of peers.

Table 5: Comparing common perceptions and research experiences

Common perceptions and counter-arguments encountered whilst establishing the project	Experiences and research evidence arising from project implementation
State-of-the-art, digital technologies – traditionally seen as a tool for affluent business executives – are inappropriate tools for teachers of the global south, particularly in remote rural areas.	Project teachers report the benefits of a range of digital technologies for carrying out diverse Professional Activities: the devices have helped teachers develop aspects of their professional knowledge and competences.
The devices will either be stolen or will not survive the rough and tumble of daily life in a rural or resource challenged urban environment.	Only 2 of the 149 digital devices used in the project have been stolen, one in South Africa, the other in the United Kingdom. After two years' use, only 4 of the devices were no longer in working order (unconnected to damage or misuse).
Computers and other digital devices will be too complex for teachers to use, especially if they are novice ICT users.	The majority of project teachers find ICT 'useful' or 'very useful' for professional and pedagogic practices. Many teachers in both country contexts employ them regularly, some on a daily basis.
Small 'personal' hand-held computers and lap-tops do not lend themselves to classroom use, especially when there are very few devices, and very many students. (This was largely the project team's perception too.)	The hand-helds and lap-top computers were used extensively in the classroom by many teachers and students. The majority of the teachers find hand-held computers as useful as desktop or lap-top computers.

The Intambanane effect
Case Study 6 takes a look at the impact of the programme from a broader perspective by focusing on one school and its community over a two and a half year period, from project inception in January 2002 to the present. It illustrates how an intervention such as DEEP can lead to broader institutional change.

Other studies have suggested that computers can be a means of raising the status and interest of a profession that suffers from low pay and low morale. The findings of this study not only show how activities for teacher education can be developed to ensure teacher capacity to exploit the potential for ICT, but also suggest that such training could be developed to encompass the educational needs of rural communities more broadly.

More work needs to be done on studying the impact of an ICT intervention such as this at whole-school and community level. However, a key lesson learned is that ICT innovations should be looked at holistically: not just in relation to teachers and their classrooms, but also to the needs of institutions and communities more broadly. Such approaches could help ensure a range of additional benefits such as strong learner support networks, multi-use of costly equipment, consistency in approach to childhood and adult literacy and delivery cutting across the range of Millennium Development Goals.

Case Study 7: The 'Intambanane effect'

'Ladies and gentlemen, honorable guests, mums and dads, grandmas and grandpas, brothers and sisters, special friends, dear colleagues (applause) – it is my pride…[laughter] and my joy…and my greatest honour [more applause] to stand in front of you today.

Our presentation today is based on our experience of computer technology in our school, that is: a lap-top computer and three in one printer scanner and a photocopier…and a jornada' (Student 1)

(Laughter as title 'ICT for model C schools' appears on the large cinema screen behind the speaker)

'It was a new experience for us all. We thought that new technologies were just meant for Model C or well resourced schools' (Student 2)

(Shouts and laughter from audience)

'As second language learners who live in a disadvantaged area we found it so helpful to develop our language skills. As a result we have created an interesting story with a moral. It will be a lesson for many of us all. It is about the fox and the crow. It goes like this…' (Student 3)

One day a fox took a walk in the wood

Mmh! That smells tasty. IGINYIS'INGWIQI…………' (Student 1)

(Transcription of Grade 7 Intambanane student presentation, Eastern Cape affirmation ceremony, March 2004)

Intambanane Combined Primary School comprises five classrooms with commanding views across the hills south-west of Berlin; over 200 learners are taught in classes 35–44 strong. The school has electricity but no phone line; the nearest secondary school is an hour's journey, presuming transport. In recent years both school and local community had become a cause of strong concern on the part of the provincial education department. High deprivation in the community, coupled with negligible educational achievement, had led to ever-lower self-esteem amongst young people in the village and its surrounds. In the words of a senior provincial education official, the young people of this area were 'out of control, teachers' backs were against the wall'. Parents and the community in general had turned their backs on the problem – refusing to support teachers in what had become a daily struggle to contain severe discipline problems in the school.
Before the programme's inception, project partners Zama and Ncedo, both in their early 30s, had worked hard with

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colleagues to try and raise student achievement and self-esteem. Zama involved the school in a forward-looking literacy programme, READ, funded by USAID, which provides small classroom libraries and literacy activities to rural schools. He also used a course at a provincial university (Rhodes) to research the use of Xhosa (the local language) for student learning across the curriculum. The availability of quality curriculum resources in Xhosa to support this work was, however, sparse.

The research team documented the impressive energy with which Zama and Ncedo interpreted the DEEP programme over the lifetime of the project. ICT was being integrated into the curriculum, not merely an add-on. Students working on the project were permanently allocated to groups, each with a rotating leader and scribe. Zama in particular experimented with imaginative multi-lingual literacy activities, including entering his Grade 6 class for a multimedia story-writing competition via the web (accessed from East London some 40 kilometres away). Classroom activities were developed that encouraged originality and independent thinking, whilst drawing closely on students' home language and local experiences.

Both partners described their work prior to the project as driven by the minutiae of daily demands. Commuting to school one hour each way by train and public taxi daily, they faced large classes with minimal resources: 'Every day we arrived to write the lesson for the day on the board. The next day it was rubbed out; we started again. No work could be saved. They [the students] often couldn't read my writing' (teacher interviews, 2003). ICT use in the school began to provide project partners with some opportunities to rise above this tyranny of the immediate and take a broader perspective. Planning for lessons became somewhat easier, since the lap-top could be taken home overnight and resources created and integrated into lessons the next day. Re-use, revision and storage of professional materials and learners' work became much more feasible. The electronic medium also enabled the partners to work on longer-term approaches to curriculum planning, classroom management and organisation, reflecting and building on past and current practice to create more ambitious and imaginative schemes of work.

Over the two and a half years the research team worked with Zama, a personal transformation became apparent. He successfully completed a Master's degree, grew ever more confident in using ICT and involved local parents in following their children's progress. Early in 2004 he successfully bid to a local donor to provide the school with refurbished PCs:

'I've got some good news I wish to share with you. But before that, let me just express my gratitude, my appreciation and my pleasure for being part of Inkanyezi Project.

I, as a person have grown in many ways ever since I became part of the project. My computer skills have developed, as a result I wished that my school should one day have more computers. Sometimes wishes come true if you believe in yourself and in what you are doing.

It was last week (5th of January 2004) when I requested computers from many different companies here in South Africa and abroad. My wish was a dream- come- true.

I was motivated when I visited the website, www. ==============. I became proud of myself and considered myself a flower; I wanted to bloom right away. I received good news, the one I want to share with you. I received fifteen (15) computers from _____in Cape Town on the 14th of January 2004. Now my school has many computers.

[…]

Regards,

E-mail to project team, January 2004

At the mid-point of the project it had appeared inevitable to the research team that Zama would move out of the challenging environment of Intambanane as soon as possible, seeking work in an easier, more resource-rich context where his considerable abilities as a teacher, together with his ever-growing range of new skills, could flourish. Latterly, however, he has seen his career developing within – rather than away from – Intambanane. Rather than moving away Zama began to imagine how he could help make school and community a well-resourced 'centre of excellence' for learning. He has created plans with local parents and community leaders to develop the school as an ICT centre for the

community and locality, and has submitted an application for the recently vacated school principal post at the school.

Intambanane was chosen by project teachers as the site for Inkanyezi's affirmation ceremony in March 2004. The local community became centrally involved in preparations in the weeks leading up to the event: parents painted the external walls of the school building, and swept classrooms clean, sponsorship was gained for a school sign, mothers scythed the extensive grounds. The whole village attended the event to hear their sons, daughters and grandchildren sing, dance and present work of outstanding quality (see http://www.open.ac.uk/DEEP/iau).

Management theory uses the phrase 'helicopter ability' to describe leaders' capacities to rise above the everyday, to look beyond the immediate and distinguish, as it were, the wood from the trees. We term the distancing effect that ICT use has had in the project 'the Intambanane effect': *intambanane* is Xhosa for a dancing kestrel. Not only has professional use of ICT allowed Zama, his colleagues and students to rise above the day-to-day minutiae, it has also enabled them occasionally to dance, to dip and dive. Zama has begun to think creatively with colleagues about how new technologies might be appropriated for school and community – but in so doing their use has significantly facilitated his own personal and professional development.

Daily Dispatch

dispatch *online*

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Teacher makes ICT happen for rural school

By Zine George

AT LAST: Learners at ▓▓▓ School near Berlin are amazed by the magic of technology, a day after the arrival of computers at their school.
Picture by MIKE THAYER

EAST LONDON - When a Berlin teacher decided to further his studies three years ago, he had one primary aim - to do whatever it took to improve the standard of education at his rural school.

In 2002 ▓▓▓, a teacher at ▓▓▓ School on the outskirts of Berlin, took time off from his master's degree in language studies at Rhodes University and did an Internet search for programmes which would help his learners in communication and computer literacy.

He came across a United Kingdom website and saw a programme called the Digital Education Enhancement Project.

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Chapter 6: **Implications for Policy & Practice**

Over the last decade there has been sustained and increasingly strident rhetoric around the harnessing of ICT to the needs of education in the global south. Strong declarations have been made by governments and international agencies that information, knowledge and communications networks have an important role to play in reducing poverty. Yet, as indicated in Chapter 1, research and evaluation records of the use of ICT in developing country contexts for teacher education are sparse. This is particularly true of investigations into the use of the more recent flexible and mobile technologies. Of course, research and development projects take time to set up and keeping pace with changing technologies is problematic. Such research, however, is well under way in North America and European contexts, as the literature review appendix 3 indicates. Across the lifetime of the DEEP project the research team has documented a considerable reticence, particularly amongst policy makers (in national contexts and within international organisations), to consider the importance of ICT in short-, medium- or even long-term educational planning for teacher development. And this itself is in a context where, as the Muster project has shown (Lewin, 2002), many countries have relatively weak policy systems in place to support existing, let alone new, forms of teacher education.

In presenting DEEP to a range of audiences (see Appendix 11), the implied and occasionally explicit question 'Is Africa ready for ICT yet?' has been found to pervade some discussions. Such scepticism has been particularly evident with respect to the potential of ICT for training teachers in the poorest, more isolated regions of sub-Saharan Africa. The findings of this study, however, confirm the anticipated outcome of the study that teacher education and training can be developed to ensure such teachers' capacity to exploit the potential of ICT, a potential cogently articulated in DFID's (2002) policy document The significance of information and communications technologies for reducing poverty (Marker et al., 2002). Within both countries in which the DEEP programme has been implemented, the significance of the project has been recognised by a national commitment to build on the research. In Egypt, a plan for up-scaling DEEP to encompass 72 rural schools across all the governorates of the country in 2004–5 is under way. In the Eastern Cape the Nelson Mandela Foundation (NMF) has endorsed the work of the programme and a close partnership is planned between the NMF's Rural Schools' Development Programme and UFH as a result of both organisations' practical commitments to the use of new technologies for provision of quality rural education. Makano Marojele, NMF Education Adviser, reported:

'The use of new information communication technologies for curriculum enhancement and community development is one of the key components of the Nelson Mandela Foundation (NMF) Rural Schools' Development Programme. The programme seeks to mobilise rural schools and communities to work together to develop innovative models that will provide possibilities for improving the quality of rural education.

Digital Education Enhancement Project (DEEP) and NMF are part of a growing community of researchers that are continually looking for ways in which to improve the situation of the rural poor through educational and community development interventions.

DEEP holds great potential not only for widening opportunities for the ongoing professional development of educators but also laying a strong basis for innovative strategies to address the challenges of poverty. It is in this way that DEEP complements the efforts of NMF to roll back the boundaries of poverty. DEEP is significant in that it will help shape our understanding of the challenges in rural education in South Africa in the context of poverty, inform the development of responsive strategies to the day to day realities of rural schools and communities and stimulate further research into the provision of quality rural education'

The DEEP research suggests that forms of ICT, software and associated training should be primarily determined by the purposes and context of use, and this means they must be strongly focused on schools and classroom practice. School-based professional development uniquely permits ICT to simultaneously provide the medium, context and content for:
• teachers' personal and professional development;
• new and improved curriculum, school and classroom practices;
• student learning and activity.

This approach challenges conventional views of ICT teacher training (i.e. off-site courses focusing on discrete IT skills), as well as conventional views of ICT provision in schools (i.e. desktop computer suites for the development of individual students' IT skills). DEEP provides evidence that teachers and students can quickly develop a wide range of ICT skills in the process of using a range of digital technologies for strongly focused curriculum purposes, provided collaborative and peer learning approaches are exploited. Educational policy makers in developing contexts have the opportunity to by-pass conventional, unproductive and expensive ICT practices and the option to create enabling environments that focus primarily on the quality of teacher and student learning. DEEP also demonstrates that it is impossible to isolate teacher development from student- and curriculum- focused ICT developments.

Key policy implications
In evaluating the DEEP research findings a number of policy issues have been identified. In summary:
• Policy planning for the development of national systems of teacher education should explicitly recognise the increasingly important role of ICT and its potential for increasing access and improving quality.
• ICT policy and practice must be closely matched to local contexts and needs, with a particular focus on classroom relevance and learner achievement.
• The potential of new, mobile technologies needs further investigation in a wider range of contexts and purposes.
• Existing cost analyses are likely to be based upon outmoded models of ICT and use; further evidence is urgently required as to the way in which new forms of technologies, particularly mobile devices, can impact on the logistics/costs of ICT provision for teacher education.

Principles for ICT provision and programme development
In addition to these broad policy implications, the study suggests the following principles will determine the quality of ICT– enhanced school-based teacher education in developing contexts:
• personal access to ICT;
• ICT appropriate to local context and conditions;
• the opportunity to integrate ICT activity into daily routines and practices;
• use of ICT-supported peer and team learning;
• a focus on ICT for curriculum and classroom purposes, not skills;
• availability of relevant content in the appropriate language medium;
• access to local, national and international professional e-networks;
• assessment practices relevant to ICT-enhanced teaching and learning;
• frequent evaluations of the relevance of ICT hardware, software and related curriculum uses for local learning;
• strong vision of the potential of ICT for learning from national ministries and policy makers;
• observable political determination to provide ICT access to communities served by schools that ensures synergy across and between adjacent services (e.g. education, healthcare, agriculture);
• research and development that strengthen exemplification of the way ICT can be effectively used by teachers and students, in order that evidence, rather than rhetoric, becomes the authority.

A key lesson from this study is that investment in high-quality programme design and implementation is necessary to realise the potential of new models of teacher education using ICT. The new technologies that DEEP exploited also created new parameters, around which different models could develop in the future. The study, for example, saw the following patterns emerging:
• competition 'bidding in' by schools for a project placement (thus creating a sense of ownership and responsibility);
• self-help approaches to 'technical' support;
• partnerships between educational institutions, crossing national and international boundaries;
• multi-use of ICT that ensured full exploitation of provision;
• self-monitoring procedures that ensured good security;
• private sponsorship of ICT.

The DEEP research, drawing on outcomes of around 2,000 students and their teachers across two country contexts, has shown that new digital technologies can have a significant role to play in transforming the opportunities for teacher education in developing contexts.

Teachers and schools in poor environments could benefit from the many advantages that ICT is currently affording richer peers, whilst leap-frogging expensive mistakes made in more developed countries. Mobile digital devices that have, to date, been largely aimed at the business market can be exploited by teachers and students for a range of professional and learning experiences. Teachers, together with parents, governors, school principals and community members have reported that the use of new technologies had positive effects on areas central to UBE, including attendance, motivation and the quality of student learning.

Most significant of all, perhaps, the use of ICT in some of the poorest parts of the world, if well planned and implemented, can have a significant impact on the self-image, confidence and professionalism of teachers. In this sense ICT offers the potential to redefine and enhance the status of teachers within communities and more broadly across the societies they serve.

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Appendices

Appendix 1a: Original timetable

Publication of project outcomes.

Lead researcher/ assistant fieldwork.

Pilot evaluation conference.

Lead researcher/ assistant fieldwork.

Publication of draft framework and training packs and web resources.

Lead researcher/ assistant fieldwork.

Lead researcher/ assistant fieldwork.

Launch conference, to include e-conference and web launch.

June
May
April
Mar
Feb
Jan 2002
Dec
Nov
Oct
Sept
Aug
July
June
May
Apr
Mar
Feb
Jan 2001

Phase 3
Revision of framework and materials

Phase 2
Piloting of framework and materials

Phase 1
Development of framework and country-specific training packs and web resources

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Appendix 1b: Amended timetable

Activity	Timeline	Phase
Publication of project outputs	Mar / Feb / Jan 2003	**Phase 3** Evaluation of project and materials
End of project field visits Cairo (March); Eastern Cape (April)		
Mid-project fieldwork (Cairo)	Dec / Nov / Oct / Sept / Aug	**Phase 2** Project launch and implementation ** delayed start to Egypt due to 9/11
Trialling of activities	Jul / Jun / May	
Mid-project fieldwork (SA)		
Programme launch (Egypt)	Apr / Mar	
Programme launch (Eastern Cape)	Feb / Jan 2002	
Redrafting and country-versioning of activities	Dec / Nov / Oct	**Phase 1** Development of framework and country-versioning of DEEP programme
Completion of website and preparation for launch workshop	Sept / Aug	
Writing of teacher guide and programme activities	Jul / Jun / May / Apr	
Partners meet for scoping workshop week	Mar	
Project scoping visits including field visits to schools in Egypt and SA	Feb / Jan 2001	

Appendix 2: Data collection

All data was coded by the research assistants for ease of reference, created as electronic artefacts by scanning where necessary. Data was then coded by key words and electronically filed by country/school/date and data type. Thus data has now been stored within an electronic archive for the purposes of future study using the software, *Portfolio*.

Questionnaires

In the course of the study 317 questionnaires were collected and analysed.
- Pre-project questionnaires with project teachers (48: 24 SA; 24 Egypt);
- Mid-project questionnaires with project teachers (46: 22 SA; 24 Egypt);
- End of project questionnaires with school principals (17: 5 SA; 12 Egypt) ;
- End of project DEEP evaluations by project teachers (37: 13 SA; 24 Egypt);
- End of project evaluations by students (93: 57 SA; 36 Egypt (31 in Arabic));
- Exit questionnaires by project teachers (37: 13 SA; 24 Egypt);
- Hand-held computer questionnaires – teachers only (39: 24 Egypt; 15 SA).

Questionnaires were short, designed to take no more than 15 minutes to complete. They were produced and responded to in Arabic in Cairo and in Xhosa for students in the Eastern Cape. English was the language of choice for the teachers in SA. Questionnaires were completed during workshops at a central location in Cairo and in the Cape, mostly at project schools. Interviews and observations took precedence over questionnaire completion where time was restricted due to long journeys to rural locations, hence the lower number of SA respondents during field-work.

SPSS software was used to log and analyse questionnaires, thus enabling the team to explore and compare different fields (e.g. time/settings) with ease.

Translations were carried out by a professional translation service.

Field visits

The overall time spent in field-work (an average of four hours per school both mid-and-end of project, 36 days in all, using a minimum of two researchers per visit) was pragmatic given the challenges of access to many of the schools. Qualitative survey design was particularly suited to the research team's need to work flexibly around schools' many commitments: music festivals, exams, new curriculum development pressure and so forth. This design also provided for data collection tools and methods that were portable and flexible – since visits might need to be rescheduled at the last minute (perhaps because a road was inaccessible, electricity had failed, a teacher needed to accompany children to an event or a death had occurred in the community).

Time for a range of events to accompany more structured interviews and data collection was always allowed for. Schools were invited to lead the agenda of visits to enable opportunities for teachers and students alike to share and celebrate their work – and any problems. This informal dimension of field visits was important to provide the research team with a depth of understanding of the school setting, as well as ample opportunity to form a clear understanding of the kinds of knowledge and activities the teachers and their students had been working on together. The team knew from previous research that confidence and expertise in digital activity is best gauged by close observation of the interaction of users with ICT in real situations.

Teacher and school principal interviews

42 semi-structured interviews (mid-and-end of project) were carried out encompassing all but four project pairs, as set out below. These mostly took place in project schools. 35 hours of interviews were recorded on video tape. In addition notes were made on informal conversations during workshops, via e-mail, discussion board and text messaging.

Egypt

Mid-project: 23 out of 24 (96%) of the original teachers gave feedback in the course of 10 semi-structured interviews during a review week held in the schools, November 2002.

End of project: 20 out of 24 (83%) teachers gave feedback in the course of 10 interviews carried out with project pairs, March 2003.

Eastern Cape

4 semi-structured interviews were carried out with 20 out of 24 (83%) teachers in small groups over a review week, May 2002.

Mid-project: 9 semi-structured interviews were carried out with 18 out of 22 (81%) project partners, August 2002.

End project: 9 semi-structured interviews were carried out with 18 out of 22 (81%) project partners, April, 2003. The majority of interviews in Egypt were carried out in Arabic. Most interviews in Eastern Cape were carried out in English, but some in Xhosa. In paired interviews there was often code switching between Xhosa and English.

Items on the mid-project interview schedule included questions about how the school and community had responded to the computer, whether the technology was working, and what teachers had been doing within the project. End of project questions focused on teachers' personal experiences using ICT, their attitudes to the role of new technologies for enhancing their own learning and their positions on the role of ICT in enhancing student learning. Interviews were designed to begin with an informal chat about what project teachers had been recently working on in their classrooms more generally and how they and their families had been keeping. Interviews generated a range of insights that did not surface in the questionnaires, as well as confirming aspects of that data. Formal interviews were not carried out with students, although field notes were made during observations, some of these were video-taped and sometimes childrens' comments about the project were captured on video. More informal interviews took place with school principals. The research team talked with 18 school principals during field visits (excluding the 3 project partners who are also school principals).

Classroom observations

Classroom observations (mid-and-end project) were carried out in 19 of the project schools and approximately 40 hours of classroom observation were video-recorded. The research team selected video as a means of capturing classroom observations for the following reasons:
- Any form of classroom observation is a rarity in most of the project schools and so in this sense any form would be intrusive. Video enabled teachers and students, and in some cases parents, to view their own interviews, and to understand the research process. The videos were of keen interest to participants.
- Video enabled the research team to capture settings precisely; project schools and the arrangements of classrooms and so forth could therefore be recollected after a period of time most precisely.
- It was also intended from the outset that video and video stills of classroom practices might be integrated, with teachers' consent, into project workshops – allowing teachers to share and discuss practice: a rare opportunity, particularly for those in extreme rural settings.
- Some of this video work could also perhaps be used, it was proposed, by project teachers themselves, to create authentic case studies of classroom practice for future use.

Concept maps

Teachers were asked to complete a concept-mapping task at the beginning and end of the project. Concept maps are thought to be particularly useful as a tool for exploring the acquisition of knowledge and understanding about a new tool or set of tools. Concept mapping is a commonly used method for clarifying connections between concepts, and for this particular project draws on previous work carried out in two projects in the UK (REPRESENTATION, 1998; ImpaT2, 2000). The focus here was on teachers' understanding of the potential use of ICT in teaching and learning and the approach was used to try and track conceptual change in teachers' views of the potential of ICT in pedagogy and learning across the life of the project. Students also completed concept maps at the close of the project.

An example of a pre-project concept map:
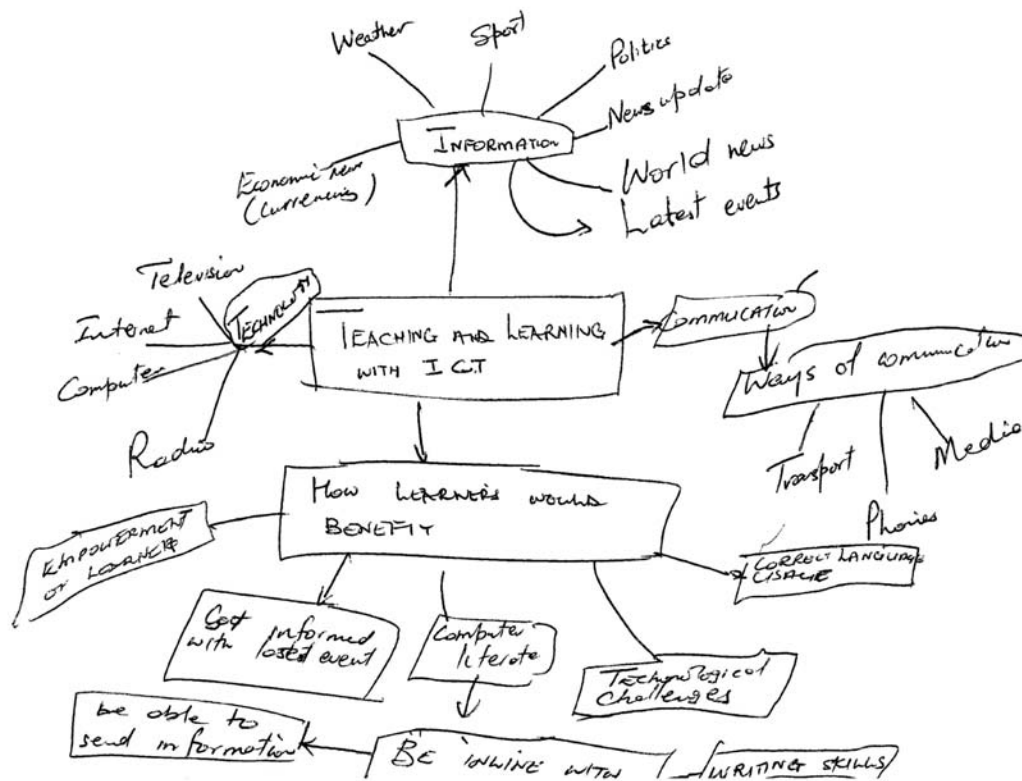
Data analysis

Four members of the research team worked independently on analysing the concept maps and carrying out a content analysis on the qualitative data, sharing and referring in discussion to their perception of emerging themes. They jointly explored the data in terms of the categories of teacher knowledge presented by our conceptual framework.

Lap-top histories

During the two field visits, with the teachers' agreement, the researchers captured files and activities created on the lap-top computer hard drives. This enabled the research team to create a snapshot in time of the learner and teacher interactions with the technology. An entire lap-top history was easy to capture since the lap-tops were project-owned. This data was analysed from a linear time perspective (using *Properties*) as well as through the lens of categories of teacher knowledge as outlined in Chapter 2.

Appendix 3: Summary review of the literature on ICT and teaching and learning (including teacher professional development)

Background

There is an expanding literature on the application of ICT to teaching and learning. Nearly all the published literature available internationally, however, reports research that is primarily based in industrialised, relatively resource-rich contexts. Yet Castells (2000) in a number of studies has shown, looking at the Internet in particular, how use is expanding in Asia, South America and Africa from a low base but with the same phenomenal growth pattern of North America and Europe. This trend is confirmed by World Indicators of ICT (see for example World Bank Data and Statistics: http://www.worldbank.org/data/countrydata/countrydata.html). Most governments have also established the use of ICT as a national priority.

Six country case studies were undertaken on behalf of the Commonwealth of Learning to examine ICT-based learning and distance education across the Commonwealth (Intelecon, 2004). The countries selected were illustrative of the Commonwealth's diversity, based on criteria such as geographic size, economy and region: Canada, Trinidad and Tobago, Fiji, South Africa, Mozambique and Ghana. Policy recommendations in relation to education were: (1) government awareness of the importance of ICTs for national education, including the understanding that (a) information and communications technology are vitally important to the development of the economy and to participation in the global information society, with a corresponding need to develop appropriate skills, and (b) ICT-based learning and distance education can play a crucial role in broadening access to education for the whole society, (2) the need for strategic planning and policy based on an analysis of needs and priorities for the use of ICT to improve education. Key elements and concrete steps of such a strategic plan proposed were:
• ICT skills integration in national curricula;
• equipping schools with computers;
• teacher training on ICT.

Egyptian context

In Egypt, following a major investment in computers in schools, a national programme of teacher training in the use of ICT has been launched. The majority of schools in Egypt are now being connected to the Internet in order to give both teachers and students the opportunity to use its resources in teaching and learning. In addition, large numbers of schools are receiving educational digital satellite channels which are transmitted by the Ministry of Education. The Minister of Education in his book *Education and the Future* stresses that, in order to achieve the objectives of development, Egypt needs 'to prepare a new generation who can deal with the language of this era, which is information and communication technology. This generation should be able to cope with the technology and integrate it' (Bahaa El-Din, 1997, p. 118).

South African context

South Africa's first White Paper on Education and the National Education Policy Act of 1994 set out its intention to 'redress the imbalances of the past through the implementation of new teaching and learning strategies…flexible delivery of services and the equitable distribution of technological and other resources'. Educational policy would seek to 'develop a problem solving and creative environment' in which new technologies would be harnessed 'to produce knowledge, growth and development'. Such long-term policies take time to develop and are still to be effected in many of the poorest regions of the country. A range of national and local projects are under way, however. The South African Information Technology Industry Strategy (SAITIS, 2004) is complementary to and supportive of the government's broader socio-economic development goals, particularly with regard to its emphasis on 'social upliftment and empowerment', whilst the ICT Research Priorities for the South African National Research Foundation (2002) stress the convergence of information technology and communication technology to form the new field of information and communication technology (ICT) that will have a revolutionary impact on learning. The Shoma Project is one of a number of new teacher education projects in the country. Developed by 'Multichoice', it uses satellite technology to transmit interactive courseware developed in collaboration with higher education units.

What does existing research tell us about ICT and learning?

Twenty-five years of research on computer use (e.g. Vahey and Crawford, 2002; Bransford et al., 1999) in resource-rich environments has demonstrated that, under the right conditions, computer technologies can have a beneficial impact on teaching and learning. These conditions include appropriate resources, support, training, as well as time for teachers to experiment and plan (Vahey and Crawford, 2002).

The fundamental role of tools as mediators of learning (Vygotsky, 1962; Cole and Wertsch, 1996) is now well established. Salomon and Perkins (1998) point out that human tools of all kinds play a double role: (a) as a means by which we act upon the world, and (b) as cognitive scaffolds that facilitate our activity. Some tools not only enrich our learning; they can also transform it. Such transformation of learning has two key aspects.

Learning effects *with* the tool
This recognises the changed functioning and expanded capability that takes place as we use and get used to a particular tool. Impact occurs through 'the redistribution of a task's cognitive load between persons and the device used' (Pea, 1998; Salomon et al., 1991), including symbol-handling devices (e.g. a spell checker) or 'across persons, mediated by devices and symbol systems' (e.g. telephones, fax machines)

Learning effects *of* the tool
This concerns the more lasting effects of our use of a particular tool beyond discrete occasions of use – the impact on our 'cognitive arsenal of skills, perspectives, and ways of representing the world' (Salomon et al., 1991).
A large-scale review of 81 studies of IT use carried out in the UK in 1994 indicated a growing body of research confirming a range of 'specific educational benefits that could be attributed to the use of IT' (NCET, 1994). These included factors already known to be important for effective learning, such as increased:
• learner enthusiasm and confidence;
• concentration;
• learner autonomy, leading to improved motivation.

Research also shows that the quality of learning generally (e.g. Davis et al., 1997) in a range of areas can be significantly enhanced when ICT is approached and utilised as an intellectual 'multi-tool', adaptable to learners' needs, including:
• critical thinking;
• information-handling skills;
• higher-level conceptualisation;
• problem solving (e.g. Bransford et al., 1999).

In addition, because many new technologies are interactive (Greenfield and Cocking, 1996), they can be used to create and sustain a wide range of collaborative processes and activity. Studies (e.g. Bereiter and Scardamalia, 1999; Leach, 2000) show that ICT can facilitate:
• the refining of understanding;
• the giving and receiving of feedback;
• collaborative tasks;
• discourse around a common text/resources/data;
• joint decision making and reflection;
• complex group interactions;
• a shared history of learning.

Reflection, or metacognition, enables learners to think about thinking. ICT also enables a range of tools that facilitate such a process, such as software tools that can be used to replay performance and try out possible improvements. Sophisticated tutoring environments that pose problems are also now available; they can give students feedback on the basis of how experts reason and organise their knowledge in physics, chemistry, algebra, computer programming, history, and economics. The CoVis Project developed a networked hypermedia database, called the Collaboratory Notebook, for a similar purpose. The collaboratory notebook is divided into electronic workspaces, called notebooks, that can be used by students working together on a specific investigation (Edelson et al., 1995). The notebook provides options for making different kinds of pages – questions, conjectures, evidence for, evidence against, plans, steps in plans, information and commentary. Using the hypermedia system, students can pose a question, then link it to competing conjectures about the questions posed by different students (perhaps from different sites) and to a plan for investigating the question. Images and documents can be electronically 'attached' to pages (Bransford et al., 1999).

In order to make a decision about what any specific tool is to be used for, learners also need to have a mental representation of the specific potential, as well as the 'affordances', of the technology in question. The notion of affordances is what seems to be prominent, i.e. to have salience to the learner, in a new situation. 'To be perceiving the world is to be acting in it – not in a linear input-output relation (act-observe-change)' (Clancey, 1993, p. 95). Recent

research (Somekh, 2001) into children's concepts of the potential of networked technology indicates that learners often have a far richer understanding of ICT than either the researchers or teachers assumed. When concept mapping has been used to elicit pupils' representations of ICT and reflect on its uses, in some cases they are able to depict possibilities which go beyond the current technological realities of their lives.

ICT and pedagogy
A number of recent papers provide summaries on the application of ICT to teaching and learning (Bransford et al., 1999; Leach and Moon, 2000; Mumtaz, 2000; Cox et al., 2004). Although the context of the literature is being outpaced by the speed of technological development, some key findings are beginning to emerge. In summary these are:
- that particular ICT applications depend on the teacher successfully adapting them to specific teaching and learning contexts (see Davis et al., 1997; Somekh, 2001; Caswell and Lamon, 1999; Moseley et al., 1999; Collins and Duguid, 2000);
- that classroom- and curriculum-focused teacher professional development is a crucial element in realising any investment in the provision of ICT (see Venezky, 2004; Zhao and Frank, 2003).

Both findings indicate the importance of training to strengthen teachers' professional knowledge (see Banks, Leach and Moon, 1999).

The Bransford et al., review of research on teacher learning and ICT (1999) reported that the introduction of technologies to classrooms has offered new insights about the roles of teachers in promoting learning generally. Technology can give teachers license to experiment and tinker (Means and Olson, 1995). It can stimulate teachers to think about the processes of learning. It softens the barriers between what students do and what teachers do. Studies reported in this review suggest that when teachers learn a new technology in their classrooms, they model the learning process for students; at the same time they gain new insights on teaching. McCormick and Scrimshaw (2000) argue that ICT can make some aspects of teacher pedagogy more efficient, and that it also has the potential to extend and transform the process of teaching and learning itself.

Research also indicates that the success of ICT to support learning is dependent upon the way in which a variety of classroom strategies are integrated into the teacher's overall pedagogy (Wood, 1998). A study by Newcastle University (Moseley et al., 1999) looked at specific ICT uses in a range of classrooms and concluded that successful teachers need to take account of a range of factors including:
- 'ensuring pupils have adequate ICT skills to achieve subject specific purposes';
- 'a planned match of pedagogy with the identified purpose of ICT and learning outcomes';
- 'clear identification of how ICT will be used to meet specific objectives within subjects of the curriculum to improve pupils' attainment'.

Passey (1999) suggests that educational benefits are linked to a teacher's ability to integrate networked ICT resources with other classroom resources, rather than substituting traditional methods with technology. Passey (2000) has also drawn attention to the way in which the boundaries of settings are changing, arguing that the home community can provide a substantial extension to the educational arena if teachers consider the appropriate approaches to be gained and the potential benefits offered. The advent of a connected learning community, he suggests, has a direct impact on pedagogy in terms of the access it provides to knowledge beyond the classroom.

Complexity
Lankshear et al. (1997) carried out a two-year study on the relationships between technology and teaching and learning in Queensland. They identified three overarching patterns: complexity (classrooms are complex systems, which has implications for implementation); fragility (classrooms are more sensitive to the loss of particular components: an expert teacher, a piece of hardware or connectivity); continuity (continuity of practice and provision in ICT is critical for ongoing learning).

The notion of complexity is present in much of the literature. The findings of a range of recent impact studies of technologies on learning (i.e. Lewin et al., 2000) show that ICT has a highly positive effect on learner achievement when a number of variables come together. New models of teaching and learning using ICT need to acknowledge a complex set of interactions between learners, teachers, tasks and the new technologies (McCormick and Scrimshaw, 2001; Leach and Moon, 2000).

Lesgold (2000) suggests that technology effects are difficult to assess in schooling, precisely because of such complexity: technology is generally not a direct cause of change but rather a facilitator or amplifier of various educational practices. Because 'hothouse' environments, in which sympathetic schools are demonstrating new technologies, and evangelising technologists tend to have good infrastructures and often have stronger than usual support for good training and instructional practices, it can be simple to show positive effects of technology in them. However, in wider implementations, more complex designs are needed to assure that both the strengths and weaknesses of new approaches are understood.

Teacher confidence
Cox et al. (2004) show that the uptake and use of ICT by teachers depends upon teachers' attitudes and confidence and this is confirmed by a large-scale study of teachers' implementation of ICT in subject teaching within the UK (Leach et al., 2004). Other studies suggest that teachers' own pedagogical beliefs and values play an important part in shaping technology-mediated learning opportunities (see Cox et al., 2004).

Technical support for teachers
Venezky (forthcoming) in reporting on the findings of the OECD's international study on ICT and the quality of learning in schools concludes that a 'critical level' of ICT infrastructure must be reached before teacher ICT skills can have an impact. School context was also considered to make a difference in this study. Where the ICT demands on teachers are high, teacher competencies are critical. Where, alternatively, the demands are mostly on the technology infrastructure, they become the dominant factor. An additional feature of schooling context suggests that technical support and teacher ICT skills might compensate for each other, he has argued: strong technical support for teachers reduces the need for strong teacher ICT skills.

Subject knowledge
Numerous studies suggest that the types of uses of ICT and the way it is used in lessons are influenced by teachers' knowledge about their subject and how ICT relates to this. This is confirmed by a recent investigation of the research evidence relating to ICT pedagogy carried out by Margaret Cox and colleagues in the UK (2004). The review concluded that when teachers use their knowledge of both the subject and the way pupils understand the subject, their use of ICT has a more direct effect on pupil attainment. Teachers also need knowledge of the potential of ICT within their subject. Leach and Moon (2000) suggest, however, that national curriculum requirements may deter teachers from pursuing authentic domain-related uses of ICT in their pedagogy, although there is exemplary work in this field – particularly well developed in the areas of literacy, numeracy and science (Bransford et al., 1999).

Within mathematics, for example, ICT can enable learners to explore data, observe mathematical patterns, and visualise geometry (see Table A, below). Authentic mathematical activities can be developed through a range of learning technologies including calculators, spreadsheets, graphing programmes, function probes, 'mathematical supposers' for making and checking conjectures (e.g. Schwartz, 1994), and modelling programmes for creating and testing models of complex phenomena. A 'Middle-school Mathematics Through Applications Project' (MMAP), developed at the Institute for Research on Learning, has enabled learners to explore problems such as designing insulation for Arctic dwellings using software tools that explore concepts in algebra (Goldman and Moschkovich, 1995).

Table A: Opportunities for exploiting the power of ICT in mathematics.

Mathematical activity	What processes will ICT enable?
Learning from feedback	The computer can provide fast and reliable feedback which is non-judgemental and impartial. This can encourage students to make their own conjectures and to test out and modify their ideas.
Observing patterns	The speed of computers and calculators enables students to produce many examples when exploring mathematical problems. This supports their observation of patterns and the making and justifying of generalisations.
Seeing connections	The computer enables formulae, tables of numbers and graphs to be linked readily. Changing one representation and seeing changes in the others helps students to understand the connections between them.
Working with dynamic images	Students can use computers to manipulate diagrams dynamically. This encourages them to visualise the geometry as they generate their own mental images.
Exploring data	Computers enable students to work with real data, which can be presented in a variety of ways. This supports interpretation and analysis.
'Teaching the computer'	When students design an algorithm (a set of instructions) to make a computer achieve a particular result, they are compelled to express their commands unambiguously and in the correct order; they make their thinking explicit as they refine their ideas.

(Source: NCET, 1995)

Table B, below, gives a similar exemplification for literacy.

Table B: ICT and literacy

Literacy activity	What processes will ICT enable?
Composing texts.	Word processing; E-mail, Computer Conferencing; Digital cameras; voice recording software.
Focusing on Audience/Purpose; Presenting texts.	E-mail; Computer and Video Conferencing,Desktop Publishing; Web authoring;Databases and Spreadsheets; Multimedia software; Presentation software.
Transforming texts.	Word processing; Desktop Publishing; Hypermedia
Exploring information.	CD-ROM; Internet; video conferencing; electronic mail.
Reading texts.	Internet; CD-ROM; Talking Books.
Asking 'What if?' questions.	Simulation; Data bases; Internet text debates;video conferencing
Identifying features of text.	Word processors; Text Disclosure Programme
Developing knowledge about language.	Text Disclosure Programme; Internet; CD-ROM

(Source: Leach and Scrimshaw, 2000)

Changing roles of the teacher

Leach (2001a) has pointed to the 'fallacies emerging from some of the rhetoric around ICT that it reduces the teacher's role to "facilitator" or "guide on the side"; she stresses the increased importance of the teachers' pedagogic and subject expertise in ICT-enhanced teaching and learning. Cox et al. (2004) reported that there is a fundamental misunderstanding by many teachers about the importance of the leadership and planning role when incorporating ICT. They concluded in their study that ICT use has a limited impact on learning when teachers are unable to integrate it into their short-, medium- and long-term planning for lessons and curriculum delivery (p. 6).

Teacher learning and ICT

Studies tend to focus on the importance of the following aspects of ICT-related teacher development:
• teacher access to ICT for personal development (both at home and school) including relevant technical support and skills training;
• teacher confidence and competence in the use of ICT, including the importance of positive attitudes to innovation (including communicating value of its use to pupils and clear objective setting);
• pedagogical practices (including educational philosophy teaching styles, strategies and classroom management).

Peha (1995) has noted that the rapid pace of technological change requires teachers continually to update their skills and knowledge. Watson (1997) and Schacter and Fagano (1999) have also argued that, unless teachers understand the philosophy of the software they are using, the effectiveness of its use with learners will be limited. Some technologies, for example, place a strong emphasis on pedagogical skills – computer conferencing, for instance, requires the teacher to act as moderator, and to be skilled in promoting discussion.

Marx et al., (1998) have developed a threefold categorisation of applications of ICT (multimedia, productivity tools and information and communications systems) as a conceptual framework for teacher development. They argue that when and how such technologies for professional development are introduced and used is key. Care must be given to the design of the tasks that teachers are asked to perform. They should also not be used in isolation from other professional development approaches and means. Leach (2001b, pp. 383–93) distinguished the following categories of use of ICT for professional development:

- Informational tools: enabling knowledge building;
- Communicative tools: facilitating teacher networks;
- Tools of the discipline: developing subject teaching;
- Productivity tools: ensuring teachers become professionally effective;
- Pedagogic tools: affording new teaching practices;
- Research tools: accessing evidence based practice.

Others studies (e.g. Leach and Moon, 1997; Leach, 1997; Moon, 2000; Roschelle and Pea, 2002; Leach, 2001a; Hargreaves, 2003) focus on the way in which new interactive forms of communication expand the availability of support for teachers, as well as access to new kinds of knowledge.

Lesgold (2000) in discussing the complex nature of ICT innovations argued that when technology is used for professional development of teachers such complexity becomes even greater, since it 'must land in an appropriate infrastructure, be part of an effective professional development scheme that it can facilitate, and the resulting changes in teacher competence must find their way into classroom changes that can stimulate increased student learning'.

Such complexity is also mirrored in the framework for ICT in Teacher Education prepared for UNESCO (Khvilon, 2002), designed to support teacher educators and policy makers in applying ICT to teacher education. Four themes – context and culture; leadership and vision; lifelong learning; planning and management of change – form the background within this framework to four key competencies seen to be critical to the success of ICT use for teaching: pedagogy; collaboration and networking; social and health issues; and technical issues.

Venezky's study (2004) found that professional development was one of the most important supports in most schools for ICT integration into teaching, yet professional development time was not budgeted for in many of the schools in the study. However, the provision of ICT staff development did not guarantee that teachers received the training they desired for using ICT to teach specific curricular subjects. In some cases the staff development provided was considered by the teachers to be too theoretical while in others it was found to be too distant from classroom application. A few reports within this study offer staff development models that are exemplary and which the study suggests should be considered by other countries. Most of the Danish schools reported successful staff development models, and these were all implemented with local school expertise. At one school, teachers could schedule assistance as needed from other teachers who had ICT skills. Such an arrangement helped to create a secure environment for trying to use ICT in teaching by providing assistance within the context where the need for it occurred. In a Singapore school a core group of teachers, called ET Champions, were taught authoring tools and other web-based technologies, along with pedagogical procedures with ICT. They then became responsible for developing web-based learning materials and for teaching other teachers how to use these same tools.

Zhao and Frank (2003) suggest teacher-level factors are the most significant in promoting change in computer use within the classroom, including teacher training and opportunities to explore and learn. Their evidence suggests that teachers' practice is most changed when working alongside other teachers in their own institutions. They recommend that instead of spending time and money on external in-service programs and conferences, teachers could be given more time to help

each other: 'Individualised release time for exploration may not be as helpful as group-orientated activities such as technology-playdays, including district support but with ample opportunity for teachers to help each other' (p. 833).

The use of new technologies in developing-country contexts
The advent of new information and communication technologies provide a new impetus for researching the potential of computer technology in the countries of the global south. Dhanarajan (2001) points out that 'if applied with thought, extreme sensitivity and knowledge…[ICTs] afford the means to extend access to education and training to the knowledge-poor, the unreached, the isolated and those who have been ignored for too long' (p. 134). Pontefract (2001) has cautioned, however, that effective use of ICTs must be tied to the needs of developing countries and challenges the 'one size fits all' approach of many programmes. A study of computer costs and other issues in developing countries carried out for DFID by Cawthera (2001) concluded that 'the training of teachers in the use of ICT in schools is an important aspect of provision which may often be overlooked and under budgeted'. He suggests that in contexts such as sub-Saharan Africa, where there is simply not the capacity to train and retrain the huge numbers of teachers currently required, 'school based, computer supported teacher training might be part of the solution to this problem. Technology could make teacher training experiences better and shorter'.

A study (Perraton and Creed, 2000), prepared for UNESCO, and presented at the April 2000 World Education Forum in Dakar, summarised international experience in using communication technologies for basic education in schools and distance education. It found that in recent years technological development in education has been piecemeal, haphazard and unplanned. The study argued that education needs to build on the general local state of development of technology rather than lead it and that educational projects at the cutting edge of technology generally prove unsustainable. Among the key points made in the paper were:
• The cost of introducing new technology is often underestimated and usually greater than that of employing teachers.
• The standard of teachers trained at a distance compares reasonably well with those trained conventionally and it is often cheaper.

The report recommended that educational planners and donors realise that:
• Communication technologies can play a significant role in pre- and in-service training of teachers, health workers and agricultural extension agents.

Moon (2000), Leach and Moon (2002), Dladla and Moon (2002) and Leach (2003) have pointed to the potential of communication technologies for transforming the models and processes of teacher development in the less developed countries (LDCs), as well as for enabling access to quality resources and professional support. Leach, Moon and Power (2002) suggest that ICT offers:
• scaffolding tools, that support teachers' construction and understanding of new professional knowledge;
• environments and new contexts for learning, enabling teachers to experience new situations, practices and people;
• communicative tools, facilitating social participation structures between teachers and other educators (e.g. collaborative tasks);
• metacognitive tools, enabling teachers to reflect on the learning process, at both individual and group level (e.g. conferencing; joint products such as electronic self-assessment).

Capper (2001) suggested that in the contexts of LDCs newer technologies provide the capability to address several common problems in the provision of teacher professional development. The technologies allow school systems to provide training and development that has the following characteristics: it expands teachers' opportunities for learning; it gives teachers anytime, anywhere access to learning; it provides teachers with opportunities to view numerous instances of teaching practice and to engage in reflective, analytic learning activities and discussions around specific teaching attributes and practices; it allows teachers to access the instructional products related to teaching practice, such as student work, and teachers' lesson plans and assessment instruments; it provides access to a broad array of teaching and learning resources across subject areas and often keyed to a specific curriculum; it allows teachers to participate in learning communities, to share ideas, analyses, reflections, and resources with their peers and other experts throughout the city, country or even the world; it provides sustained, ongoing opportunities for teacher development; it can involve a range of individuals and groups with different types of expertise that can contribute to teacher development, such as university faculty, subject experts, researchers, curriculum specialists, members of professional subject associations, etc.; it provides uniform training quality with the flexibility of local customisation; it can be tailored to the specific needs and curriculum of an education system; and it may become more cost-effective as use increases.

The 'Trojan Mouse': hand-held computers and teacher use
Information and communications tools are becoming increasingly portable, flexible and powerful (Sharples, 2000) and numerous other studies point to the potential of hand-held technologies as learning tools (e.g. Fung et al., 1998; Hennessey, 2000; Soloway et al., 2001). Many studies have investigated the use of hand-held computers as learning tools in classroom settings but mostly focusing on pupil learning (e.g. Fung et al., 1998; Sestokas-Filho and Bonafini, 2002; Yarnall, 2003; Hand-held Computing in Education Project). A major systematic evaluation for SRI International (Vahey and Crawford, 2002) with over 100 teachers on the educational uses of hand-held technologies in schools in the US suggested that teachers are highly positive about the use of hand-held computers in the classroom. They are perceived as 'effective instructional tools', with the potential to have a positive effect on pupil learning. Key benefits are seen to be increased time using technology; increased motivation; and increased collaboration and communication.

Soloway (2002) argued that hand-helds provide an opportunity for making major changes in educational settings. He dubbed this mode of technology the 'Trojan Mouse'. His research team at the University of Michigan is developing a science curriculum for pupil use and complementary professional development material intended to embed technology into the everyday experiences of students and teachers via hand-held technologies. Soloway et al. (2001) and Roschelle and Pea (2002) have proposed ways in which hand-held wireless Internet learning devices in particular can offer physical affordances that are vastly different from school computer labs or classrooms with five students per computer. Such affordances (see Gibson, 1979) they argue, may lead to learning activities that differ significantly from conventional images of school learning.

Waycott and Kukulska-Hulme (2003) investigated the use of hand-helds to support adult learners studying on an Open University course. They reported that the 'anytime, anywhere' access to learning resources is an important advantage of the hand-held computer, enabling adult learners to fit study time around other activities. Pownell and Bailey (2000) outlined six functions for 'educational leaders' that hand-held computers can offer: Organising and Planning; Reference Information (timely access to important information); Gathering and Analysing (supports decision making through analysis of data); Learning and Self Improvement (supports life long learning of current information and techniques); Communicating; Teaming and Collaborating (including sharing organisational documents, databases and schedules).

Stroup and Petrosino (2003) have usefully distinguished 12 horizontal and vertical design attributes of devices for school-related use. Horizontal design is the familiar 'all things to all people' 'just in case' design, associated with desktop, lap-top and main frame computing. Less familiar is vertical or 'just enough' design, where device functionality is tightly coupled with specific needs in identifiable markets. Two physically similar portable devices (hand-held computer and graphing calculator) are used to explore these attributes. They concluded that equitable access to key forms of learning functionality for all students and issues of total cost of ownership will provide the impetus for K-12 schooling to integrate horizontal and vertical technologies.

Vahey and Crawford (2000) suggested that hand-held learning technologies overcome some of the major limitations of desktop computers, as well as providing new affordances for learning (Roschelle and Pea, 2002). Yet in an extensive database search we have been unable to locate research reports on the use of hand-held technologies for teacher learning in developing contexts where teacher education is now so pressing. SATELLIFE (bridges.org, 2001), however, was a hand-held project conducted in Ghana, Uganda and Kenya between 2001 and 2002. This put PDAs into the hands of physicians, medical officers and medical students in different settings in order to demonstrate their viability and usefulness, especially for the collection of health data and dissemination of medical information. Its main findings were that hand-held computers are an appropriate technology for use in the African context: useful in the healthcare environments, an effective tool for collection of health data and an effective tool for information dissemination. More detailed outcomes of this evaluation are set out below, together with other projects in LDCs that have used a range of ICT for learning across a range of settings.

Specific projects examined during the DEEP study

Learn-O-Vision
Reported in:
• http://www.teacher.co.za/edutech9910/learnovision.html
• ICT in Rural Areas in South Africa: Various Case Studies ME Herselman Technikon Pretoria, Pretoria, South Africa herselmanm@techpta.ac.za
• http://www.col.org/events/0002events.htm#EdTech

The Learn-O-Vision offers teaching staff a solar-powered computer system, television, video machine, writing and flannel board in a portable and secure box. The complete Learn-O-Vision unit is housed in a standard wardrobe-sized box on wheels and it has front flaps that open out and act as the writing board with the video machine and television in front. The computer sits at the back of the unit and works with battery power that beeps for 10 seconds if you forget to switch it off. The unit has two solar panels, which provide power to the batteries. When fully charged these batteries have enough power to last a full school day and as an alternative it can work with electricity mains. Wheeling and locking the unit in a secure room at the end of the day can overcome the security issue; according to Callaghan (1999, p. 6), the Learn-O-Vision unit will eventually evolve to give rural schools access to the Internet and make distance education possible. Rural schools will be able to view educational tapes on the video machine and watch academic programmes on the television. The units' flannel boards will be used as writing boards.

SchoolNet in South Africa
This is the national body that co-ordinates the linking of South African schools to the Internet since the establishment of SchoolNet South Africa (SNSA) and has become important in the South African education system. 'Educators are constantly trying to understand educational process and must make professional decisions that have immediate and long-range effect on others: students, teachers, parents, and, ultimately, our communities and nation' (McMillan and Schumacher, 1993, p. 26). The World Bank has targeted disadvantaged schools in the country for computer access though this project.

The Commonwealth of Learning Case Studies

Source: Intelecon 2004

Key themes from the case studies:
• **Fee-based usage of ICTs for distance education:** Even small charges help to finance ongoing operating costs. E.g. in Ghana schools charge an additional monthly fee to sustain computer labs; funding could be arranged for pupils who definitely cannot afford even the most modest charge.
• **Universal service fund or equivalent as 'seed capital':** In South Africa the USF which supports the establishment of telecentres is secured from a small levy on telecommunications operators. Also, the projects are sufficiently modest that many centres promise to become self-sustaining in the medium term if the operational glitches are ironed out.
• **Multi-user concepts in facilities usage:** e.g. in Ghana some schools in the WorLD programme charge for evening use of their computer lab for adult teaching of software skills.
• **Regionalisation:** This seems to be the best answer for large-scale projects, especially in small markets (e.g., the African Virtual University or the University of the South Pacific).
• **Private sector sponsorship:** In the projects reviewed evidence exists of considerable willingness by a broad range of private sector companies (even many non-IT companies) to make cash or in-kind contributions, including computer equipment for schoolNets, and discounts on services to well-defined projects. National governments and international agencies can broker such partnerships; the WorLD programme is a very successful example of such a strategy.

Chile's Learning Network

This programme in Chile has attracted worldwide interest. The Learning Network allowed teachers in remote schools to actively participate on-line in an electronic environment focused on professional development. Potashnik, M. 1996.

World Links for Development (WorLD)

McGhee, R. and Kozma, R. (2000)

This programme provides Internet connectivity and training for teachers, teacher trainers and students in developing countries in the uses of technology in education. WorLD then links students and teachers in secondary schools in developing countries with schools in industrialised countries for collaborative learning via the Internet. Paraguay is one of the original four World Links pilot countries in Latin America and the programme is being developed within the framework of the country's National Policy on New Technologies in Education. In the initial phase of the project, 12 schools were selected from various administrative zones of Asuncion. Building on the success of this initial phase of the project, World Links recently partnered with Schools Online to add 10 new schools; 545 teachers in Paraguay have received World Links training, and 315 of these are participating in leading over 3,000 students in 30 collaborative projects.

Jhia Remote IT Village project
The Remote IT Village pilot seeks to link five villages in the Hin Heup District, Vientiane Province of Laos in a wireless Wide-Area Network (WAN). Villagers will use Voice-over-I.P. telephony and Lao-language business tools to improve their standard of living while preserving traditions. It is intended that the network will enhance business and trade opportunities for organic rice and produce in market towns and the capital, Vientiane, and the establishment of a local market for sales of a variety of products among villagers themselves. Villagers will also connect by voice and e-mail with family members who now live overseas.

The Jhai Foundation is building an 802.11b wireless computer network to link five villages in Laos with each other and the internet, providing e-mail, voice-over-IP telephony, and telephone access. The network will link five ultra-rugged Jhai computers and printers in each village whose power requirements in various configurations have been measured at less than 20 watts – which allows the systems to be powered by a battery charged by stationary bicycle. The Jhai Foundation is also localising the Linux-based KDE Graphical Desktop and productivity resources, allowing for communications, word processing, and simple spreadsheets, all in the Lao language. Stage 1 of the process was a single village launch, connecting Phon Kham village to the network as a demonstrator for the other villages in the proposed network.

SATELLIFE

Source: http://www.bridges.org, 2001

This project was conducted in Ghana, Uganda, and Kenya during December 2000 – December 2002 and put PDAs into the hands of physicians, medical officers and medical students in different settings in order to demonstrate their viability and usefulness, especially for the collection of health data and dissemination of medical information. An evaluation focused on the aspects of the project implemented in Uganda and Kenya, and proposed 16 criteria that represent the determining factors of whether people have real access to technology.

The overall recommendations were that 'hand-held computers could revolutionise technology access for the people of Africa. Hand-held computers offer enormous potential for improving service delivery in national Ministries of Health as well as international healthcare organisations and programmes. 'This study should be a wake-up call to industry, a glimpse into the untapped markets where their attention would make a real difference to people's lives.'

Key findings of the evaluation included:

Hand-held computers are an appropriate technology for use in the African context: useful in the healthcare environments, an effective tool for collection of health data and an effective tool for information dissemination. The medical reference materials available on the PDA helped the physicians and students improve their provision of healthcare. They proved to be an inexpensive alternative to PCs in terms of computer power per dollar; simple to use, and the technology was easily integrated into the daily routines of the healthcare professionals.

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Appendix 4: Sample Activity Card

Introducing ICT – step 4

Introduction

This Professional Development Activity explores why Information and communications technology (ICT) is important for educators and learners and some ways in which ICT can support literacy and science learning in particular.
It asks you to consider the way in which ICT can be introduced to your school and community, as well as to your own learners.

Educators

Outcomes of this activity are that you can:

* Discuss the importance of ICT for learning;
* Organise your classroom for ICT;
* Evaluate a multi media story ;
* Use a web site to support pupils in scientific research

Resources to support this activity

* Deep web library: Principles of Health and Safety; Resources to Support ICT
* Deep web site: Hare and Tortoise animation;
* Deep CD-ROM: Aesop's fables web site; Enchanted Learning: African Animals

Learners

Outcomes of this activity are that your learners can:

* Know some ways in which a computer can support their learning;
* Read an animated story;
* Select scientific information from a web site.

Portfolio Evidence

Evidence of your Professional Competence in this Activity can include:

* Sketch of planned classroom lay-out;
* Educator diary entry
* Learner diary entry

Appendix 5: Technical Specifications.

Requirement	Minimum specification	Ideal specification
Large screen for viewing by groups of pupils.	12" LCD or 14" CRT supporting at least 800 x 600 pixels @ 75Hz+.	14"+ LCD or 19" CRT supporting at least 1024 x 768 pixels @ 75Hz+.
Whole-class viewing (may not be part of absolute base spec.).	19"+ CRT monitor or video out for external TV.	LCD Projector and screen.
Support for current generation software.	Windows 98 SE or OS9 Pentium II or G3 Processor 64Mb RAM, 4GB HD	Windows 2000 or OSX 128 or 256Mb RAM, 10+GB HD
Multimedia	CD-ROM, microphone and speakers.	DVD-ROM, external active speakers.
Productivity Software.	MS Office (current supporting Arabic/English), Apple-works, Storybook Weaver deluxe.	
Reference Software.	Encyclopaedia(s) Dictionary Thesaurus Atlas	Curriculum specific software relevant to topics – endangered species – Animals and plants of Africa/Egypt – TBA

Internet Access.	Internal 56k modem
	Current-generation browser pre-loaded with plug-ins for:
	    Quicktime
	    Flash/Shockwave
	    Acrobat Reader
	    Real-Player
		Broadband connectivity

Appendix 6: Supporting infrastructure.

Programme requirement	Infrastructure requirement
Operate ICT equipment.	**Power supply to school** [Portable equipment may bee used without a school-based power supply, but the equipment would need to be sufficiently light and portable for the teacher to transport it to and from school in safety. The teacher would need sufficient access to a power supply to recharde the equipment easily and arrangements would have to be made to ensure sufficient battery life to carry out the activities in class.]
Access the Internet and participate in Computer-Mediated Communication.	**Network access** [probably telephone] from the classroom [If the school has telephone access, connections (wired or wireless) will need to be arranges to the classroom being used. It may be that alternative (high bandwidth, satellite or LAN) access to the Internet can be arranged, but this would require third-party funding, which is not currently secured.] Current-generation mobile telephone networks do not provide sufficient bandwidth to provide a viable connection at present. (Technical upper connection speed 28.8kbps; actual band rate likely to be no more than 9kbps at best, in South Africa at present.
Keep equipment functional	**Technical support** Schools will need to be located within a reasonable travel time of their source of technical support.

DEEP IMPACT: *an investigation of the use of information and communication technologies for teacher education in the global south*

Appendix 7: School and teacher profiles: Cairo.

School Profile				Teacher Profile		
School	Socio–Economic context	ICT resource and infrastructure	Enrolment	Teacher subject and grade	Prior professional and ICT experience	age and gender
El-Hekma	El-Hekma is located in the city centre; east bank of the Nile. 'High fertility and birth rates in urban areas have coupled with decreasing death rates to produce rapid natural population growth'. Housing problems, heavy traffic and inadequate infrastructure. School fees £E250.00pa; 4.5% unable to pay.	1 computer in computer suite for 3 yrs; 1 IT technician	21 teachers (2 male; 19 female)	Inas teaches Arabic to grade 3–5.	3 +yrs teaching exp; 'some' exp of computers, cell phone, & internet for personal use. 'A lot' of exp. of TV, radio.	F, 20–29 years
Teacher 1: Saraa			110 students (58 female; 62 male)	Saraa teaches maths to grades 1–3 & 6–8	Over 3+ yrs teaching exp; 'some exp of computers & internet for personal use. 'A lot' of experience of TV, radio. Access to computer at friend's house. Part of maths cpd scheme.	F, 30–39 years
Teacher 2: Inas						
El-Salam	El-Salam is in the El Marg district of northern Cairo. Linked to centre of the city and the West bank by a metro service. Practical capacity of the road network is inadequate; unemployment, poverty and lack of housing also affect the community. School fees are E£250 per annum; 3% of learners are unable to make these payments.	Available resources include a computer room that can be used with individual classes. The school has had these computers for five years.	19 educators (9 male and 10 female educators)	Amira teaches Arabic; grades 3–5	3+ years teaching experience. 'Some' prior use of computers and mobiles, radio and TV; none of internet No other cpd experience..	F, 30–39 years
Teacher 1: Amira			357 learners (209 male; 148 female)	Amal teaches Science to grade 1, 3, 4 and 5 pupils.	3+ years teaching experience. 'Some' prior use of computers and mobiles, 'a lot' of radio and TV. None of internet. No other cpd experience.	F, 30–39 years
Teacher 2: Amal						
Al-Amal	Al-Amal is in the southern Cairo district of Al-Khalifa. High unemployment, poverty, housing problems and inadequate infrastructure.	Available resources include 3 computers, which are organised in a computer room for use with individual classes. The school has had these computers for 4 years.	17 educators (5 male and 12 female)	Kawther teaches Arabic to grades 1–5.	3+ years of teaching; 'very little' experience of computers, internet, tv, mobile; 'a lot' of radio. Has participated in a Video Conferencing teacher education programme.	F, 30–39 years
Teacher 1: Kawther	School fees are £E250.00pa; all learners are able to make these payments. Many travel up to 10 miles to school.		206 students (105 male and 101 female)	Heba teaches Science to learners of grades 1–3.	3+yrs of teaching; 'some' experience of computers, tv, mobile; radio; 'none' of internet.	F, 30–39 years
Teacher 2: Heba						

		Available				
Al-Noor	Al-Noor school fees are £E250.00 and all learners are able to make these payments.	Available resources include 3 computers, not available for use with individual classes prior to DEEP. The school has had these computers for 4 years.	44 educators 338 students (176 male and 169 female).	Marim teaches Arabic to grade 3 learners.	2–3 years of teaching experience. 'Some' experience of computers, TV, radio; none of mobile or internet.	F, 20–29 years
Teacher 1: Marim						
Teacher 2: Ibrahim				Ibrahim teaches Maths to learners of all grades.	Has been teaching for more than three years. 'A lot' of experience of TV, radio; mobile; 'some' only of computers and none of internet.	M, 30–39 years
El-Nahda	El-Nahda is an urban school, located in the Hadayek El Koba district of Cairo, east of the Nile and close to 'down-town' Cairo. Tendency for informal housing to develop on the fringes of built-up areas, creating unplanned and 'low-quality' developments deprived of basic services and infrastructure. Unemployment has risen over the last ten years, and in addition to the evident class polarisation, inter-class disparities are increasing. School fees E£250pa, which all learners are able to pay.	3 computers, in a computer room. School has had these computers for three and a half years.	38 educators 427 learners (233 female; 194 male)	Galal teaches Mathematics to Primary Grades 1–3.	3+ years teaching; taken part in schemes to improve his knowledge in Mathematics, English and computers. 'Some' prior experience of computers & mobile; 'a lot' of radio/TV; none of Internet.	M, 20–29 years
Teacher 1: Galal						
Teacher 2: Samir				Samir teaches Science to Primary Grades 1–4.	3+ years teaching; has previously participated in a computer education programme & has 'some' experience of using Internet, 'a lot' of radio and TV; 'v. little' of mobile phone.	M, 20–29 years

El-Hagah	El-Hagah is an urban school, located in the El Sharabia district, northern Cairo. Second highest population density in Cairo, according to the 1994 census. Although central stations for regional infrastructure are situated here, certain zones suffer from unreliable water, electricity and telephone supplies. Due to overcrowding and virtually non-existent urban planning, there is no space for new buildings that would improve the area's existing services. In addition, the poor condition of the roads and heavy traffic prevent the district from communicating with adjacent provinces that could provide vital support to services. As a result, El Sharabia functions as an isolated area in the North Zone of Cairo. Industry in the middle of residential areas has led to environmental degradation that affects the health of the community.	3 computers, which the school had for 6 months; until DEEP not available for use with individual classes.	26 teachers (16 male and 10 female) 448 learners (244 male, 204 female)			
Teacher 1: Hosni				Hosni teaches Maths to grades 1–3.	'Some' prior contact with computers; no use of internet. 'A lot' of use of TV/radio/mobile. Prior experience of professional development scheme related to Maths, English and Windows. Access to a friend's computer outside of school hours.	M, 20–29 years
Teacher 2: Farah				Farah teaches Arabic.	'Very little' prior use of computer and none of internet or mobile phone. 'A lot' of use of TV/ radio. No prior cpd experience.	F, 30–39 years
Al-Ahramat	Al-Ahramat is a suburban school located in the 15th of May City, a New Town, south east of Cairo. Built in the 1980s in the desert away from the population concentration. Financial incentives for industry in such New Towns, but reluctance on the part of businesses to move from traditional centres in Cairo. Many infrastructure projects have been implemented, but the region still faces urban problems such as unemployment and lack of housing. 1% are unable to pay school fees which are set at £E250.	Available resources include 4 computers, organised in a computer room that can be used with individual classes. The school has had these computers for 3 years.	72 teachers (13 male and 59 female) 1010 students (540 male; 470 female) Class sizes are around 45.			
Teacher 1: Atef				Atef teaches Mathematics to all Grades 1–8. outside of school.	3+ yrs of teaching; 'some' exp of computers, TV, mobile; 'a lot' of radio; no experience of internet but owns own computer for personal use.	M, 30–39 years
Teacher 2: Mona				Mona teaches English and Arabic to pupils in Grades 1–3,	3+ years teaching exp; 'v. little' exp of TV; computer, mobile; internet. 'A lot' of radio. Has participated in video conferencing teacher ed programme.	F, 30–39 years

	Context	Available resources	Numbers	Teaches	Experience	Gender, Age
El-Nile	El-Nile is in the residential area of Al Manyal ar-Rawdah, one of two main islands in the Nile at Cairo. Increase in population, resulting in housing problems, heavy traffic and inadequate infrastructure. School fees are £E250.00 and approximately 2% of learners are unable to make these payments.	Available resources include 2 computers, organised in a computer room that can be used with individual classes. The school has had these computers for 5 years.	49 teachers (31 male and 18 female) 832 (434 male and 398 female) Class sizes are about 40 learners.			
Teacher 1: Nadia				Nadia teaches Science to grades 3–7 learners.	3+ years experience of teaching; 'a lot' of experience of computers, mobile, tv, radio and 'some' of internet. Owns a computer and has taken part in a professional development scheme to improve Word and Powerpoint skills; also participated in a programme about laboratories for Science.	F, 20–29 years
Teacher 2: Mohammed				Mohammed teaches Maths to grades 3–8.	3+years of teaching; 'some exp' of computers, 'a lot' of tv, radio, mobile; none of internet. Was an 'envoy' to the UK, where he spent three months improving his English.	M, 30–39 years
Tiba	Tiba is an urban school in the Bab-El Sharia district, situated in the oldest part of the city. School fees are £E264.00 and 3% of learners are unable to make these payments.	Available resources include 2 computers, which are organised in a computer room that can be used with individual classes. The school had these computers for 15 months.	44 teachers (28 female and 16 male) 582 students (279 male and 303 female)			
Teacher 1: Ahmed				Ahmed teaches Maths to learners of all grades.	3+ years teaching experience. 'a lot' of experience of radio, TV, mobile; 'some' of computers, but very little of internet. No previous cpd experience.	M, 30–39 years
Teacher 2: Nailah				Nailah teaches Arabic to grade 3.	3+ years teaching experience; 'A lot' of experience of TV and radio; 'some' of mobile. 'Very little' of computers & none of internet. No previous cpd experience.	F, 30–39 years
El-Shrouk	El-Shrouk is in the Qalaat Al-Qabsh area of the impoverished, working-class district, Sayeda Zeinab. Central district faced with many urban problems: poor-quality housing, inadequate infrastructure, lack of basic amenities, unemployment and homelessness. NGOs and local authorities are attempting to tackle the problem of 'street children' by establishing orphanages and reception centres. School fees: E£250 and approximately 3% of learners are unable to make these payments.	10 computers, in a computer room. The school had these computers for 8 years.	52 educators (21 male and 31 female) 502 students (258 female; 244 male)			
Teacher 1: Hani				Hani teaches Mathematics to grades 1–5	3+ years teaching experience. 'A lot' of experience of all forms of ICT & internet.	M, 30–39 years
Teacher 2: Eman				Eman teaches Arabic to grades 3 and 5.	2 years teaching experience; participated in a teacher education programme about video conferencing. 'A lot' of experience of all forms of ICT except internet. Has access to a friend's computer at home.	F, 20–29 years

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Appendix 8: School and teacher profiles: South Africa.

School Profile				Teacher Profile		
School	Socio–Economic context	ICT resource and infrastructure	Enrolment	Teacher subject and grade	Prior professional and ICT experience	age and gender
Imimoya	Imimoya is a rural school, north-west of Butterworth. Area; faced with high rates of unemployment and there are limited opportunities in agricultural activities. AIDS has also severely hit the community. School fees are between R5-00 and R30-00 depending on the grade of study and approx. 40% of learners are unable to make these payments.	No electricity or telephony; available resources include a small library. The school does not have the use of TV or radio.	300 learners (170 female; 130 male). 11 teachers: (10 female; 1 male). Average class size: 30, although the Reception class is significantly larger with 45 learners.			
Teacher 1: Rebecca				Rebecca teaches the Reception class. Her main subjects are literacy and numeracy.	25 years teaching experience, some of this in Nigeria. Has a Cert 'A', Association in Education. Professional goals – 'to upgrade myself; learn more about the computer; uplift the standard of education in our school'. She had no previous experience of ICT; as a result of DEEP she has bought her own computer.	F, 40–49 years
Teacher 2: Nolundi				Nolundi teaches literacy numeracy and science to Grades 3–9.	30 years experience including two other schools. Has a P.T.C. Business Management Diploma and a Bachelor's degree in Primary Education. Has no prior experience of computers or the Internet but uses mobile, tv & radio 'a lot'. Has been involved in OBE cpd. Professional goals 'to see my learners grow and achieve great things, poor as they are. It is my passion'.	50+ years
Ubolumko	Umbolumko is a rural Junior Secondary School, located in the Butterworth region, affected by poverty, unemployment, environmental degradation, lack of social amenities and inadequate infrastructure. AIDS has taken a heavy toll on the community. There are no other development initiatives in this area. School fees are between R10 and R30, depending on the level of study, and 90% of pupils are unable to make these payments. Most of the community are pensioners.	No telephone but there is electricity in the school; some homes have a battery-operated television & the school has a battery-operated radio. On average, pupils spend 15 minutes getting to school and live within a 2-mile radius.	Approx 300 learners (180 female & 120 male) 11 teachers (4 male and 7 female)			
Teacher 1: Nomvula				Nomvula Senior phase class teacher Class size 40+	11 years+ teaching experience. Has BA Ed, STD. Dip. In Translation (English/ Xhosa). No prior experience of computers or internet; 'some' of mobile and tv & 'a lot' of radio. No other cpd experience.	F, 30–39 years
Teacher 2: Nomsa				Nomsa teaches Intermediate phase Class size 33+	20 years+ experience. JPTD; no prior experience of computers or internet; 'a lot' of mobile, tv & radio. No other cpd experience.	F, 40–49 years

pensioners.			radius.			
Elintla Teacher 1: Nkuli Teacher 2: Bulelwa	Elintla is a peri-urban school in the Qumbu area of the Eastern Cape province. Qumbu is a poor region severely afflicted by environmental problems, such as soil erosion, which affect the quality of agricultural land. Many development programmes have targeted Qumbu as an area in particular need and consequently poultry, piggery, bakery, sewing and health projects have been established in an attempt to create systems of sustainable production. Although rates of unemployment are high, most of the learners come from middle-class backgrounds. School fees are R500-00 and nearly all learners are able to make these payments. The local village is about 15–20 minutes away and the remainder of learners live in a hostel 3 miles from the school.	Telephone, electricity and transport facilities exist and available resources include a library.	326 learners. Grade 2: 58 learners Grade 4–7 learners per class: 69 Grade 4 59 Grade 5 53 Grade 6 37 Grade 7	Nkuli reaches learners in grades 4–7. Bulelwa teaches 58 learners in a grade 2 class.	Teaching for over 20 years; teachers' Diploma. No prior use of computers or the internet, and 'very little' experience of television, radio and mobile phones; DEP multi-grade cpd course. Between 2 and 3 years experience.; teachers' Diploma. No prior use of computers or the internet, and 'very little' experience of television, radio and mobile phones. SABC programme for using TV in teaching.	F, 40–49 years F, 40–49 years

			155 learners.			
Izingwe	Izingwe is a rural Senior Primary School situated in a rural area of the Eastern Cape province, on the outskirts of Queenstown. Many schools in this Zwartwater region have participated in the Isithole project, a project of the District Development Support Programme funded by the US Agency for International Development. According to a report analysing the situation of primary education in the northern region of the Eastern Cape, carried out by Isithole, 70% of the population live in the former homelands with a 'legacy of poor infrastructure, limited employment opportunities, and chronic poverty…The low quality of education is evident not only in low matriculation examination pass rates but also in qualitative factors such as lack of physical resources in schools and the under-qualified and unqualified nature of a significant proportion of teaching staff. These problems are worsened by inadequate institutional capacity in terms of administration, school governance, leadership and teacher support mechanisms. School fees are R30-00 and all learners are able to make these payments. Pupils live within 1.5 miles of the school. Most of the adults are pensioners.	The school has electricity but no telephone. Although there are regular bus services and taxis, the school does not have its own transport. Learning resources are limited to a mini-library.	Approx. 35 in grade 2 class; grades 4–6 approx. 30 in each class			
Teacher 1: Sipo				Sipo is the school principal. Teaches grades 4–6.	19 years previous teaching experience, including one other school; PTD. Participated in the Isithole project. No prior ICT experience except for TV and radio.	M, 40–49 years
Teacher 2: Rose				Rose teaches Grade 2.	21 years in the school; PTD. No prior ICT experience except for TV and radio.	F, 30–39 years

Ingqanga	Ingqanga is a rural school near Whittlesea, south of Queenstown. The school was opened in 1999 as part of a government community-based public works programme. The Department of Education set aside R5 million for the initiative that placed the maintenance of schools high on its list of priorities. Although the Department of Education's director of physical planning stated that the government would support the school's attempts to connect to an electricity supply, the school still has neither electricity nor a telephone. No transport routes serve the area and in addition to poor infrastructure, the region has a high rate of unemployment. School fees are R30-00 and approximately 38% of learners are unable to make these payments. The average distance a learner might travel to school is between 1 and 3 kilometres. The school has been involved in the Rhodes University Mathematics Education Project (RUMEP). RUMEP is an 'independently funded NGO linked to the University, with the specific purpose of assisting teachers in disadvantaged schools. The aim of the project is to improve the quality of teaching and learning mathematics in primary schools' (http://www.ru.ac.za/affiliates/rumep/).	Resources are extremely limited; the school has neither a library nor any form of ICT resources. Though it has electricity this is often not functioning; there is no phone line.	817 learners (M: 360; F: 457) 22 teachers (15 female; 7 male)		
Teacher 1: Baby				Baby teaches grades 3–7.	6 years teaching experience. STD; ACE, BEd. Has participated in other teacher education projects (RUMEP, Isithole, READ and DEP). Very little experience of computers and ICT resources, none of internet. Reasons for participating: 'I want to empower my learners as well as the teachers in my school with technological information. I also want to develop self-dependent and self-motivated learners who can learn on their own. It will also be a great pleasure for me to benefit other schools in the area.	F, 20–29 years
Teacher 2: Tami				Tami teaches grades 4–7.	Tami has been teaching for 16 years in 3 schools. PTD. ACE, BA & BEd. Very little experience of computers and ICT resources, none of internet or mobile. Her reasons for DEEP: 'I want to improve myself professionally and improve the learning and teaching in my community and uplift the education standard especially of black people by equipping them with skills necessary for the new technology.'	F, 40–49 years

	Location	Resources	Students	Course / Subject	Experience	Age
Indlovu	Indlovu is a peri-urban school in Queenstown. The region's electricity costs are the second cheapest in the world and the water quality is of a very high standard. However the school serves the 'location' on the outskirts of the town where poverty and unemployment are the norm. School fees are R40-00 and approximately 10% of learners are unable to make these payments. The average journey to school is between 5 and 10 minutes long. The majority of learners come from very low income families.	The school has access to a telephone and electricity, but has neither a library nor ICT resources.	960 students (550 F; 410 M) 32 teachers (F 22; M 10)			
Teacher 1: Zoe				Zoe teaches Certificate course (one year) Bridging courses. In 4th year, 6 classes, 66 learners.	Zoe has 16+ years teaching experience but no previous experience of ICT tools except for TV and radio. DEP qualification without Matric JC & PTC. Has taken part in cpd scheme about Outcomes Based Education and in Isithole project.	E, 40–49 years
Teacher 2: Beverly				Beverley replaced earlier project partner, no other data.	Beverley has no previous ICT experience. Has taken part in cpd scheme about Outcomes Based Education.	E, 40–49 years
Inkwenkwezi	Inkwenkwezi is located in Butterworth, one of the principal towns of the Eastern Cape Province. An urban pocket in a largely rural landscape, the town is served by the N2, a major national route. The roads, cheap electricity and readily available industrial land have given rise to good-quality factories in the town. However, the region, formerly at the heart of black homelands, has inherited ongoing problems of unemployment and homelessness. Rural–urban migration has contributed to growth of shanty towns. Before 1994 the school was mainly a white school; after 1999 the learners are mainly black. School fees are R1440-00 (£144) and approximately 20% of learners are unable to make these payments.	Available resources include 'mixed readers', school library, swimming pool, tennis courts, a tape recorder for recording the choir. The school has both electricity and telephones and 14 computers, organised in a computer room that can be used with individual classes. The school had had these computers for one year.	870 students (480 female; 390 male), Average class size 40+. 28 teachers (5 male and 23 female) employed Average distance a learner might travel to school is 10 miles. Most families of a low socio-economic status.			
Teacher 1: Lulama				Lulama is a natural science specialist	6 years teaching experience; 'some use' of computers. 'A lot' of use of mobile phone, TV and radio. Very little experience of internet. No cpd experience.	E, 30–39 years
Teacher 2: Pamela				Pamela is an Africaans specialist	+3 years teaching experience; some use' of computers & mobile phone. 'A lot' of TV and radio. Very little experience of internet. No cpd experience.	E, 20–29 years

Uxolo	Uxolo is located in Grahamstown, one of the major towns of the Eastern Cape Province. The town is served by an adequate network of infrastructure including a major national route and other secondary roads. However, many urban problems such as ongoing unemployment and homelessness, a legacy of former apartheid…affect Grahamstown. The majority of learners come from disadvantaged communities, many of which have been targeted by other development initiatives, such as the Imbewu project. This programme aims to 'develop all levels of the education system in order to establish, nurture and support development initiatives in strong vibrant educational communities'. Thanks to Imbewu, the quality of teaching, educational resources and the management of schools have improved. The school has also participated in a Ministry of Games initiative, an exchange programme with Demuou and an HIV/AIDS awareness project. School fees are R2160-00 and approximately 22 learners are unable to make these payments.	Pupils live within a 6–7 mile radius. There is electricity and a telephone, but no means of transport. Available resources include small class libraries.			
Teacher 1: Connie			Connie is the school principal; teaches literacy.	Teaching experience: 22 years at other schools, 11 years at Uxolo. LD. B.Ed. 'A lot' of experience of computers, including in the classroom, for admin and research. A lot of experience of TV and radio, very little of mobile phone; 'some' of the internet. Has been involved in Imbweyu development.	F, 50+ years
Teacher 2: Peter			Peter teaches maths and science.	Taught for 7 years in a previous school and 2 years in Uxolo. BEd. (Honours); HDE; DE. Had 'some' experience of using computers, mobile phone, TV and radio; no prior use of ICT in teaching or cpd experience.	M, 30–39 years

Intambanane Teacher 1: Zama Teacher 2: Ncedo	Intambanane is a rural school in Dongwe region, close to Berlin. Has inherited ongoing economic and social problems; in 2001 had 80% unemployment rate. Many development initiatives focus on this Dongwe region because it is one of the most disadvantaged areas of South Africa. The Dongwe Community Development Forum entails community development-based agricultural activities, including small stock and poultry production, cattle farming, piggeries and skin and hide tanning. READ researches, develops and delivers a comprehensive language and literacy programme in the area.	The school comprises five classrooms. The school has electricity but no telephone.	200 students: average class sizes are 35.	Zama	+3 years teaching experience. Has 'some' experience of computers and the Internet & 'a lot' of radio, TV and mobile. Has been involved in teacher education programmes run by READ Educational Trust.	M, 30–39 years
				Ncedo	+3 years teaching experience. Has 'very little' experience of computers, 'some' of TV and radio; never used the internet or mobile phone. Has been involved in teacher education programmes run by READ Educational Trust.	M, 30–39 years
Iqhude Teacher 1: Winnie Teacher 2: Beverley	Iqhude Senior Primary School is an isolated rural school in an underprivileged area faced with severe infrastructure problems. There is only one male educator. School fees are R5-00 for foundation pupils, R12-00 for intermediate and R25-00 for senior, and approximately 56% of learners are unable to make these payments. The majority of learners come from families of a low socio-economic status.	The school has no telephone or electricity and the nearest bus route is 47 kms away. The average distance a learner might travel to school is 6 miles. Available resources comprise 'mixed readers' and a tape recorder for recording the choir.	241 learners (M 131; F 110), 7 teachers Average class size: 35	Winnie teaches English and general science	Winnie has taught 8 years in the same school; MATRIC + P.T.D. + FDE.	F, 40–49 years
				Beverley teaches Mathematics, Xhosa	MATRIC + P.T.B. + FDE	M, 30–39 years

Umceu	Umceu Senior Primary School is a peri-urban school near the former township of Zwelitsha, south of King Williamstown. The area, like many other parts of the Eastern Cape, is served by a deteriorating network of infrastructure. The water supply to local communities is unreliable, hospital buildings are inadequate and communal facilities are scarce. Confronted with HIV/AIDS and diseases spread by mal-sanitation, the death rate of the Zwelitsha area is high. The government recognises the extreme poverty of the area and has dedicated funds to the construction of classrooms, toilets and administration blocks in schools. In addition, several NGOs have set up development initiatives. In 2000, the Zwelitsha Education forum (ZEF) was revived. Dedicated to the improvement of education, this community organisation comprises representatives of the African National Congress, South African Communist Party, United Democratic Front, South African National Civic Organisation, school governing bodies and teachers from various Zwelitsha schools. The rate of employment in the peri-urban area where the school is located is fair. School fees are between R1225-00 per annum and approximately 5% of learners are unable to make these payments.	A good transport service is in place and the school also has electricity, telephone, fax and copier facilities. However, there is no library, television, radio or music equipment available.	461 students (F 216; M 245) 13 teachers (F 9; M 4). Classes are large, with 50 learners on average. Learners live within a 1.5 mile radius and spend, on average, 20 minutes getting to school.		
Teacher 1: Sibusiso				Sibusiso teaches grade 7 pupils.	Sibusiso holds a PTD qualification and has 14 years experience in 3 schools. No prior ICT experience of any kind.	M, 30–39 years
Teacher 2: Thoko				Thoko teaches grade 5 learners.	Thoko has a PTCBA. and 25+ years teaching experience in 3 schools. No previous ICT experience of any kind.	F, 50+ years

Appendix 9: Technical annexe

Significant technical obstacles were encountered in preparing quality multimedia educational resources in a multi-lingual project.

The hand-held computers used were not orientated for educational use, and would need significant adaptation for optimum use in the North African or sub-Saharan context.

Arabic software issues

DEEP provided the teachers with richly illustrated resources, using a range of media (print, web, CD-ROM, e-book). The UK-based OU team carried out much of the initial design work for the learning materials on the Apple platform, using OSX – which did not support Arabic. Arabic support subsequently became available in OSX.2, but not in any of the software used to create the learning materials (e.g MS Office; Adobe Indesign and Acrobat). Arabic support was not built into the Windows OS being used on new project equipment either. The Egyptian project team was provided with two new lap-tops purchased outside Egypt; these ran the latest versions of Windows and Office (XP). They have been able to use these machines to view documents containing Arabic text, but have not been able to use them to create documents in Arabic. For this, they have had to revert to older machines running the ageing Windows 98 operating system. It may now be possible for them to make the XP machines 'Arabic enabled'. It has been an important aspect of the research to discover how challenging working in a multi-lingual project can be. The solution has often meant reverting to software tools that were several years old.

Hand-held computer issues

Multimedia resources for the hand-held

Extensive effort was required to take existing resources (movies, animations, Acrobat files, web pages, reading materials) and reformat these so that they could also be used on the hand-held. Sometimes this was because new software had to be used (e.g. to make the course materials into e-books viewable on the hand-held, *MS Reader* had to be used, which was very particular in its requirements for text and image formatting). *Palm Reader* has since been made available for the pocketPC platform. In our experience, the process of making Palm reader e-books is more straightforward.

A number of software upgrades/installations were necessary in order for the hand-helds to fulfil their full potential as educational devices, including:
• Media player upgrade (required for viewing movies embedded in web pages);
• Flash plug-in installation (required for viewing flash content on web pages);
• Adobe Acrobat installation (required for reading reference resources);
• MS Reader (for reading e-books).

At other times reformatting was necessary due to the screen size (i.e. available resolution – the asset existed, and the hand-held had software to handle it, but the asset was effectively unusable at such a small screen size, requiring significant re-design). A lot of related technical information required some burrowing to find. The whole process was demanding and time-consuming, and represents a significant obstacle to presenting educational materials using this medium without dedicated technical expertise.

Adapters

At the time of issue, hand-helds had to be purchased from the UK, as they were unavailable in South Africa or Egypt. In both countries this required the purchase of travel adapters for the AC power supply. In relation to local wages, these are a relatively expensive option and not easily available.

Some hand-helds are supplied with a range of inexpensive 'pin plates' that snap onto the power adapter, making them usable in most countries 'from the box'.

Docking and synchronising

The hand-held's 'docking station' required a separate power supply in order to recharge the unit. In both countries, where electricity was available, there was usually a limited number of available sockets (sometimes only one). It would have been a significant advantage for the hand-held to be capable of recharging via the power supplied from the computer's USB cable; this would have greatly reduced incidences of data loss.

A small number of the hand-helds lost the ability to synchronise with the desktop or lap-top computer. The problem seemed to reside in the hand-held itself – reinstalling software on the desktop or lap-top, resetting the hand-held, using alternative docking cradles or the infrared port to synchronise the devices did not rectify this problem. When some of the affected machines subsequently suffered power loss (and the consequent data loss) there was then no method of reinstalling the DEEP educational software and learning materials.

Back up batteries
In both countries, difficulty was found in locating replacement back-up batteries. Roughly a third of the hand-helds' reserve batteries had to be replaced on field visits some months after the devices were issued to teachers. Where both the rechargeable main battery and the back-up battery had become depleted, the devices had lost all data.

Loss of data and additional applications
When power loss occurred (where teachers had not 'synchronised' their hand-helds with their desktop or lap-top), all the teachers' documents and data were lost. This led two of the teachers in particular to be wary of the hand-held's reliability.

E-books, holy books and multimedia web pages (animation, audio and video) all required additional applications to be installed on the devices: when data loss occurred, these additional applications were also lost from the devices. The devices then required a reinstallation of all the additional software and learning resources. On such occasions, reinstallation became a significant technical burden.

Screen wear
In both countries, after two years the hand-held screens were often highly abraded, particularly on the writing area, due to sandy, dusty conditions. One of the hand-helds' screens was accidentally cracked. In 2005 98% of the devices are still useable, although a small number have lost the ability to synchronise.

Navigation issues
Although few teachers reported the pocketPC Operating System as a problem in questionnaires, informal observations suggest that users often became 'lost' in the OS, having difficulty finding files, navigating between programmes, and being aware of which programmes/windows were open (or about to be closed). The research team experienced similar problems of use.

Lap-top issues
Several of the new lap-tops were rendered temporarily unusable by a password error, some 6–9 months into the project – it is not known whether the system's refusal to allow a log-in was an ICT problem or a human error. For reasons that have never really been understood by the project team, the South African manufacturer did not ship the lap-tops with CD-ROMs of the OS and installed software; this, combined with Microsoft's new 'activation' procedure for XP products, meant that the only solution was to exchange these machines with loaned lap-tops, until the original items could be returned to the manufacturer for a software reinstallation, and then returned to the original users (a process that took several months).

Appendix 10: A note on costs

Total Cost of Ownership

Total Cost of Ownership (TCO) is an important concept in understanding the costs of any technology, i.e. considering all of the costs involved from the point of purchase to retirement from active service. Moses (2004) provides a number of 'ball-park' costs for considering TCO for ICT in the context of schools in developing nations, suggesting the following as a guide to annually recurring costs:

• Maintainance: 15% of the original purchase price (even if donated) of hardware and software (ideally 20%);

• Supplies: 8–10% of original purchase price (even if donated) for printer ink, floppy discs and CD-ROMs etc.;

• Electricity: 10 cents per kilowatt hour, with computers running 1,600 hours (8 hours a day, for 200 days a year), with 400W being a typical desktop power consumption.

Moses points to two other areas of cost that need to be considered in a TCO model, *Professional development* and *Retrofitting*.

Professional development is defined in terms of 'training people to use the computer'. In this regard, Osin has offered the following advice:

'Don't start your project by buying computers. It is true that installing computers is very attractive from a political standpoint: they can be shown; they are modern; they give a feeling of progress; there are highly sophisticated demonstration programs; parents are happy; the school principal will declare that his or her school is computerised; but...when buying the equipment is the first step, the second step will be to discover that the teachers are not prepared to integrate the computer activities with their current educational practice.' (Osin, 1998).

The DEEP research suggests that professional development should not be seen as a costly ancillary to the provision of ICT. ICT should be seen as an ancillary cost of teachers' work and students' learning, and only where it can be shown to make the teaching and learning process more efficient, or to extend teaching and learning in some way, or to enable teachers and learners to do things that could not otherwise not be done. 'Professional development' will not therefore be considered separately in this analysis; it will be seen as an essential and prior consideration.

Retrofitting is defined as 'the cost of modifying buildings, space, electrical wiring and network connections to make a computer useful', to which list we would add making the location secure.

Two models of ICT provision

1. 'Thinking as usual' ICT provision

    Retrofitting is a highly significant issue if a traditional, office-based model of provision is used (i.e. school computer suite, associated wiring, benches, power supplies, cooling, window shades and security). Moses makes no estimate of the cost of retrofitting, as there are too many variables to allow any general figure to be proposed. We will simply point out that the cost is likely to be significant for a computer suite.

2. 'Thinking DEEP' ICT provision

    Retrofitting is negligible by comparison, when modest numbers of mobile technologies (i.e. lap-tops and hand-held computers) are being used: within or outside the classroom, for teaching purposes; at home for professional purposes; and elsewhere in the local community – such as in the DEEP Eastern Cape model, since such locations require little if any modification.

A TCO comparison

If we accept Moses' figures for ongoing costs without criticism, and use them as the basis for costing these two models of ICT provision, how does the Total Cost of Ownership (TCO) compare? Before we can answer, it is necessary to make a few assumptions.

We assume for the 'Thinking as usual' model that a school has been donated 20 second-hand desktop computers, and that these each consume 400W. For calculating costs of maintenance and supplies, we will assume these were budget computers at new equivalent cost of US$1,000 each.

For the 'Thinking DEEP' model we assume one new lap-top computer (at US$1,500) and two new hand-held computers (at US$500 each), and that the lap-top and hand-helds together consume a maximum of 40W.

The TCO comparison is set out in the following table.

Table C: TCO comparison over 3 years

	Thinking as usual		Thinking DEEP	
Cost Type	Description	Cost (US$)	Description	Cost (US$)
Initial purchase cost (I.P.C.)	20 free computers (new equivalent price $1,000 x 20 = $20,000)	$ 0	2 hand-helds 1 lap-top Total:	$ 1,000 $ 1,500 $ 2,500
Maintenance (15% I.P.C. p.a. x 3 years)	15% of $20,000 p.a., x 3.	$ 9,000	15% of $2,500 p.a., x 3.	$1,125
Supplies (9% I.P.C. p.a. x 3 years)	9% of $20,000 p.a., x 3	$5,400	9% of $2,500 p.a., x 3.	$675
Electricity (10c per KWhour, running 1,600 hours p.a. x 3 years)	20 machines @ 400W = 8,000W = 8KW 0.1$ x 8 x 1,600 x3	$3,840	1 machine28 @ 40W = 40W = 0.04KW 0.1$ x 0.04 x 1,600 x3	$19.20c
Total Cost of Ownership		$18,240.00c		$4,319.20c

The DEEP model also makes use of a number of multimedia devices – a high-resolution camera and a digital video camera, shared among 12 schools. Over the course of the project, there have been no ongoing costs associated with either of these devices – the IPC would be $1,200 for both items together; spread over the 12 schools, this would add an additional $100 to the TCO for the DEEP model.

In both models, a printer would also be required; old and donated printers are not likely to function well, due to the mechanical nature of the devices, and the high volume of use they usually experience in a corporate environment. Unlike computers, where printers are replaced from an office, it is usually because they have reached the end of their useful life. The all-in-one device used in DEEP would add $140 to the TCO in both scenarios (the cost of paper and ink is already included in Supplies). In the Thinking as usual model, a network printer might be more appropriate. These are usually significantly more expensive to purchase and power, although 'ink' is cheaper. Because of these variables, printers have been left out of the table above.

Discussion
The use of a TCO model for costing ICT seems an obvious approach, but is only just beginning to be taken up in the context of schools in LDCs. SchoolNet Africa, having supported the Thinking as usual' model of ICT for schools in its own practices, has recently published the results of a major review of the use of refurbished computers. This notes that:

> *"…the solution to Africa's digital divide is not as simple as excess supply of second-hand PCs in the developed world meeting excess demand in the developing world. Not every second-hand computer is suitable for re-use and, by sending un-usable second-hand PCs to Africa, the developed world is simply dumping its environmental problems (relating to the disposal of toxic substances in PCs) on Africa. Some practitioners have argued that the total cost of ownership of a refurbished PC could be higher than that of a new PC owing to its additional maintenance costs and shorter lifespan."*

(SNA, 2003)

Using the figures provided by Moses, and accepting those assumptions, the TCO over a 3-year period for accepting a free suite of donated computers may be in excess of four times more costly to a school than purchasing brand-new 'state-of-the art' mobile technologies. Indeed, the situation is likely to be starker than the unmodified assumptions would suggest, because the percentage of IPC set for maintenance has been kept the same in each scenario. In practice, the second-hand (possibly refurbished, possibly not) machines are much more likely to require frequent maintenance; further, the new machines will all be covered by a warranty for at least one of the three years. Accordingly, the figures for maintenance

should be substantially adjusted down for the new machines and up for the 'free' machines, resulting in a further gap between the two models; a five-fold TCO difference in favour of the DEEP model seems a more realistic assessment, and perhaps even more if the costs of retrofitting are also taken into account.

In reality, poor schools in remote regions do not spend $18,000 to keep their second-hand computer suites running for three years, because they do not have $18,000 to spend. The implication is either that computers are not used anywhere near as often as Moses suggests they might be, or they fall into disrepair, or both.

It may be argued that more pupils have access using a suite than the smaller number of computers available in the DEEP study. However, it has been demonstrated that the DEEP devices were always available in the classroom, and that shared between two teachers, levels of usage were very high. Pupils were also likely to have more access than they might through occasional visits to an ICT suite and as a result their fluency in computer use to support curriculum work developed quickly.

Another concern has been around survivorship of 'fragile' mobile equipment – but, as reported, the majority of devices remained in working order at project close. As part of the DEEP field-work, two schools in the Eastern Cape were visited that had 'free' computer suites. In one, the computers were in a vice-principal's office, unused by staff or pupils, who did not know how to use them for curriculum purposes. In the other, a supermarket chain had donated 14 ageing, refurbished desktops amid a flurry of positive media coverage. Only 3 of these computers were useable, because cables had not been provided for 11 of the machines. The argument that 'free' suites of ageing PCs is an appropriate (even the only) response to the information needs of the global south needs to be approached with caution.

References for Appendix 10

Moses, K. D., (2004). 'Educational computers system maintainance and support: they cost more than you think!' *Policy for Open and Distance Learning*, H. Perraton and H. Lentell, London and New York, Routledge/Commonwealth of Learning.

Osin, L. (1998) 'Computers in education in developing countries: why and how? *Education and Technology Notes*.

This paper was written by Tom Power and presented to the Pan Commonwealth Conference, Commonwealth of Learning, Dunedin, New Zealand, July 2004.

Appendix 11: Project Dissemination and Further Links

Newspaper articles

Daily Dispatch (East London, SA)   Report on Launch   January 2002
Daily Dispatch (East London, SA)   Report on Dongwe: 'Teacher makes ICT happen for rural school' January 2004
Times Educational Supplement (UK)   'Cape of Good Hopes'   November 2003

Presentations of DEEP to variety of audiences and stakeholders outside the immediate communities of the project
June 2002:
  Jenny Leach and Bob Moon, keynote address to 2nd European Conference on Information Technologies in Education
  and Citizenship: 'A Critical Insight, Barcelona, 26 June 2002: Globalisation, digital societies and school reform:
  realising the potential of new technologies to enhance the knowledge, understanding and dignity of teachers', available
  from http://web.udg.es/tiec/default.asp

September 2003:
  British Education Research Association, Edinburgh: Leach, J., Patel, R., Peters, A. and Power, T. (2003) 'DEEP
  impact: a study of the use of hand-held computers for teacher professional development in primary schools in the
  global south'

August 2002:
  Commonwealth of Learning (COL) Conference, Durban, South Africa: 'Transforming Education', July 30th–August
  1st 2002: Leach, J., Klaas, N., Mnqgibisa, M. and Power, T. (2002) 'ICT and the building of professional knowledge:
  experience in different African contexts'
October 2003:
  Seminar to the Open University International Development Centre on DFID research strategies and profiles:
  'DEEP Impact: using ICT to transform the pedagogic knowledge and practice of teachers in the global south'

May 2003:
  Video conference lecture, Harvard Graduate School of Education, USA, to the Harvard International Education Policy
  Program

October 2003:
  DFID research seminar series: Researching the Issues
  'Improving the Teaching of Literacy, Numeracy and Science through ICTs (Egypt & South Africa)'

August 2003:
  Presentation of research findings to Hewlett Packard

March 2004:
  Presentation to the British Council 'ICT in Education' Conference for Jordanian teachers, Amman, to launch Jordan's
  e-Initiative:
  'Evaluating the impact of ICT in learning'.

April 2004:
  Presentation to HRH the Princess Royal

April 2004:
  Video conference lecture, Harvard Graduate School of Education, USA, as part of Harvard's *Improving Performance
  through Online Learning* course

May 2004:
  Seminar for Minister of Education, Iraq

May 2004:
  Presentation to the Open University's Professional Learning Development Conference.

Publications

Leach, J., (2003) 'DEEP Impact: teachers and technology' in *Insights Education 1* Missing the Connection – using ICTs in Education, February, www.id21.org

Leach, J., (2003) *The Digital Education Enhancement Project South African Institute of Distance Education* (SAIDE) Journal.

Leach, J., Patel, R., Peters, A., Power, T., Ahmed, A. and Makalima, S., (2004) 'DEEP impact: a study of the use of hand-held computers for teacher professional development in primary schools in the global south', *European Journal of Teacher Education* 27(1), March.

Websites

Project's public website: http://www.open.ac.uk/deep

Communication Initiative (2003): http://www.comminit.com/ctrends2003/sld-7578.html

Essay on DEEP submitted to the Higher Education Policy Research Essay Competition of the International Association of Universities by the Open University and University of Fort Hare: See http://www.open.ac.uk/deep /iau

Research partnership
With Multichoice Africa Foundation and Nelson Mandela Foundation.Joint research agenda established to further development in the Eastern Cape focusing on the following questions:
• To what extent does the use of Information Communication Technology based content contribute towards the transformation of teacher development?
• To what extent can ICT be leveraged to enhance community development in rural areas?
• What are the most appropriate intervention programmes to develop the schools into community centres of excellence?