Report for Kagiso Trust

A Framework for Use of ICTs in Schools

An Options Analysis

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Foreword

Over the last few years, enormous progress has been made in introducing computers into South African schools. It is however generally accepted that not sufficient support or professional development has been offered to enable the majority of schools to use information and communication technologies (ICTs) optimally. This pertains to the whole range of ICT use, from use of ICTs in school administration and management through lesson preparation and resource procurement to integration of ICTs in teaching and learning delivery as well as the use of ICTs as a resource for the communities in which schools are situated.

Additionally, there is much literature, most notably, the Department of Education *Report of the Ministerial Committee on Rural Education* (2005) and the SA Human Rights Commission *Report of the Public Hearing on the Rights to Basic Education* (2005) which point to the even greater resource and capacity deficit experienced in rural schools making barriers to effective use of ICTs starker.

Therefore, before proceeding with their intention to equip rural schools with ICTs, the Kagiso Trust *Beyers Naude Schools Development Programme* (BNSDP) sought advice from SAIDE on developing a framework for the integration of ICTs into whole school development.

To achieve this aim, SAIDE undertook an options analysis to establish what works, what does not work, and why this is so.

The options analysis focussed on the following key aspects of ICT integration into schooling:

- **The range of possible roles and functions of ICTs in schools** – from the use of ICTs in management and administration through integration across the curriculum to exploring possible models for harnessing ICTs to generate funds and support community development. Concomitant models for school ICT integration, provisioning, implementation in teaching and learning, placement of ICTs in schools and achieving ICT literacy were also presented.
- **Critical success factors in sustaining school-based ICT initiatives** – including an investigation into models of community involvement in sustainability. Issues pertaining to purpose and vision, buy-in and ownership were also interrogated.
- **Professional development of school staff -** policy requirements and options for professional development were explored; and
- **The importance of developing a technology plan** – a blue print for implementation. Key components of a technology plan were considered and a range of technical, layout and cost implications were presented.

The findings of this investigation are written up and presented in this Framework Report.

Following the SAIDE presentation to Kagiso Trust of the options contained in this Report, Kagiso requested that SAIDE distil the key findings and prepare a report containing a proposed model for implementation in the BNSDP schools. The recommended model is contained in the accompanying Report, *A proposed Model for Use of ICTs in the Beyers Naudé Schools Development Programme Schools.*

Acronyms and Abbreviations

ACE	**Advanced Certificate in Education**
ADSL	**Asymmetric Digital Subscriber Line**
AMD	**Advanced Micro Devices**
AP	**Access Point**
ATM	**Automatic Teller Machine**
BNSDP	**Beyers Naudé Schools Development Programme**
CAD	**Computer-Aided Design**
CAT	**Computer Applications Technology**
CD	**Compact Disc**
CPTD	**Continuing Professional Teacher Development**
CPU	**Central Processing Unit**
DoE	**Department of Education**
DLP	**Digital Light Processing (projector)**
DSL	**Digital Subscriber Line**
DVD	**Digital Video Disk**
EDN	**Educator Network**
EMDC	**Education Management and Development Centre**
EMIS	**Education Management Information Systems**
FET	**Further Education and Training**
G3	**Generation 3 (fast wireless internet connection)**
GET	**General Education and Training**

GIS	**Geographical Information Systems**
GPS	**Global Positioning System**
ICDL	**International Computer Driver's Licence**
ICT	**Information and Communication Technology**
IT	**Information Technology**
IWB	**Interactive Whiteboard**
LAN	**Local Area Network**
LCD	**Liquid Crystal Display**
MPCC	**Multi-purpose Community Centres**
NCREL	**North Central Regional Education Laboratories**
NCS	**National Curriculum Statement/s**
NEPAD	**New Partnership for Africa's Development**
NQF	**National Qualifications Framework**
PC	**Personal Computer**
SA SAMS	**South African School Administration and Management Systems**
SAQA	**South African Qualifications Authority**
TCO	**Total Cost of Ownership**
UK	**United Kingdom**
UN	**United Nations**
UNESCO	**United Nations Education Science and Culture Organisation**
VSAT	**Very Small Aperture Terminal**
WiFi	**Wireless Fidelity**

Introduction

Why should we have computers in schools?

The amount of information we have is increasing all the time. So is our need to record it, process it, store it and share it with others often at great distances from us. Computers, either alone or in combination with some other technology, enable us to do all these things quickly and efficiently. The term *information and communication technology* (generally abbreviated to *ICT*) includes the technologies which together support people's ability to manage and communicate information electronically. ICT includes not only computers, but also equipment (or hardware) such as printers, videos, digital cameras and scanners as well as the software and systems needed for communication, such as the Internet. Television and radio are also included, but these technologies are under-used in most school contexts. However, the technology that plays a key role in bringing these media together is the computer, and this guide focuses on this form of ICT.

One reason for the focus on computers and the Internet is the role that ICT plays in enhancing learning, especially in the context of 21st Century skills and cross curricular outcomes mentioned in the e-Education White Paper. Learners are expected to demonstrate improved outcomes to:

- apply ICT skills to access, analyse, evaluate, integrate, present and communicate information;
- create knowledge and new information by adapting, applying, designing, inventing and authoring information;
- enhance teaching and learning through communication and collaboration by using ICTs;
- function in a knowledge society by using appropriate technology and mastering communication and collaboration skills

Teachers are expected to facilitate improved achievement in the:

- application and production of knowledge for the real world;
- ability of learners to manage learning;
- ability to promote achievement for learners who experience barriers to learning;
- access to information that increases knowledge, inquiry and depth of investigation.

Many studies of the impact of technology on teaching and learning conclude that technology has an important role to play in education at all levels, from Grade 0 to Grade 12, although it will not solve all educational problems. One such study,

conducted by the North Central Regional Education Laboratory (NCREL) in the United States of America[1],suggests that "technology can:

- Make learning more interactive;
- Enhance the enjoyment of learning;
- Individualize and customize the curriculum to match learners' developmental needs as well as personal interests;
- Capture and store data for informing data-driven decision making;
- Enhance avenues for collaboration among family members and the school community;
- Improve methods of accountability and reporting".

Computers are part of our daily lives

Increasingly, computers are part of our daily lives. Each time a cashier scans a barcode in a shop, a customer uses an ATM to do her banking, or we query an account at the local council offices, a computer is involved. This is the case, too, when we use e-mail to exchange written messages and photographs with friends and family in distant places, or when we look for information, order books and buy airline tickets on the worldwide web. Over the last 30 years, computers have changed from large boxes that were found in only a few research institutes and large organisations, to portable items that are in millions of private homes.

Computers are linked to social and economic development

Computers can contribute to social and economic development. They do this by supporting administration, financial and governance systems, helping to make them more efficient. They enable communities to link more effectively with global and national communication networks, to remain in touch with new and changing knowledge and to participate more successfully in global and national economies. For these reasons, both globally and within our own country, narrowing the 'digital divide' which separates those with access to ICT resources from those without access has become a major target on the development agenda.

The role of education in narrowing the digital divide: What does policy say?

Narrowing the digital divide means ICT resources must be provided to those who do not have them, and that their competencies to access and process the knowledge that these resources make possible must be developed. It is generally recognised that

[1] NCREL Report entitled *Computer-Based Technology and Learning: Evolving Uses and Expectations* (http://www.ncrel.org/tplan/cbtl/toc.htm).

programmes to develop ICT capability in a country should give priority to ICT in education. Learners need to develop ICT skills so that they can function effectively in the broader society and can contribute to the sustained use of ICTs within it. With this in mind, the South African Department of Education has defined the following as a key goal in its e-Education policy document (Department of Education 2004):

> All South African learners from grades 1-12 will be ICT-capable by 2013. This means that South African learners will be able to use ICT confidently and creatively to develop the skills and knowledge they need both to achieve personal and economic goals and to participate effectively as a member of the global community

The current status

Providing South African schools with ICT resources is a challenging task. At the most basic level, there is a serious shortage of the minimum infrastructure to support ICTs at many schools. Statistics in the 2004 edition of *South Africa Survey* (South African Institute of Race Relations 2004) reveal that, in 2000, only 64.5% of schools had access to any form of telecommunications, and only 49.3 % had access to electricity. In addition, the number of schools with computers for teaching and learning was very small, with only 3 335 schools, or 12.3% of South African schools, having computers for teaching and learning. There are considerable differences between provinces: Gauteng and Western Cape respectively report ratios of 11 and 9 computers to one school, while Northern Cape has a ratio of 4 computers to one school, and the other provinces only one or two. Given that these are averages, it is clear that many schools, particularly in the more rural provinces, do not have any computers at all, and that large numbers of teachers and learners have no access to computers at school.

The White Paper on e-Education (Department of Education 2004) acknowledges the magnitude of the task of delivering ICT and the infrastructure required for ICT in schools. It proposes that the integration of ICT into schools should take place over three phases. When the final phase is complete, in 2013:

- All education departments in the country will use ICT for planning management, communication and monitoring and evaluation;
- All schools will have access to a networked computer facility for teaching and learning, and to high quality educational resources;
- All schools, teachers and learners will be confident and competent users of ICT, and ICTs will be integrated into teaching and learning at all schools;
- Communities are involved in ICT developments at all schools.

Even if these ambitious targets are not achieved by 2013, the implications of the White Paper on e-Education (Department of Education 2004) are that, over the next few years, the number of schools with improved ICT resources should increase rapidly. Undoubtedly the emphasis will be on the provision of computers and associated technologies such as CD-ROM and DVD drives and Internet connectivity.

Already, in certain provinces, large-scale roll-out of computer provision has begun. The Gauteng-on-line project of the Gauteng Department of Education and the Khanya project of the Western Cape Education Department are examples of two major government-funded initiatives in this regard. Large corporations, such as Sentech and Telkom, have been drawn into the initiatives, and many schools have undertaken fund-raising drives in order to obtain funds for the purchase of computers, or donations of new or refurbished second-hand equipment.

Focusing on data about computers per school or learners per computer in a school could give rise to the notion that the hardware alone provides a solution to educational needs in this country. While the Khanya project in the Western Cape has succeeded in placing many computers in schools, it is also supported by a considerable support infrastructure and largely sound management principles. Even though this project promotes itself as successful, its current focus on curriculum delivery through content and software resources is not fully achieving national learner ICT literacy levels, nor equipping teachers with the full range of ICT integration skills. However, it is the most successful school ICT implementation project in this country thus far. Gauteng Online has set similar goals in ICT provision but with considerably less success so far, giving rise to the term "Gauteng Offline" which is most commonly heard being used by Gauteng educators themselves. One reason for this unfortunate situation is the relative lack of teacher professional development being provided to Gauteng teachers. The technology-focused project management processes and lack engagement of school senior management in decision-making are further deficiencies in the Gauteng Online model. The Northern Cape has also provided computers to most schools, but remains one of the least developed provinces in terms of ICT in education. The mere presence of computers in a school therefore does not represent a fraction of the effort required for successful integration of ICT into teaching and learning. This starts to illustrate the complexity of issues involved in providing ICT to schools. If a donor is really committed to a successful implementation it requires long term commitment and engagement with the issues of sustainability and capacity building.

Systemic change and sustainability

The rationale for investing in ICT for schools is made from diverse perspectives, but an overarching assumption is that ICT can only add value to educational processes if it improves quality and makes the performance of these processes more efficient. At the school level, managers and administrators must be able to be more productive, save time and/or be in a position to create better systems for more effective and efficient school management. Teachers must be able to stream line their administration and support and enhance teaching and learning and learners be provided with a tool for current of further study skills that are useful for entry into the workplace.

However, schools may not feel compelled to improve their internal systems unless the lead is taken by national and provincial education departments to institute systemic changes that can harness the power of ICT as an effective tool in education. The South African government is "carrying out a feasibility study on the implementation of ICT in teaching and learning aiming to widen access to high quality resources and learning opportunities for all teachers and learners. The study also aims to expose all pupils in advantaged and disadvantaged areas to enriched educational experiences and provide to all learners and teachers the means of communication and collaboration to enhance teaching and learning thereby give all learners the opportunities to excel in a 21st Century environment."[2]

By the end of the study in the second quarter of this year, the country will be able to present feasible models of ICT implementation including ICT hardware and software, access to broadband technologies, curriculum support and innovation, ongoing professional development. Actual implementation may take much longer.

While this report wishes to hold a positive view of education in South Africa, it may be necessary to concede that such systemic change and the sustainability that it may provide to schools will not take place at national or provincial levels in the timeframes required to successfully implement ICT in schools at this stage. It therefore becomes necessary to focus on systemic changes and sustainability models that can take place at school level through the leadership of the school's own managers and community.

Need for government support

The recent New Partnership for Africa's Development (NEPAD) e-Schools Demo Project has illustrated the need for government participation in ICT provision to schools. Six consortia spent two years each implementing a solution in a total of six schools in three African countries – 36 schools in all. One of the consortium members from Advanced Micro Devices (AMD) is reported to have said that "efforts by private companies to set up computer labs in rural schools throughout Africa will fail unless governments play their part by investing to make the projects sustainable". (Business Day, 21 April 2008) Many consortium members found themselves at odds with the governments and did not enjoy great cooperation because they had not fully consulted with governments or had consulted at Ministerial level but did not consult the persons lower down in the hierarchy that actually run the system. The project was poised to fail in some countries because no state-level sustainability models were apparent. On the other hand, in Mauritius the government became intimately involved with the Demo Project and great progress was reported during the project. However, no plans were made for the expansion of the project by the government, thus reducing potential long-term impact. While provincial education departments may lack full capacity to support and sustain ICT in schools at this stage, it is recommended that BNSDP coordinate with province education departments in a

[2] Report on address by Deputy President Phumzile Mlambo-Ngcuka, to the NEPAD Stakeholders Conference in Kemptin Park, April 2008, http://www.skillsportal.co.za/learning/schools/706266.htm

projects involving ICT in schools. Without their active involvement and commitment, however, the sustainability of investments is sure to be undermined. Some synergies may exist and it may be possible to align with some aspects of the provincial rollout and support of ICT in schools. The school cannot operate in isolation from its provincial context.

Provincial departments of education all have different strategies for implementing ICT in schools. Many now have district ICT facilitators who support schools in their ICT implementation. Budgets are allocated for professional development and support. In the Western Cape, the Khanya project has operated as a separate entity but has never lost sight of its provincial education contexts.

> "It is the strong partnerships that Khanya has helped forge - between the schools and stakeholders like donors, local communities, the education department and provincial government - that are instrumental in its success." (Financial Mail Dec 2006)

Recommendations

1. The Beyers Naudé Schools Development Programme (BNSDP) should liaise with Provincial Departments of Education to align, where possible, with and bilaterally gain from current educational ICT initiatives in the province.

2. Liaison with Provincial Departments of Education should include an agreement on the commitment of the province to sustain investments made to this project by The Beyers Naudé Schools Development Programme.

The rural context

In many countries, ICT has, with varying degrees of success, played a role in rural development programmes, mostly in non-school contexts. Since teaching and learning is the primary role of the school and the challenges of limited access to ICT for teaching and learning are severe in themselves, this report will focus largely on the use of ICT for teaching and learning and administration, while the role of community development through engagement with the school's ICT resources will be analysed only as far as the school's sustainability of its ICT resources are concerned.

Overview of profile of BNSDP pilot schools

To contextualise the options analysis for the schools in the Beyers Naude pilot and make relevant recommendations it was necessary to try and establish a resource and

infrastructural profile of the schools. Information was provided by the Kagiso Trust regional project coordinators. Unfortunately, it is not possible to always be sure as to what respondents understood by certain questions and how they responded. For example, while SAIDE did not request information pertaining to *computer laboratories*, the information provided indicates that 15 of the 29 schools in the pilot have *computer labs*. However, further discussion with a Kagiso Trust staff member, suggested that in many instances a classroom in the school is designated by the school as being the *"computer lab"*, but it may not necessarily be equipped with any computers.

Types of schools in the pilot

There are 29 schools in this pilot, ten each in the Eastern Cape and the Free State and nine in Limpopo province. 26 of the schools offer Grades 10-12 thus providing curriculum in the Further Education and Training (FET) band. Two schools (one in Free State and one in the E Cape) offer grades 8-12 and one in the E cape offers Grades 9-12. This means that only these three schools offer curriculum in the General Education and Training (GET) band (as well as the FET curriculum).

Learner-teacher ratios

14 (48%) of schools have a learner – teacher ratio above the stipulated secondary school ratio of 1:35 (a few schools have particularly extreme conditions with as many as 56, 57, 67 and 90 learners per class)

Financial considerations

The fact that 15 out of 29 (52%) are no fee paying schools is an important consideration as it means they are in quintiles 1 and 2 and deemed to be located in the poorest of the poor communities – communities which are unlikely to be able to contribute to the financial sustainability of the computer lab in the school.

Infrastructural considerations

- 11 schools (38%) have no electricity
- 13 (45%) do not have a land line telecommunication
- 10 schools (34%) do not have an administration block – that is, a dedicated space for administrative and management purposes.
- According to the information provided – 15 schools (52%) reported having a computer lab. However, it appears that is this probably a regular classroom that has been designated for use as a computer room without any computers in it.
- 13 (45 %) do not have water - the ones that do (17) have a water tank
- 8 (28%) of the schools have reported that they have no access by road
- All schools indicate that there is cell phone coverage although they have not indicated whether this is Vodacom or MTM.

Given this brief overview of the schools in the pilot which provides some sense of context, beyond "just being" rural schools, it is necessary to set out the guiding principles that underpin this investigation.

Guiding principles for implementing ICT in schools

The following guiding principles are common to many educational ICT initiatives across the continent (NEPAD 2007, Khanya 2006, and SchoolNet SA 2004)

- Each school context is unique;
- There is no single technical or educational model/approach to integrating ICT in schools which can be successfully applied to all schools;
- The primary objective of schools should be to create an enabling environment which stimulates and supports their ability to invest in, acquire, and effectively use ICT to enhance teaching and learning;
- Cost effective achievement of the school's primary objective (stated in the previous point) should be the basis of all technical decisions regarding deployment of ICT in the school;
- To be successful, any investment in ICT infrastructure should be accompanied by investments in:
    - Affordable connectivity;
    - Relevant educational ICT applications and electronic teaching and learning materials;
    - Professional development of school principals, administrators, teachers, and learners;
    - Maintenance and support strategies;
    - Effective governance and operational systems and processes.
- Dysfunctional schools (or teachers) cannot be made functional through deployment of ICT;
- Successful integration of ICT into education depends on schools developing the capacity to produce their own technology plans, which support their unique requirements and contexts and to make their resulting choices and investments accordingly;

Criteria for evaluation of options

In evaluating the options that will be presented in this document, decision makers (either school management or donor funders who will decide on which models to adopt as most appropriate to the school's needs) should apply the following criteria when making a decision on which option to select:

1. The decision needs to align with existing national and provincial education policies and guidelines and consideration given to legislative requirements and regulations.
2. The decision has to support the school in implementing its educational goals.
3. The decision should align with the specific objectives that may be outlined by the Beyers Naudé Schools Development Programme.

4. The decision should be able to deliver clear benefits that are sustainable over the short and long term.
5. The decision should be feasible, taking into account the scarce human resources required for the implementation, operation and management of the initiative.
6. The decision needs to consider the total financial impact, including the initial capital investment required as well as the ongoing capital and operating costs throughout the full project life cycle.

ICT in Schools

Computers are used in schools in various ways largely within the following categories (which may not be mutually exclusive):

1. ICT in Management and Administration;
2. ICT for teaching and leaning:
    - Application of ICT in Subject Areas
    - Integrating ICT across the Curriculum
    - ICT Specialization (subjects such as IT and CAT, which will not be covered in this document)
3. ICT Literacy
4. Supporting Community Development

1. ICT in management and administration

School management teams, administrators and teachers use ICT to enhance the school's administrative capability. This may include a range of daily tasks including the management of learner attendance, subject choice, assessment and promotion schedules. Managers and financial staff set up and maintain budgets while administrators send and receive departmental communications electronically, and communicating with the District Office by email, where possible. School and ICT policy revision and decision-making is subject to analysis of data captured through various means, and electronic data capture makes the analysis of such data more efficient. One of the primary responsibilities of managers as information leaders is to develop and maintain a knowledge-sharing culture in the school and community. ICT plays its role in the capture and dissemination of such knowledge amongst the school's role players.

School Administration and Management Systems (SAMS) are an important element of more effective school management. SA SAMS was developed by the Department of Education to provide schools with a cost effective, easy to use and fully integrated computer solution containing all aspects of school management requirements including a Timetabling Assistant. The administrative use of ICT will receive attention in this document since it addresses changes that can be made at the school's systemic level.

Key points to consider

1. Having management use ICT could eventually significantly enhance school administration efficiency.

2. When managers use ICT, they are more likely to provide ICT leadership to the school as a whole.

3. The primary purpose of the BNSDP will determine at what stage administrative and management use of ICT will be implemented.

4. Given that some schools may not have readily available learning spaces for ICT, infusion of ICT into administration and management, with some teacher access to ICT, may be a strategic intervention at this stage.

2. ICT for teaching and learning

Application of ICT in Subject/Learning Areas

ICT can be used at an individual level by all members of the school. This is the point at which individual teachers most often make contact with ICT for the first time and it is the basis of their further growth as ICT users. Teachers may decide to type out old worksheets and prepare assessment tools; others may like to research topics relating to their learning area or support their professional development by communicating with other teachers. Each individual will have his/her own needs and interests and will be drawn to ICT be a unique "hook" that engages their interest and shows the value of ICT. It will be important to address ways of achieving this entry level introduction most effectively and, most importantly, in realistic timeframes.

Access to educational software and digital content helps support under-prepared learners in learning areas such as Mathematics, Science and Language. Other learners may make use of simulation software to engage in critical thinking and gaining a deeper understanding of concepts. When teachers challenge learners' thinking digital information sources (amongst others) could be accessed to provide the basis for decision-making, problem-solving and other complex higher order thinking processes.

Various curriculum statements in the GET and FET bands make reference to the possible use of computers. Other than Information Technology and Computer Applications Technology, which are focused on computers as subject, Engineering Graphics Design requires the use of Computer-Aided Design (CAD) software at some stages of the learning programme. Some subjects, such as Accounting in the FET band and the Technology learning area in the GET band, cite computers as examples of resources that can used, but the use of computers remains optional at this stage. Where the use of computers is mandatory the schools need to be registered with the Education Department to offer the subject. Such registration is subject to schools meeting the stipulated requirements for preparing learners successfully for the Senior Certificate. This includes having teaching staff that is

qualified to offer these subjects as well as having the necessary hardware and software resources.

The applications that are subject/learning area specific include, but are not necessarily restricted to one or more of the following categories:

- Educational software, including edutainment or educational games
- Drill-and-practice applications
- Modelling and simulation software, which would include logging and feedback devices
- Creativity applications such as computer graphic or music software

Each of these kinds of resources has strengths and weaknesses which will be exposed in the way in which their use is managed. No resource can replace good teaching, but each can supplement good teaching in some way.

Some teachers will find value in ICT for the first time in specific subject applications. For example a Physics teacher without access to a laboratory may find a data probe apparatus and software very useful and see many opportunities in its use. Alternatively, a Geography teacher may see the value of GIS software, or an Accounting teacher will follow curriculum guidelines and use an accounting application. Applying ICT in subject/learning areas is not necessarily a simpler approach to using ICT than other alternatives, but the intensity of need and interest by the teacher can cut across the logic of so-called developmental levels, which outline simpler uses of ICT before more complex uses. One view of sustainability is that it is dependent on a match between a resource and its processes on the one hand, and its perceived value on the on the other hand. (BECTA 2005) It is important to note that this kind of match is more likely to take place if the teacher expresses the need or interest in the resource in the first place, rather than being expected to use a device which is delivered to the school without prior notice.

Guidelines for selecting subject specific applications

When considering the value of the subject-specific applications such as CD-based content, educational software and other specialist applications for subjects one should consider the following factors:

- The extent to which learning can be enhanced by the resource
- The value of the resource as perceived by the teacher
- The extent to which the resource supports and enhances good teaching
- Whether good teaching may not be sufficient to render the resource obsolete
- The extent to which the resource schedules the use of ICT resources and whether the value that it adds to the learning process can justify the cost of such a resource.

Integration across the curriculum

Although subject-specific uses of ICT require considerable staff development, especially in understanding why, when, where, and how ICT tools will best contribute to enhancing learning outcomes, ICT integration across the curriculum is generally regarded as a much greater challenge, demanding a much greater range of professional development and taking much more time to do competently. It is in fact more of a lifelong learning process than a product for which one can be trained.

Teachers across the curriculum, as they grow in confidence with ICT, use it as a resource to enhance their teaching and learning strategies. Teachers could gain access to digital curriculum content that will deepen their understanding of their subject content and support more effective teaching and learning. Such content is available on CD, DVD, Internet and broadcast channels. The same sources provide a wide variety of resources that teachers can take and adapt as they prepare teaching and learning resources. The Internet provides various opportunities for teachers to interact with others in their profession and gain access to professional development resources. Teachers are at the coalface of efforts to improve the quality of education and teachers' access to ICT is a critical requirement if ICT is to be successfully harnessed to enhance teaching and learning.

The e-Education White Paper refers to curriculum delivery and ICT integration when describing the contexts in which teachers and learners use ICT. Teaching and learning is initially supported and can eventually be enhanced through the use of ICT resources, but it should be noted that, while good teachers can become better teachers through the support of ICT, ICT alone will not make poor teachers better teachers (although it may help learners overcome this constraint to some extent through the delivery of curriculum learning objects). Professional development is critical if teachers are to maximise the gains that ICT offers to the learning environment.

Learners, through their use of ICT in learning contexts, acquire ICT skills that will support their lifelong skills development. While the actual skills that they require may soon become redundant, they develop the confidence to keep learning independently as new technologies and software become available. In various contexts across the curriculum learners are able to deepen understanding and acquire a variety of academic skills through access to the Internet and CDs – including research skills and broadening their grasp of global issues by participating in multi-classroom collaborative activities. In the process the learners access and use a wide range of ICT resources.

There are many purposes for ICT integration and a seemingly endless range of possible processes and benefits. Some of the most common purposes for using ICT across the curriculum are:

- Information gathering that fuels thinking and responses to challenging questions and tasks;
- Collaborating and communicating beyond the classroom with other learners who can add value to their learning process;
- Processing, transforming and producing/sharing information in individual and group activities;
- Using multimedia and digital content to deepen understanding;
- Using ICT to overcome barriers to learning associated with learning with special education needs;

Teachers require a wide range of competencies to design and manage ICT integration. These are articulated in the Guidelines for Teacher Training and Professional Development in ICT (DoE, 2008). Suffice to say that this category of ICT use could at the same time be the most challenging and the most stimulating and far-reaching in its benefits.

ICT integration is one of the major models by which learner ICT literacy can be achieved. It provides the most useful learning contexts for learners who are building awareness and understanding of ICT. It is these contexts that make learning ICT skills meaningful and relevant. This is referred to just-in-time learning, a well-known principle for learning skills in the context of their everyday application.

Key points to consider

1. For maximum learner access to ICT, ICT needs to be integrated across the curriculum so that learners are faced with diverse opportunities to use ICT.

2. Certain subjects do require the use of ICT. In some cases it is mandatory and in other cases a mere recommendation. Given the scarcity of learning space and initial access to ICT in BNSDP schools it will be advisable to carefully consider what subject demands will be imposed on the available resources. A carefully planned phased implementation will be necessary.

3. The rationale for ICT in schools should be focused on enhancing teaching and learning. Whether this is achieved through subject content and educational software or project-based learning approaches in which ICT is a tool catering to diverse needs across the curriculum should depend on the needs expressed by the teachers and leadership of the school.

4. Given the short term need for school leavers to gain confidence with ICT, it is recommended that ICT curriculum integration be supplemented by specific ICT Literacy for school leavers, although this may not be necessary in the long term as broader learner access to ICT may become possible with time. Paragraph 2.3 refers.

3. ICT literacy

ICT Literacy is often regarded as being different from ICT Integration and is often equated with the need to teach ICT skills. This is an over-simplistic view of ICT Literacy. The Programme for International Student Assessment defines ICT literacy as *"the interest, attitude and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate and evaluate information, construct new knowledge and communicate with each other in order to participate effectively in society"*. (Partnership for 21st Century Skills 2003)

The International Computer Driver's Licence (ICDL) can be regarded as an example of an ICT Literacy course in the narrowly defined way, specifically because it excludes contexts relating to its participants' scenarios of ICT use.

There are a number of reasons why schools would justify the installation of computers. The school wishes to:

a. Make learners ICT literate.
b. Implement ICT for the teaching of IT and CAT as subjects.
   These first two reasons focus squarely on the technology and not on any broader educational outcomes.
c. Implement ICT for curriculum delivery with the combined benefits of ICT integration and subject-specific ICT applications.
   In this instance, specifically through ICT integration, learners gain ICT literacy through their use of ICT in curriculum contexts.

While all three of these types of activity do prepare learners for the world of work – almost every kind of job these days requires computer skills - the SITES report reminds us that the workplace is more specifically looking for independent thinkers with a broad range of information skills. This makes the embedded curriculum context of using ICT more meaningful. At times learners will use basic office applications and at times specific applications such as CAD for Design, Architecture and Engineering and Pastel which is used in Accounting, but more importantly the learners are learning to self-manage, make decisions, solve problems and work with others. These skills are as important as their ICT confidence. However, it may be necessary on occasions to provide school-leaving learners with specific and certified ICT courses, but the role of such courses should not be over-emphasised, because these certificates do not necessarily guarantee jobs in today's work place.

Key points to consider

1. ICT Literacy (as an exercise in skill acquisition) is best achieved in meaningful contexts in which the learners will use ICT.

2. Achieving internationally benchmarked certification in ICT skills may be useful at face value, but too much value should not be attached to this as a guarantee for

finding employment; demonstrated proficiency with ICT and ability to work with information will carry more weight.

4. Generating funds and supporting community development

If appropriate in the specific context, the school computer labs may be used in after schools hours in a range of ways. For example, to provide computer literacy lessons to adults in the community. This may enable the school to derive some extra income as well as serving to benefit people beyond the immediate school community. It may also be possible to enter into an arrangement whereby a local person/small business may be contracted to maintain the school computers – thus providing a service to the school and a boost to the local business.

It is however extremely important that one should not loose sight of the fact that the core business of a school is delivery of quality learning and teaching. To this end the use of ICTs must necessarily first and foremost be harnessed to the achievement of this goal. Once all aspects of the school's management and educational delivery are efficiently run and quality results are produced, secondary functions such as community involvement may be explored.

Implementation options

Models for School ICT adoption

The application of ICT to management and administration is often regarded as the essential first step to ICT being implemented more widely in the school for a range of curriculum-related educational purposes. For example, the Western Cape prefaced the Khanya Project with the Schools ICT Project in which each school was equipped with one or two computers for administrative use, including an Internet connection. Departmental circulars are now only distributed electronically by Internet connectivity in that province. Education Management Information Systems (EMIS) data is also captured online.

Option A: Management first, teachers and learners later

In this implementation option the administrative ICT precedes the ICT for learning and teaching by a significant period of time. The fact that school management will be required to use ICT first will play a very positive role in the further roll out of ICT to schools as is the case in the Khanya Project. School-based ICT leadership is essential for the effective and sustainable use of ICT more broadly in a school. The advantage of this process is that management is given a period in which it can become confident about the use and value of ICT before having to divert attention to the more complex issues of ICT for teaching and learning.

Option B: Management and teachers first, learners later

This second option is similar to the first option but includes the simultaneous equipping of teachers, either in a shared work area or by personal access. This has the same benefits as the first model in that teachers are also granted a period of time in which they can gain confidence see the value of ICT in supporting their everyday practice, saving them time and making them more efficient. A variant of this model could be the supply of a wireless tablet laptop and projector to the school so that teachers who feel ready may experiment with the use of ICT in the classroom.

Option C: Management, teachers and learners synchronised

A third option is that the provisioning and involvement of management and administration should be synchronised with the process of providing ICT to the school for teaching and learning. This is more typical of donor funded implementations and in situations in which there is a sense of urgency with timeframes of implementation, although this may not be the primary reasons for such an implementation. The advantage of this option is that everyone in the school can be swept up by the excitement of new technology and that this can serve to create a mutually supportive environment, led from the front by the schools leaders. The risk is that, because attention is diverted to multiple processes, the use of ICT for management and administration is not carefully planned and supported. Alternatively, and perhaps more alarming, is the possibility that teacher professional development and change processes are not managed, thus increasing resistance amongst the teachers.

Key points to consider

1. In considering which model to adopt it is important to note the capacity of both the project management and each school concerned to cope with the implications of implementation beyond the installation of hardware and software. This specifically refers to ongoing management of the resources and professional development of the staff.

2. Given relatively low resource levels and the probable initial low capacity of the schools to manage ICT in the different spheres of the school environment, a phased implementation may be advisable. Each school situation will determine the best option to select.

Models for provisioning of management areas

The decision about what kind of ICT should be placed in which management areas will depend on various factors including:

- Size of the school (which affects the number of personnel)
- Size of management and administration spaces
- The nature of the management and administrative tasks using ICT
- The need for secure access to ICT

Option A: Shared network devices

The principal, deputy(ies) and administrative assistant(s) are connected on a network with a shared printer device. Alternatively, an additional secure printer device can be located in a secure space. Because of the greater mobility of the principal it is commonly regarded that a laptop is a more efficient device for that office. Security levels can be altered per device depending on whether the devices are to be regarded as shared or secure.

Option B: Shared network devices in a shared office space

The principal and/or deputy(ies) and/or administrative assistant(s) are connected via shared devices on a network with a shared printer device in a shared office space. In this case no administrator or management member will have exclusive access to a networked device. It is still possible to have permutations of this option if it is decided, for instance, that the principal should have exclusive access to a networked laptop. The shared office space could be in the main administrative office or in a separate room. There could be two shared spaces, one for administration and the other for teachers.

Option C: Shared portable network devices in a shared office space

The principal, deputy(ies) and administrative assistant(s) are connected via a network with a shared printer device in a shared office space. In this case the administrative assistant will have access to a desktop device, but no management member will have exclusive access to a desktop networked device. All devices will be portable with network access where and when required. Each management member will not have exclusive access to a laptop, but will share these devices as necessary according to a planning roster. The network points could be in the main administrative office or in a separate room. There could be two shared spaces, one for administration and the other for teachers.

Key points to consider

1. Consideration should be given to the impact that ICT will have on administration and management.

2. Administrative areas should have secure networks.

3. The use of laptops allows for flexible use of ICT (in terms of space and time) by management.

4. Configurations of ICT will be best determined by a) the available space and b) the envisaged use of ICT for administration and management, and c) the needs expressed by the school management.

Models of implementing ICT for teaching and learning

Option A: One computer in a subject class

The one-computer classroom is a well-published concept and lends itself to a range of innovative uses.

Model characteristics:

- One computer in a classroom that can be used for demonstration purposes and scheduled individual and small group use. (The latter requires specific planning and specific professional development.)
- Permutations of this model include:

    a. The use of a data projector to display the screen contents on a bigger screen, making the information more accessible to the class. (The teacher does not necessarily have to be the only user of the projector; it is therefore not necessarily only a teacher-centred resource.)
    b. Accompanied by a data projector the **applications of the computer can increase**; if the device is a tablet laptop (with Interactive Whiteboard (IWB) software installed), the addition of a data projector would give full IWB functionality without having to purchase an IWB. A tablet laptop with a data projector (which has the same functionality as the IWB) offers the teacher all the features of teaching with IWBs while the learners are able to interact with the learning materials in class.

Advantages	**Disadvantage / Challenges**
• Teacher has access at all times • Teacher can become a specialist on the use of the application • No scheduling required	• Security of classroom at risk • Lack of unscheduled access to other teachers of that subject • Computer may lie idle for long periods • Limited/no access to learners

Option B: Cluster of computers in subject class

Characteristics of the model:

- This option is similar to option A, but allows more flexibility of use by learners.
- Network broadcasting software, which enables the teachers to send the contents of one particular screen in the classroom to all the other learners' screens, can be used to share and collaborate between work stations. This increases the number of pedagogically effective possibilities for use.

Advantages	**Disadvantage / Challenges**
• Teacher has access at all times • Teacher can become a specialist	• Security of classroom at risk • Lack of unscheduled access to other

on the use of the application • No scheduling required • More access for learners	teachers of that subject • Computers may lie idle for long periods - less cost effective than option 1 • Dependent on space in classroom • Teacher requires professional development

Option C: Dedicated multi-computer venue for specific or various subjects

Model characteristics:

- This model is useful if the number of subject-specific applications is high; so high that a computer room is likely to be quite fully booked by the use of such applications.

- One must be especially aware of the pedagogical value of the applications in this case and assess whether such an application(s) justifies the cost of a dedicated or partially dedicated computer room.

  Examples of this kind of use in South African schools include the use of drill and practice software, language laboratories and content packages. In many cases the quality of the applications and the educational value of their use do not justify the cost.

Advantages	Disadvantage / Challenges
• Relatively easy to schedule, competing with other users that use the room less regularly • More access for learners • More cost effective to secure • Likelihood that computers will be used more regularly	• Teacher may not have sufficient access • Advantages/disadvantages may not apply across all specialist subject applications • Teacher requires professional development

Option D: Portable, handheld devices

Portable and hand-held devices are becoming more powerful, more robust, more numerous in type and cheaper. Handhelds are not usually purchased on their own unless there is already a PC/laptop available to which they can link and transfer information. Robust laptops could be useful as portable devices that could be used in flexible learning circumstances such as learning outside of the classroom.

Model characteristics:

This option offers opportunities to:

- Act outside the more established paradigm of conventional devices. For instance, a GPS device could be used to plot the distribution of plants or litter and data can be downloaded to field laptops and processed in the field. Once back at school learners can access the server by wireless network and store or further process the information.
- The use of a durable, low power laptop such as the Intel Classmate PC could provide great mobility and flexibility to resources and the teacher can perform some experiments outside of the classroom, with learners accessing and processing data at the same time.

Advantages	**Disadvantage / Challenges**
• Greater flexibility of location of use • Flexibility if device for different applications • Good access for learners • Easier to store securely without additional cost	• Easier to steal portable devices • Teacher requires professional development

Key points to consider

1. The installation of computer centres, although widespread, is not the only option for implementing ICT in a school and may not always reflect the immediate needs of the school.

2. The school's learning vision should be established before it or the donor can reliably make a decision about the focus of ICT for teaching and learning purposes.

3. Funding and existing infrastructure will play an important role in establishing how the learning vision and related to use of ICT can be implemented over time.

4. The most effective use of ICT is most likely to be made where the educators at the school understand the use and value of the hardware and software that has been installed. This is best achieved when their needs (according to the learning vision) are considered. This in turn may affect where ICT is best placed in the school. Section 2.4 refers.

Models for placing ICT in the school

Traditionally computers have been placed in computer rooms, also known as laboratories, in rows representing the equally traditional classroom. When computers were first placed in schools in the mid 1980s, school-based learning with ICT was very technology-focused and could more accurately be described as learning *about* ICT.

While knowing relevant ICT skills is always going to be important, the e-Education White Paper refers to learning *with* ICT and learning *through* ICT. This approach involves using ICT as a resource to support existing teaching and learning, and then enhance teaching and learning in ways that are often not possible without ICT (DoE 2003). ICT skills are learnt just-in-time, when the need to know the skill emerges. For instance it is now possible to gather earthquake data about earthquakes that have happened just minutes ago, and then to connect with communities that have just experienced the quake and to gather the human story. Learners can then launch a blog in which they canvas support for the victims of the 'quake and this might be the learners' first exposure to blogs. Learners would need to know a range of ICT skills during this process and would learn these skills as the need arose. It is of interest to note that one does not need a computer room with rows of computers for such activities.

Option A: Computer room with high density of computers

This is the "traditional" model which assumes that all learners should have access to ICT at the same time. Whereas there are advantages in giving learners access to ICT, these should be weighed up against a) the costs and b) the pedagogical uses that are informed by the school's learning vision.

Most schools, and especially the schools in this project, have classes that are so large that a 1:1 computer: learner ratio is rarely possible during class access to the ICT room. Whether this is a challenge or not depends on the intended purpose and role of ICT in the school and during that particular lesson. The notion of 1:1 access is largely a developed world notion, but also stems from the traditional view that ICT is the object of study (as in computer literacy classes or during IT and CAT lessons, the subjects that teach ICT skills). While these subjects do require 1:1 access, such access is not always required in other contexts. For most curriculum integration the teacher can overcome the challenge by removing the focus from ICT and using ICT as a resource (for example, for gathering information or processing of data) that is only required during some stages of a unit of work that is characterised by a variety group activities. Fifteen groups can more easily access the resource than 45 or more individuals. The fact the school has large classes and only, say, 20 computers is therefore not really a serious concern if managed properly.

Advantages	Disadvantage / Challenges
• Relatively easy to manage technically with all devices in one location • Easy to network • Easy to secure • Caters to large classes (if the room is large) • Learners have more direct access time	• Relatively higher cost of ownership of high number of devices • Lack of space • Difficult to manage large groups • Tends to decrease desktop space • Pedagogically poor layouts installed to accommodate large numbers of devices • Pressure on available connectivity bandwidth, because of the potentially high number of devices accessing the Internet simultaneously

Option B: Computer room with low density of computers

A permutation of the Option A that requires group collaboration where ICT is just one of the resources. It becomes possible to include interaction spaces away from the devices in the same room, or to make space for alternative devices. Note: this should not be confused with having low numbers of computers in a small room, resulting in a high density of computers (Option1).

Advantages	Disadvantage / Challenges
• Relatively easy to manage technically with all devices in one location • Easy to network • Easy to secure • Caters to large classes (if the room is large) • Learners have less direct access time • Cost of ownership of fewer number of devices • More flexible use of space • More desktop space available • Less pressure on available connectivity bandwidth • Layout can reflect learning vision	• Learners have less direct access time • Difficult to plan and manage coordinated group work • Cabling and power supply to cluster of computers that may not be against the wall

Option C: Clusters of computers in strategic locations

Schools that are secure can place smaller clusters of computers in a variety of locations. Most commonly smaller numbers of computers are placed in a location that can serve as a resource centres to assist with information gathering. In some schools such a resource centre could act as an "Internet café" for learners and the community. This option could also include the placement of computer clusters in subject classes for specialised subject use of a more general nature (not specifically related to a software application or digital content). This diluted use of ICT normally supplements an existing computer room rather than replacing it, but this depends on the school's technology plan and the role outlined for ICT. It is feasible that such a model could precede a computer room with higher numbers of computers.

Advantages	Disadvantage / Challenges
• Learners possibly have more direct access time • Flexible use of smaller spaces in the absence a large room for a computer centre • Layouts can reflect learning vision • ICT perceived as being more pervasive • More flexible use of ICT	• More difficult to manage technically with devices in various locations • More expensive to network • More difficult to secure • More difficult to maintain against dust and tampering • Not always easy to schedule

Option D: Mobile units offering relatively high density use

Most typical configurations here include the use of a bank of laptops on a trolley complete with project device and network devices (wireless networking being the most convenient). Robust laptops with a long battery life would be ideal for this scenario.

Advantages	Disadvantage / Challenges
• Learners possibly have more direct access time • More flexible use of spaces • Layouts can reflect learning needs of the lesson by moving the classroom tables around, if possible • ICT perceived as being pervasive, available in many locations at different times according the different needs by different	• More expensive to network • More difficult to maintain against dust and tampering • Possible high initial capital costs

teachers • More flexible use of ICT • Easy to manage technically • Easy to secure in existing strong rooms • Normal scheduling possible • Can be used in out-of-class contexts as well	

Key points to consider

1. The installation of computer centres, although widespread, is not the only option for implementing ICT in a school and may not always reflect the immediate needs of the school.

2. In addition to the learning vision expressed by the school, consideration should be given to available infrastructure and the school's ability to manage the resource at each stage of implementation.

Models of achieving learner ICT literacy

When considering what models should be used to develop ICT Literacy the following factors have to be taken into consideration:
- The roles played by teachers in facilitating ICT Literacy in learners.
- Whether the skills and confidence should be gained by integrating activities with the curriculum or segregating classes to separately scheduled ICT Literacy lessons, during which relevant contexts for ICT use are sought.

Option A: ICT Literacy integrated with curriculum activities across the curriculum, facilitated by all teachers

Model Characteristics
- In the model all teachers have an equal opportunity to use the ICT resources in a wide variety of ways.
- Some planned ICT integration activities could be scheduled, but the venue is still available for all teachers of all subjects/learning areas.

This is acknowledged to be the desirable model by the e-Education White Paper but requires time and effort on the part of the whole school.

Advantages	Disadvantage / Challenges
• Teachers are able to integrate ICT to enhance teaching and learning • Learners use ICT to gain curriculum understanding • Learners use ICT in meaningful contexts • Learners develop so-called 21st Century skills and critical outcomes • Whole-school professional development aligns with this approach • Teacher skills align with DoE Guidelines for Teacher Training and Professional Development in ICT • Broad involvement from teachers • Teachers grow professionally	• Patience required as teachers develop ICT integration skills • All learners need to have a fair chance at accessing ICT • This is the most difficult model to achieve across the board because it requires long term professional development for all staff in the school • Some staff that do not want to be involved are coerced and will probably not contribute fully at first

Option B: ICT Literacy conducted in the lessons of targeted subject teachers, who facilitate the lessons

Model characteristics:

- This is similar to Option A but, in order to make scheduling easier and/or to ensure a minimum time of access by specific learners, the ICT integration is planned to take place in certain subjects. For example, language classes could be targeted because all learners do language. Alternatively this can be integrated with non-exam subjects that are taken across a grade.
- Teachers could design their own activities or use a curriculum provided by an agency specialising in curricula that have good learner contexts.
- The computer room is still available for other uses across the curriculum, but to a lesser extent than in Option A.

Advantages	Disadvantage / Challenges
• Some teachers are able to integrate ICT to enhance teaching and learning • Some learners use ICT to gain curriculum understanding • Learners use ICT in meaningful	• Patience required as teachers develop ICT integration skills • All learners need to have a fair chance at accessing ICT • This is the most difficult model to achieve across the board

contexts • Learners develop a range of ICT and information skills in the subject context • Teacher skills align with DoE Guidelines for Teacher Training and Professional Development in ICT • Some teachers grow professionally • Pre-scheduled	• Not all staff members are involved, even though some may want to be. • Some staff that do not want to be involved are coerced and will probably not contribute fully at first • A special programme will have to be designed or found

Option C: ICT literacy segregated, ICT literacy teacher appointed

Model Characteristics:

- The school seconds, assigns or employs a teacher who is dedicated to ICT Literacy. This teacher may develop an ICT Literacy curriculum which synchronises with the rest of the curriculum, in cooperation with other teachers.
- Alternatively the teacher could use curricula provided by an agency specialising in ICT Literacy with good curriculum contexts.
- This is sometimes referred to as the ICT Coordinator model.

Advantages	**Disadvantage / Challenges**
• Easy to schedule • Learner skills development easy to track • Parents may perceive this as better because their children have scheduled access	• Possible additional cost • Lack of whole school involvement • Other teachers denied regular access if there is only one amenity • ICT teacher may not be suitably qualified to find curriculum contexts or integrate the ICT in lessons • Tendency to employ an IT person who may not possess good pedagogical skills • Tendency to focus on skills at the expense of meaningful contexts a risk • Pressure to assess could turn this into a range of skills courses (especially if the teacher is not qualified as a teacher) • Teacher needs to coordinate with other teachers to find and schedule just in time curriculum contexts that synchronise with subject lessons

Options D: ICT literacy outsourced completely

Model characteristics:

- The school is either not interested committed or able to integrate ICT with the curriculum using its own teachers.
- Organisations such as FutureKids and Computers4Kids specialise in providing this service with varying degrees of curriculum integration, but some focus on an ICT literacy curriculum of their own design.
- This model would best align with the outsource model for computer room management and financial sustainability.

Advantages	**Disadvantage / Challenges**
• Easy if school management feels unable to accept responsibility • Learner skills development easy to track • Parents may perceive this as better because their children have scheduled access	• Cost to school and/or parents • Little or no school involvement • Need to monitor activities beyond school's control • Tendency to outsource to pedagogically poor programmes • Little or no curriculum enhancement • Lack of whole school involvement • Other teachers denied access • ICT teacher may not be suitably qualified to find curriculum contexts or integrate the ICT in lessons • Contractors may employ an IT person, as opposed to a teacher - IT trainers tend not to have good pedagogical skills • Tendency to focus on skills at the expense of meaningful contexts • No teacher professional growth opportunities • Clash of values between business and a school

Key points to consider

1. In assessing these options one should realise that once a literacy programme (or IT as a subject) is scheduled in a computer room, there is little remaining space on the schedule for ICT integration activities across the curriculum. Alternative ICT resources, or an alternative schedule, may need to be found for those activities.

2. Worldwide, ICT skills are being taught most effectively in the curriculum context. Schools in the BNSDP project will have different needs in the short term regarding learner ICT skills acquisition for school leavers. Options involving more focused ICT skills acquisition may be advisable in the short term.

3. In the medium to long term learners should be acquiring ICT skills in a curriculum integrated way – as best defined by the school's learning vision.

Sustainability

It is necessary to discuss sustainability at a fairly early stage in this document because an understanding of sustainability could affect many decisions at a later stage. Sustainability refers to the ability to sustain a process for an indefinite period of time. It can be defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." (Hargroves, 2005)[3]

Many authors and organisational reports dealing with ICT sustainability (Hargroves, 2005, Bridges.org[4] 2003, infoDev [5]2003 and Becta [6]2005) highlight the need for the following range of factors to be considered for sustainability of ICT in schools:

- Funds to develop and sustain all aspects of the resource and processes;
- The need to develop and communicate a shared purpose and vision for the use of the resource;
- Positive perceived value of the resources and processes;
- Buy-in;
- Commitment to developing human resources to manage and effectively use the resources and processes;
- Continuity of staff;
- Availability of technical support;
- Suitable resources and infrastructure for the context;
- Commitment from all stakeholders; and
- Commitment to change and growth.

In the following section critical aspects of sustainability are discussed.

Critical success factors in sustaining school-based ICT initiatives

Funding

At its simplest level it would appear that sustainability comes from funding, but funding, from whatever source, is only forthcoming if value is perceived in the

3 Hargroves K. and Smith M. (Eds.) 2005. The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century.

4 Bridges.org is a non-profit corporation, with origins in Washington DC and bases in Uganda and South Africa, specialising in ICT for Development.

5 infoDev is a global development financing program coordinated by the Global ICT Department (GICT) of the World Bank.

6 Becta is the government's lead agency for ICT in education in the United Kingdom.

processes that require funding. Articulating a clear purpose for the initiative and ensuring buy-in are the next important steps that need to be taken in trying to assure sustainability.

Articulating a clear purpose

Articulating a clear purpose for the ICT initiative is a critical factor in sustainability (infoDev 2003). It must be clear whether the initiative aims to enhance management and administration and/or teaching and learning and/or community development.

ICT in schools should primarily benefit teaching and learning but the dilemma exists whether the school's facilities should be available to other non-school going people in the community, and whether the school can sustain the resources with or without the community's support. If community involvement is deemed to be a significant purpose of the initiative and essential for sustainability, that purpose must be clearly stated and models of community participation should be examined. Alternatively, if the purpose of the initiative is aimed at those working and studying in the school then models of achieving sustainability within the school's own community should be explored.

The NEPAD Demo Project has shown that it is naïve of governments and schools to expect ICT initiatives to be sustained by consortia indefinitely and the spirit of financial independence has been slow to emerge. The Demo Project has been hamstrung for a number of reasons that include in the main, poor decision making on the part of participating private sector partners who assumed possibilities that were unattainable and who sought to bypass governments in order to fast-track initiatives. This was further aggravated by poor directives, a poor communication of purpose and, in most cases, poor professional development. If sustainability is to be achieved the NEPAD experience suggests that it is unwise to bypass provincial and national Departments of Education when planning and setting up a school ICT initiative. In Mauritius, where schools have been very active and positive in their perception of the project the professional development has been ongoing and the government has been actively involved in the process. (NEPAD, Cisco 2007, 2008) These stakeholders have perceived the value of the project.

Value

Becta, the UK government's lead agency for Information and Communications Technology (ICT) in education reports that only 15% of schools in Europe make effective use of the project resources with which they are provided. They identify two key issues influencing effective use of these resources. These are *values* and *processes.* Ultimately, for positive impact to be achieved there needs to be a match between the processes (including resources) that are in place and the perceived value of these processes and resources. If stakeholders do not perceive the value there is little uptake in the processes; teachers who do not perceive value in ICT do not want

to receive training and equipment in their schools lies unused - a common scenario in South Africa. (Becta, 2005) While sustainability and effective use of resources are separate issues, it is clear that one threat to sustainability is the potential non-use or ineffective use of expensive equipment, which would jeopardise motivations for ongoing maintenance and expansion of the resource during the annual review process.

Ownership and buy-in

These two issues are interlinked, especially when one starts to analyse what is meant by buy-in. It means much more than inviting the local leaders to participate in discussions. Value in an initiative must be perceived by all role players that will be expected to contribute in some way to the initiative.

Buy-in by government

First and foremost, buy-in needs to be sought from provincial and district education personnel. In fact, one might go as far as saying that without government support, there can be no sustainability of ICT initiatives in poor rural schools. Corporate social and other investment initiatives must be integrated into provincial spending plans. There are a numerous examples of failed investments both in South Africa and internationally that bear testimony to what happens when government buy-in is not secured,

Buy-in by the school community

In a school's context this could include management, maintenance staff, administrators, teachers, learners and their parents - in other words everyone directly linked with the school.

Buy-in from community stakeholders

Depending on the purpose for which the ICT facility is to be used and whether the involvement of the community at large is deemed appropriate, buy-in from various community stakeholders as part of a public - private partnership will be necessary

Risk management and communication

Sustainability requires the management of risks; these risks will increase substantially if there is not good communication with all stakeholders. Resistance to change and new responsibilities is a common cause of failure in projects. Each stakeholder will be required to make a commitment of some form for an initiative to succeed. This requires good communication, advocacy and capacity building from the donors initially, but increasingly from the within the school itself. These activities should focus on the benefits of the processes and services that are envisaged.

Human resource development

Diverse skills are required to manage, maintain and effectively use the ICT resources in a school. ICT leadership is critical to ensure that the ICT policy is established consultatively and communicated to the school community. Technical skills are required to ensure ongoing maintenance, although some of these requirements could be outsourced or initially provided by suppliers under guarantee. Teachers may be required to adapt their teaching strategies as well as acquire a range of ICT skills most appropriate to their needs. Without this investment in human capital the success of the intervention will be at risk.

Continuity of staff

A critical management function would be to establish and maintain a knowledge sharing culture within the school and to ensure that one person does not hold all the critical skills. While it is an unavoidable fact of school life that staff do come and go, the skills acquired by individuals should be shared and transferred to peers through a variety of mechanisms including digital document capture and in-house training.

Technical support

There is some debate about whether teachers should be technicians, but there are various models in which technical support can be ensured. Some models are based on provincial and district support while others involve the establishment of learner technical support teams within schools. Whichever model is adopted, technical support is indispensable.

Resources and infrastructure

While much of past ICT initiatives usually have revolved around the resources and infrastructure, experience has shown that, while the decisions about resources remain critical, they are not always the most important issues at stake. However, infrastructure, or lack of it, will determine the context and define the challenges regarding many aspects of the initiative.

Commitment from stakeholders

Good working partnerships with stakeholders are a key factor for sustainability, especially when the challenges are more severe. Non fee-paying schools are going to be hard-pressed to support an ICT infrastructure unless there is commitment from

the province to play a major ongoing role. In the absence of sufficient support from the province many school leaders have taken it upon themselves to forge relationships with other stakeholders and are often dependent on this support for sustainability. The primary donor can play a valuable role in assisting the start up of such partnerships.

Commitment to change and growth

Many interventions can take place in the interests of sustainability, but without the key school role players' (primarily teachers and management) commitment to ongoing change and growth with ICT the initiative will not be viable as an ongoing educational process.

In the following section, possible models of opening up school-based computer laboratories for community use as a strategy for sustainability are investigated.

School computer labs as community centres: A strategy for sustainability?

In his review of communal computing facilities Chigona (2006) investigates the use of communal facilities such as school and libraries for community access to ICT for both information and communication purposes. Two South African initiatives that he examines are the *Smart Cape Access Project*, in which the Cape Town City Council provides free computer access and internet connectivity to disadvantaged communities in the city of Cape Town, and the *Cape Access Project* in which the province aims to provide technological infrastructure to allow rural communities to interact with government and business. The Smart Cape Access Project operates from public libraries in the city of Cape Town while the Cape Access Project operates from libraries, schools and Multi-Purpose Community Centres (MPCC) in the Western Cape Province. This is a model where an independent organisation offering communal computing facilities is set up and operates in a public facility.

The World Bank Institute, *ICT for Education programme* and *World Links* have been working with SchoolNet Uganda to implement 15 School-Based Telecenters in Uganda. The Ugandan project includes community health education and curriculum use of the computers by the schools involved. VSAT connectivity was established at these rural Ugandan sites. By opening up its computing resources to the general public a school aims at generating additional revenues for the school as for example to support the maintenance and upgrade of the ICT infrastructure. A possible outcome of this model is that schools could afford and maintain technological infrastructures which would otherwise be beyond their reach.

Some critical success factors that were identified in these projects include:

1. Community buy–in: To ensure high acceptance it is essential to get the backing of the community. This is achieved by getting the community involved in the project from the outset.

2. Local champion: A champion is an individual with influence in the community and commands respect. Having the support of a local champion for a project encourages involvement of the other members of the community to follow suit. For the long term sustainability of a project, it is advisable to have more than one local champion. A motivated, long-term leadership can ensure the persistence and success of the project.
3. A strong host organisation: A strong host organisation makes it possible to take advantage of better price offers, an administrative infrastructure, strategic partnerships and human resources.
4. Location of the public facility: It is desirable, therefore, that the site should be at a place where people visit to do other communal activities such as a community centre, shopping centre or library. An issue related to this is that the community members should be comfortable entering the public facility. Some public (government) offices or facilities may not be an ideal because the community members may feel threatened or intimidated by the environment.
5. Marketing and public awareness: Community members must first become aware of and see the value in the services before they will get involved in a communal facility.
6. Community needs assessment: Related to public awareness this ensures that the community will indeed see the value in the facilities.
7. Coordination and continuous training: The skills of centre management and ICT support need to be acquired by more than one staff member in order to ensure continuity of skills.

It was noted in the Ugandan report that only a "certain degree" of financial sustainability was reached. While this does not conclusively prove that schools in rural areas can successfully house community centres that can generate income to ensure financial sustainability, it does suggest that they are able to cover the costs of that community involvement.

1. Models of community involvement in sustainability

Once the purpose for setting up an ICT lab in a school has been clarified, a shared vision for its use crafted and the logistics of using the ICT facility carefully considered – e.g. how many learners/classes and teachers need to use the facility, models of community involvement may need to be explored.

At present there is limited provincial government support for ICT in schools and thus schools have to play much more active roles in forging their own supporting partnerships with the community. For this reason it may make sense to think about ways in which the community can be involved to enhance sustainability. Many reports on school ICT initiatives recommend the involvement of the community. In this context this would refer to the community beyond the school community, involving people who have no direct involvement in the school. (InfoDev 2003and Hawkins 2002) This broader community involvement could be deemed necessary for sustainability reasons whether the community actually uses the school's facilities or not.

WorldLinks piloted the idea of school community involvement in Zimbabwe. At the Bindura-WorldLinks community learning centre in Zimbabwe over half of the "clients" were adult learners who received basic computer literacy training. Students from the Zimbabwe Open University used the centre to access their course material and interact with lecturers online. Approximately 70 percent of the users of the centre were women. The success of pilots such as these, even though this is a community centre project, suggests that it is worth considering whether schools should make their resources available to the community as a means of bridging the rural-urban divide, fostering contact between in-school and out-of-school youth and promoting gender equality in access to technology and education. (Hawkins 2002)

The state government of Karnataka, India, has equipped seven hundred schools with ICT labs through a partnership with NIIT, a private computer training institute. The Karnataka government contracted with NIIT to equip and maintain the school computer labs and provide an instructor for technical training for students during school hours. In exchange, the training institute is compensated with a five-year contract for providing the training, and is allowed to use the facilities after school hours for delivery of its private training courses to the community. The project is characterised by high degrees of community involvement and pride. (NIIT 2002)

In the following section, models dealing with various aspects of sustainability will be explored. These models all acknowledge the possible need for some form of out-of-school community development but include varying degrees of community involvement in the management of the school ICT facilities.

Option A: School out sources the management of the ICT resources entirely.

Members of the community are contracted to fully manage the school's ICT resources as an entrepreneurial venture. In return the school has access to the resources during school time. School teachers are minimally involved with the activities using the ICT resources. The school negotiates the terms of use with the outside stakeholders.

Advantages	Disadvantages / Challenges
• The school has no responsibility to manage resources for which it has no capacity • School has no financial commitment and responsibilities • The school could think it an advantage by not thinking it necessary to have technology plan, shared vision and change management processes in place (although this would be a mistaken view) • No capacity and support problems • Learners are easily scheduled to participate in activities • Community involvement and sense of ownership high • Skills develop in the entrepreneur	• Challenges of coordination between the school and the outside organisation • No or little enhancement of teaching and learning involving curriculum outcomes • No whole-school professional development leading to better pedagogy and more effective use of resources • Security issue could be a high risk because of the high number of outsiders on the school promises • No sense of ownership by the school community • Low community affordability in low population density rural areas • Learners have limited access to ICT • Lack of management and entrepreneurial skills in the community poses risk • Poor capacity for rural communities to provide meaningful educational input

Option B: School manages the resource during school time: A community organisation manages the resource after school hours

This is a joint management model based on the assumption that learners will only be required to use ICT during school time. Note that this assumption should align with the school technology plan, a policy document that outlines the school's short to medium term implementation and use of ICT. The school takes responsibility for the resource during the school hours and allows the community organisation to use it after school hours in the interests of community upliftment.

Advantages	Disadvantages / Challenges
• Perceived as a win-win situation by the community • Shared running and maintenance costs • Skills develop in the community • Enhancement of teaching and learning involving curriculum	• School must develop effective technology support strategies • School must manage complex change management and sustainability strategies • Challenges of coordination between the school and the outside

outcomes possible • Sense of ownership by both the school community and school community • Community can be a source of income to support sustainability • Opportunity for community entrepreneurship • Fosters good school community integration	organisation • School does not have complete jurisdiction over the facility • As teachers develop their understanding of the value of ICT, lack of access to ICT becomes a source of discontent • Security issue a high risk • Low community affordability in low population density rural areas • Learners have limited access to ICT • Risks of change management and shared vision processes not succeeding • Lack of management and entrepreneurial skills in the community poses risk

Option C: School manages the resource entirely but relies on community participation for funding

In this model the school manages all aspects of the facility, but acknowledges that providing members of the community with an opportunity to use ICT, which may not be available elsewhere in the community, is desirable from a developmental point of view and necessary from a financial point of view.

Advantages	**Disadvantages / Challenges**
• School has complete jurisdiction over its resources • School can involve community at levels with which it is comfortable • Community commitment and capacity to participate can be assessed and moderated • Because the school is much more involved there is a greater likelihood of positive growth in the school as whole school staff development and participatory processes take place for shared vision and technology plans • School can ensure maximum use of ICT to enhance teaching and learning	• School must develop effective technology support strategies • School must manage complex change management and sustainability strategies • Community may feel less sense of ownership • Community may perceive insufficient opportunity for access to ICT

Key points to consider

1. It is important to note that each model will require its own management agreements and structures to be set in place with roles and responsibilities of all parties concerned clearly spelt out.

2. Considering the possibility of adopting one of the above models of community involvement, hinges on the school having a clear purpose and plan for the use of the facility.

3. Involving under-served communities in the school ICT sustainability plans may be misdirected if the sole purpose of that involvement is to gain financially from the relationship.

4. Community involvement of any sort will require considerable commitment from one or more members of the school. Decisions in this regard should include the participation of the all potential role players in the school.

2. Models for financial and technical sustainability

Models of financial sustainability should ensure that business principles are upheld throughout. Role players should not lose sight of the fact that, although the initiative is driven by educational decisions, the project and the ICT facilities are nevertheless to be managed as a viable business.

Schools should look beyond donor-support for sustainability. This may well require innovative ways to generate income, but in reality it may not be possible to generate much income locally from the school and its broader community. The provincial department of education has a responsibility to support ICT in schools and an agreement should be reached between the donor and the department so that the donor acts in a way that makes it possible for the province to provide the financial and technical support according to its capacity. In instances where the province lacks the capacity to provide financial and technical support it will be necessary for well-established partnerships with the private sector. The provincial education department may be in a position to facilitate such partnerships.

The Khanya Project in the Western Cape makes use of a learnership programme to build capacity in- and out-of-school youth to become technicians that can service schools. Many learners are quite capable with the technology or can be easily trained to provide first line maintenance at their school. Khanya is working in partnership with Bytes Technology Group and Anglo American Chairman's Fund to fund the learnership. (Khanya, 2002)

Another example of such a program is the "Kids on the Block" initiative in Namibia, in which SchoolNet Namibia works with youth to provide them with the technical training necessary to refurbish, install, and maintain the school computer labs.

(Hawkins, 2002) Microsoft's Partners in Learning programme includes a course called *Deploying Student technical Support Solutions* (known in short as *Student Helpdesk)* which initially trains one teacher and six learners to set up and manage a school help desk that could also service surrounding schools. The Limpopo province has trained such teams in all schools with computer rooms. (SchoolNet SA)

Option A: Outsource all responsibility for technical support to an outsider

The school contracts centre manager who earns own income from entrepreneurial activities, develops own financial model that includes covering the running and maintenance costs.

Advantages	Disadvantages
• School human resources not used for fundraising or maintenance issues. • Possible success through greater dedication to the task by one focused individual. • Contributes to community development. • One person held accountable. • A perceived advantage for techno phobic managers is that they may think it possible to abscond responsibility (although this would be in error) • Fills gap left by DoE incapacity	• Lack of school management involvement • Lack of capacity growing within the school • Reduced sense of ownership by school community • Possible lack of alignment with school technology plan • Skilled person lured away by better opportunity - great risk to sustainability through lack of continuity

Option B: School manages the resources but relies on community to subsidise the finances and maintenance to some extent

The school forges partnerships with public and private entities for subsidised or donor-funded involvement in meeting the running and maintenance costs. School raises funds, imposes levy or allocates budget for balance of costs

Advantages	Disadvantages
• Positive aspects to school-community partnership • Expertise used • Community development • Sense of community ownership • Good community relationships	• School to tend to rely on community too much at the expense of its own capacity growth • Some risk to sustainability by relying on outside individuals too much

• Lack of school capacity to sustain itself is supported • Not too much burden on school's human resources • Fills gap left by DoE incapacity	

Option C: Developing in-school capacity

The school uses learners and staff to grow capacity internally. A learner helpdesk is established; curriculum based entrepreneurship opportunities and IT skills are harnessed, administration is school-based, and teachers are involved in fund raising.

Advantages	**Disadvantages**
• Learners develop technical and management skills as they run the help desk • Learners could develop entrepreneurial skills as they make the help desk services available in the broader community • Learners in CAT, IT and Economic and Management Science achieve curriculum learning outcomes if they are involved in help desk activities • Learners acquire life skills such as independent learning, responsibility, commitment, decision-making, problem-solving and working collaboratively as they run the help desk • The technical skills acquired in running the helpdesk could provide the basis for pursuing a a career in IT support. • Fosters good teacher-learner collaboration • School becomes self-reliant • Good continuity of sustainability • Achieved curriculum outcomes in some cases	• Depends on good management • Learners and / or teachers may not be adequate • Continuous capacity building required (although this is the nature of the school's business)

Key points to consider

1. Each school context needs to be assessed separately to establish which, if any, of these strategies is appropriate.

2. Technical support planning should take place prior to implementation and with the knowledge of in-built support that may accompany implementation, either from the supplier or the province.

3. Cultivating a sense of ownership

It is a fait accompli that the intention of government is that every school should be equipped with ICT in accordance with the objectives of the e-Education White Paper which has set targets for basic levels of ICT competence in all learners by targeted dates. This implies an acceptance of the benefits of ICT in supporting and enhancing the delivery of curriculum outcomes. Provinces have begun equipping schools with ICT, some to a greater extent than others. Each province will have its own criteria for identifying which schools are the most suited to the introduction of ICT at any given time. In the Western Cape the Khanya Project has employed project managers, learning facilitators and Educational Management and Development Centre (EMDC) Coordinators to plan and coordinate the implementation of ICT at a school. They follow an eight phase approach (Khanya Methodology. PDF)

1. Identification for inclusion in the project
2. Negotiation
3. Planning
4. Infrastructure
5. Installation of technology
6. Training of the local area network (LAN) manager
7. Installation of software.
8. Curriculum delivery and continuous training

The sense of ownership is established at the school level, with input from the school senior management regarding the installation and purpose of the computer facility.

If teachers do not receive the kind of sustained professional development that can grow their perceptions of the value of the ICT facilities in the school, the projects will have a high risk of failure. Teacher attitudes are important and there needs to be a clear strategy to reduce the risk of resistance. Teachers having a shared sense of ownership and understanding the learning vision is an important component of the project management.

The World Bank's Rural ICT Access Report recommends that "project planners must look beyond the technical components of their projects and consider aspects such as human resource development, capacity-building and adapting ICTs to local cultural contexts and local information and communication needs. Funding for ICT initiatives should include sufficient funds for training local people, for creating an "ICT culture" and for dealing with other aspects of the "soft" side of ICTs." (infoDev 2003)

It goes on to emphasize the importance of participatory approaches to ICT applications. "In order for any project that deals with the introduction of new technologies to succeed, the participation of the community in the design, implementation and evaluation of the project is crucial" (infoDev 2003)

While this report refers to community ICT projects in Africa, the lesson can be applied to school ICT projects as well. In many cases ICT has been "dropped in" to South African schools with donors offering computers and other ICTs to schools that are not capable of fully using or maintaining the donated technology, either through a lack of necessary skills or a lack of perceived educational or personal value of using the technology. There has been sufficient hype about the claimed impact of computers in education and the importance of computers for socio-economic development (largely perceived as employment for school leavers) for almost every school to desire ownership of computers, although not many schools could fully articulate a rational for this desired ownership on educational grounds. Merely providing a list of options to the school would serve little purpose and not sufficiently capacitate the school leadership to participate meaningfully in decision making.

It is one thing for a school to say that it needs computers, but an entirely different matter for these schools to be able to articulate the need in terms of their ICT and learning vision. Most aspects of a technology in schools project are dependent on this vision and many decisions should be subject to the implementation of this vision. It is sound to ensure that rural ICT in school initiatives are built on demand-driven and appropriate technologies but the question is who makes the demands and how do they base their decisions on appropriate technologies?.

School-based ICT initiatives have been known to fail because of a lack of commitment to a sustainable upkeep and turn out to be white elephants. This lack of commitment often stems from a lack of participation in initial decision-making regarding the implementation of ICT in the school. Top-down decisions by donors may appear better informed but do not guarantee sustainable projects. When school communities are engaged in planning and decision-making at an early stage they are not only building capacity locally, but are ensuring a greater commitment to the management of the risks that go with rural projects of any kind.

Many ICT projects (not only school ICT projects) can be classed as "top down," employing large capital resources and requiring complex management, without the revenues or skills to make them sustainable at the community level. Models, where the school community is involved in setting the parameters and defining the learning

vision, can succeed and expand as schools grow and are able to justify incremental investment according to more informed demand and local knowledge. (infoDev 2003)

On the other hand one could consider successful models of "top-down" organisations found in major corporations. They work because finances are allocated, there is top management ownership, engagement of high-level expertise, provision of professional development, job-description based requirement to use the technology, all features missing from ICT rollout in schools. Participatory management will not be sufficient to succeed; good project management based on sound business principles is also required.

Hoffman reports that about 50 percent to 75 percent of all IT projects fail to meet the three success criteria: on time, within budget and with full functionality. One reason, although by no means the only one, is the lack of participation in the project by those who will use the system when it is finished. Hoffman goes on to recommend that the users (the school community in this case) should play leading roles in defining requirements and functionality, with the assistance of advisers. Technical decisions are led by technical advisers with the input from the users, who in this case are educators who make their decisions with a learning vision in mind. Implementation is a joint responsibility. (Hoffman, 2002)

In reporting on common reasons why rural development projects often fail, the Food and Agricultural Organisation of the UN lists:

- Poor planning and programme formulation
- Misallocation of project resources
- Rural people's low sense of power
- Provision of inappropriate technology
- Inadequate promotion
- Ineffective training methodologies
- Lack of enabling policy

These factors could be applicable to ICT projects in rural schools as well and each should be considered when developing strategies for implementation.

Key points to consider

To engage with the issue of how best to cultivate a sense of ownership, some critical questions **need to be asked and answered. These include:**

1. What can we do to empower rural school communities to develop a sense of ownership and capacity to take responsibility for and sustain their project?

2. Subsidiary questions would be:
    - Who should be involved?

- How much capacity do school communities need to develop in order to make well-informed decisions about implementation
- How does the school leadership facilitate sufficient participation from school stakeholders to promote ownership of the process?
- At what stage does one introduce the technology plan?
- What evidence of capacity is required from the school before donors can be confident that the risks of failure are minimised?

Recommendations

1. School community leadership and knowledgeable representatives of that community should be involved in decision-making at the earliest appropriate planning stages.

2. At an early stage in the process the school community leadership should engage in a self review of the school's capacity to accommodate ICT.

3. Initial capacity building should empower the school community members to define its learning vision and make initial decisions within that framework.

4. School community involvement should serve to build the capacity of the school community members.

5. A balance should be sought between a) the school's capacity to rely on its own resources to sustain the ICT facilities and b) the need for out-of-school community involvement in sustaining the facilities.

6. Wherever possible the school should build capacity within its own ranks of educators and learners.

7. Each school should determine the importance of broader community involvement within its own unique contexts.

8. To try and ensure buy-in, a clear purpose and shared vision for the use of the ICT facility needs to be agreed to and a school technology plan developed in a collaborative process involving the whole school community. (The technology – a blueprint for implementing ICT in a school is discussed in detail later on in this report. See Section 5)

9. Revisions of the technology plan should be scheduled as part of the implementation process in order to harness greater understanding of ICT in schools that could be gained by the stakeholders during the initial phases of implementation.

Professional Development

Introduction

The professional development of teachers and other school-based staff is often grossly neglected by funders and other stakeholders in the implementation of ICT in schools. Studies conducted in the US, UK and Australia have revealed that computer anxiety and lack of confidence are important factors that hinder teachers' willingness and effectiveness in using computers in the classroom. Schools commonly receive ICT equipment and either receive no training or receive inadequate ICT skills training over a few days, and no further support or professional development. There are notable exceptions, for example one of the most successful NEPAD Demo Project countries, Mauritius, recently reported that it had allocated 25% of the reported project budget on teacher professional development in ICT integration.

In the South African context, teacher professional development in ICT is now informed by the *e-Education White Paper* (DoE, 2003) and subsequent *Guidelines for Teacher Training and professional Development in ICT* (DoE, 2007). While the latter document largely addresses teachers, many of the principles and guidelines also hold true for the professional development of education managers and administrative staff, which will be included in the scope of this document. While district ICT facilitators are not included in the scope of this document it will be in the interests of the school if district support staff understand the strategy for professional development on which the school is embarking. It is not safe to assume that all district educational support staff are all aware of and fully understand the professional development options for teacher, managers and administrators in schools, although many have the capacity to fund and organise professional development in their districts.

What is envisaged in policy

The e-Education White Paper characterises schools that implement e-Education as institutions that have:

- Learners who utilise ICT to enhance learning;
- Qualified and competent leaders who use ICT for planning and management;
- Qualified and competent teachers who use ICT to enhance teaching and learning;
- Access to ICT resources that support the curriculum; and
- Connections to ICT infrastructure.

(DoE, 2003)

Teachers are required to develop the knowledge, skills, attitudes and values necessary for them to be able to integrate ICT into teaching and learning and into

their other roles as educators. The Guidelines are based on three dimensions for teacher professional development:

1. **A pedagogical dimension**, which implies an understanding and application of the opportunities of the use of ICT for teaching and learning in a local curriculum context.

2. **A technical dimension,** which implies
    - an ability to select, use and support a range of ICT resources as appropriate to enhance personal and professional effectiveness; and
    - the willingness to update skills and knowledge in the light of new developments.

3. **A collaboration and networking dimension,** which includes
    - a critical understanding of the added value of learning networks and collaboration within and between partners; and
    - the ability to create and participate in communities of practice.

    (DoE, 2007)

The e-Education that is described in the DoE documents supports the problem-solving and critical thinking aspects of the National Curriculum Statements (NCS) by developing the ability of learners to:

- apply ICT skills to access, analyse, evaluate, integrate, present and communicate information;
- create knowledge and new information by adapting, applying, designing, inventing and authoring; and
- function effectively in a knowledge society by using appropriate ICT and mastering communication and collaboration skills.

Additionally, ICT use can be harnessed for the attainment of the critical cross field outcomes as it has the potential to promote the development of advanced cognitive skills such as comprehension, reasoning, problem-solving and creative thinking
To meet the needs of interpreting and implementing this high knowledge, high skill curriculum, teachers require continuing professional development in the appropriate use and integration of ICTs into teaching and learning.

DoE Guidelines for teacher professional development

The following guidelines should be taken into consideration when implementing development programmes. These include (DoE, 2008):

- **There is no single best practice or general recipe for success**.
    - Each BNSDP school is unique and each teacher is an individual with specific experience, needs and interests. The DoE Guideline discourages generic learning pathways common to all teachers. The teachers need

opportunities to explore their own learning pathways and support in determining these.

- **Teacher development programmes should be flexible in access**, modes of delivery and content in order to make learning possible in meaningful and equitable ways.
    - It is more expensive for professional development facilitators to facilitate contact courses at rural schools, although the on site training is preferable in many instances. BNSDP teachers could negate their rural location by embracing distance and online learning programmes as best possible.

- **Teaching practice, including classroom organisation, will change if ICT is integrated effectively in teaching and learning.**
    - The intention of this guideline is to emphasise that ICT will make no sound educational impact unless teachers are able to adapt their practice.
    - The challenge to BNSDP teachers is to extract as much as they can from the many professional development opportunities that come their way. This will go a long way to help them overcome possible feelings of marginalisation and to participate in national and international educational activities such as learning circles, collaborative peer coaching, *Thutong* educational portal and innovative teacher forums.

- **Teacher development should be managed**.
    - The school leadership's role in developing a spirit of whole school professional development is critical if the many professional development opportunities are to be accepted with a positive frame of mind.
    - This guideline places the responsibility for professional development with the school management.
    - ICT development for teaching and learning does not happen in isolation, it also impacts on the management and administration of a school.
    - ICT development has an impact on whole-school development. This implies that teachers at a school (especially applicable to more isolated rural schools) should develop a community of practice and support one another in developing ICT skills.
    - This guideline highlights two aspects of professional development. Not only is the concept of whole-school professional development sound for sustainability, but it emphasizes the value of teachers collaborating with each other, including beyond the school's boundaries.

- **Programmes need not necessarily provide training in advance of requirements**, **but can concentrate on giving essential training as the need arises.**
    - While it is tempting to provide educators with training prior to the installation of ICT, such training is most effective when educators have continued access to the ICT immediately after the training.
    - Training will be most effective when it meets the needs of participants. It may take time for educators to gain confidence with ICT and training interventions should be well-paced so that participants can absorb and

put into practice what they learn. In this regard BNSDP school teachers are not expected to be any different from teachers in other school.

- **Development programmes should not take teachers out of classrooms during normal school hours**, so flexible delivery modes for training will be required.
    - BNSDP teachers will have the additional challenge of rural isolation when more opportunities for professional development tend to take place in urban areas. Distance and online learning can overcome such barriers, but this will depend on reliable Internet connectivity with a reasonable bandwidth.

The Guidelines go on to refer to the five ICT developmental levels mentioned in the e-Education White Paper and use this as a framework to outline teacher competencies for integrating ICT in teaching and learning.

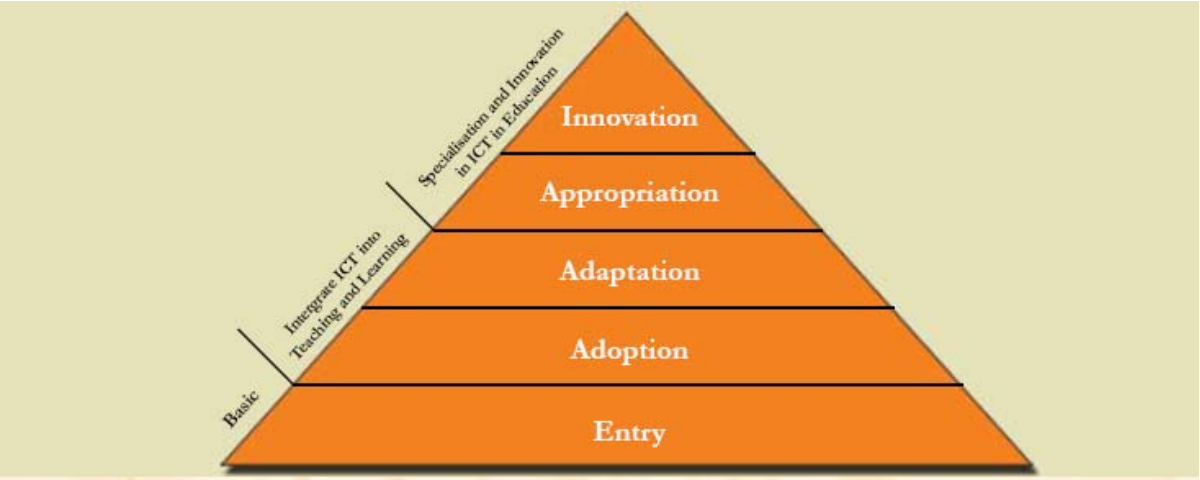

Figure 1: Screen clipping taken from DoE, Guidelines for Teacher Training and Professional Development in ICT, p7 (2007)

While it may be conceptually incorrect to assume that all teachers will follow a pathway along these developmental levels or even enter the pathway at the same level, it is nevertheless useful to retain this framework and use it for plotting how professional development courses cater to different spheres of ICT use within the three broad categories of teacher competence in ICT integration:

- Basic
- Integrate ICT in Teaching and Learning
- Specialisation and Innovation in ICT in Education.

It takes most individuals between three and five years to develop with ICT to the level where that individual is operating at the *Appropriation and Innovation* levels. There are therefore no fast-track solutions to good quality teacher professional development in ICT integration.

Identifying appropriate professional development

In the light of the national guidelines above, it is useful to identify broad categories or clusters of ICT competencies that emerge. These can then form the basis for the selection of professional development interventions that cater for teachers and other school personnel with differing needs and levels of ICT ability and confidence:

1. **New users - ICT for teachers, managers or administrators** providing guidance on integrating ICT usage in the relevant contexts. These are typically associated with *Entry and Adoption* development levels and support participants' existing practice while building their confidence in using ICT.

   Examples of such courses are:
   - Partners in Learning: ICT Skills for Teachers[7]
   - Partners in Learning: ICT Skills for Principals
   - Partners in Learning: One Step Further
   - Mindset courses in accessing and using their subject specific content

2. **The development of teaching and learning practices that can be interpreted as suitable for extracting value from ICT as a resource.**
   This would typically be associated with the *Adaptation and Appropriation* levels and would involve the development of so-called 21st century skills and critical National Curriculum Statements (NCS)-related skills outlined above.

   At its simplest level this would include courses on how to add effective pedagogical content to multimedia objects and content-based learning resources.

   At a more advanced level this should introduce teachers to higher order thinking skills, project-based learning and then the design of classroom based projects that integrate ICT.

   Examples of such courses include:
   - Partners in Learning: ICT Integration (WebQuests)
   - Intel® Teach: Thinking with Technology[8]
   - Intel® Teach: Essentials and Essentials Online
   - EDN: Working with Information [9]
   - EDN: Learning with Projects

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[7] The Partners in Learning (PiL) Programme is a teacher development programme sponsored worldwide by Microsoft. Microsoft SA uses SchoolNet SA for development and implementation of the PiL programme in South Africa.

[8] Intel® Teach is a worldwide teacher development programme that forms part of their World Ahead Programme. In Southern Africa Intel uses SchoolNet SA as its regional training agency.

[9] The Educators' Network (EDN) was developed from 2000-2002 in partnership by the National Department of Education, SAIDE and SchoolNet SA as a distance course. It is now a fully distance qualification offered by the University of KwaZulu-Natal and is subscribed to by teachers nation wide.

3. **Phase, learning area and subject specialisations** concerning the integration of ICT and use of subject-specific applications that promote interactive, learner-centred teaching and learning activities. This could cater to all levels of development.

Examples of courses offered are:

- All EDN modules allow for the inclusion of classroom-specific contexts and some focus on simple ICT integration for maths and science teaching
- EDN module on software evaluation
- Intel® Teach Essentials has a maths-focused version

4. Collaborative learning in contexts that provide ongoing professional support to communities of learning in ICT integration. This could cater to all levels of development.

*An example of a course offered is***:**

The Partners in Learning: Peer Coaching programme

5. Innovation in teaching and learning that encourages the appropriate and innovative use of ICT. This would cater to the innovation developmental level
An examples of a course offered is:

- Microsoft: Innovative Teachers

Courses for managers and administrators should:

- Provide an understanding of how ICT can enhance their administrative and managerial efficiency;
- Assist with management and timetabling for optimal use of ICT equipment and facilities;
- Support school managers to develop and implement school ICT integration plans and manage ICT;
- Introduce managers to communities of practice for managing ICT and ICT leadership; and
- Encourage a culture of innovation and creativity.

Examples of courses offered are:

- Partners in Learning: ICT Leadership for Education Managers
- EDN: ICT Leadership in Schools
- EDN: ICT Planning in Schools

A special subsidiary focus on identifying courses that build sustainability, specifically related to:

1. ICT management and leadership

Examples of courses include:

- Partners in Learning: ICT Leadership for Education Managers
- EDN: ICT Leadership in Schools
- EDN: ICT Planning in Schools
- Principal's ACE

2. Technical support

Examples of courses include:

- Partners in Learning: Student Helpdesk
- CISCO Networking Academy Programme

3. Building ICT whole school staff development

An example of courses is:

- Partners in Learning: Peer Coaching

All professional development programmes should:

- Focus on integrating ICT in practical contexts related to the participants professional environment;
- Provide participants with situated/contextualised learning experiences
- be needs driven;
- Provide ongoing support. This includes pedagogic support for teachers (particularly from subject advisers), technical support and creating communities of practice; and
- Be ongoing, due to the changing nature of ICT. Programmes should reflect new technologies and applications (DoE, 2008)

The UNESCO *Planning Guide for ICT in Teacher Education* sets out a number of key principles for effective ICT development in teacher education, one of which is, "Technology should be introduced in context. Particular ICT applications like word processing, databases, spreadsheets and telecommunications should not be taught as separate topics but rather dealt with as the need arises in all courses of the teacher education programme". (UNESCO 2002) This reflects a widely held view that ICT users pick up ICT skills best while using ICT in their real-life contexts. In South Africa provinces are realising this and adopting courses in which ICT is integrated, rather than focusing on applications training (training which focuses mainly on the skills of an application such, for instance, a word processor).

Key points to consider

1. The national framework for teachers training and professional development in ICT integration is well documented.

2. Over the past 8 years a range of professional development interventions have become established, providing clear pathways for educators to achieve competence aligned with the national guidelines.

3. Adhering to principles of professional development will afford educators the opportunities to grow professionally while remaining in a positive frame of mind, given the considerable amount of time that they will spend on such activities.

4. BNSDP school teachers are likely to rely on Internet access for professional development more than educators in urban schools.

5. BNSDP school leaders will have to play an active and proactive role in promoting whole school professional development in order to ensure that their teachers are not marginalised when it comes to professional development opportunities.

Options for professional development

Professional development should not ever be viewed as an optional extra, but a professional necessity. This is especially true in the field of high technology that is always changing so quickly.

The advent of the Continued Teacher Professional Development system will also change the status quo by making it compulsory. Because of the challenges and changing nature of ICT, a clear professional development strategy for all levels of school personnel is a vital prerequisite for the successful implementation of any initiative aimed at introducing and integrating ICTS into a school. Installing the hardware is a waste of time and money without a process in place for building and sustaining the necessary capacity to use ICT to support efficient school management and delivery of quality education. As with the implementation of ICT in schools, professional development is an ongoing *process* rather than a project.

Delivery mode

Schools and their staff should be able to manage professional development and exercise options in terms of which courses are the most effective options at any given time. The following is an analysis of the possible value of various options of delivery. It is not necessary to choose one exclusive option, but it is useful to consider the value of each.

Option A: School based – own facilitator

Some interventions are designed with the cascade training model[10], whereby teachers attend a course and are expected to replicate that course when they go back to their schools, with varying degrees of training as facilitators. This is a popular model because of the perceived savings in costs and advantages in mass rollout of the training, but this could be false economy. Dilution of quality of training is a real risk with such training in South Africa because of the relatively poor skill and confidence levels of teachers using ICT. Intel® Teach abolished this model when very poor results were returned.

In other cases teachers specifically attend training to be trained as facilitators and peer coaches. *The Partners in Learning Peer Coach* course is one example of this strategy. Peer coaches add a lot to the sustainability factor in schools with ICT.

Advantages	Disadvantages / Challenges
• School based • No facilitator costs • Builds capacity in-house • Ongoing support • Facilitator knows the environment • Teachers often feel more comfortable with a colleague as facilitator	• Allocation of time to the facilitator • Hierarchical relationships – facilitating those senior to the facilitator • If the school appoints an uses its own teacher, that person may not be suitably skilled

Option B: School-based – outside facilitator

Some service providers send skilled facilitators to schools to conduct the training in the teachers' own environment. These are normally interventions that involve large numbers of the school's staff. A course developing the initial ICT skills and confidence of teachers is an example of such a course.

Advantages	Disadvantages / Challenges
• School based • Brings in expertise • Teachers often listen better to an outsider	• Possible facilitator costs, if not funded by donor or province • Ongoing support • Facilitator does not know the environment

Option C: Centralised offsite

Where interventions are attended by a mere handful of teachers from any one school, it is more cost effective to hold the event at a centralised venue and invite teachers from a cluster of schools to attend the sessions. ICT Leadership training, which

[10] Much literature points to the weakness of this model, yet it is still often employed in South Africa, mainly with poor results.

would involve only the senior management of the school is an example of such an intervention, and so are educational ICT conferences.

Advantages	Disadvantages / Challenges
• Harnesses expertise • Teachers often listen better to an outsider • Collaboration and sharing with teachers from other schools	• Travel required • Possible accommodation costs • Course costs • Ongoing support • Possibly not the same setup as the school's computer room

Option D: Distance learning

Distance learning in this case refers to courses in which the participant can study on their own (or sometimes in small groups) from home or school. While the majority of the study time may require participants to work on their own, the importance of a range of academic support strategies - be they face-to-face contact sessions or support facilitated by ICTs, has become the hall mark of quality distance education. .

The EDN is a distance course (hosted by the University of KwaZulu-Natal) in which teachers work in groups connected to a tutor by email. Group interaction and support is factored into the course design. All course materials are CD based, with some links to online resources. There is database driven monitoring, but participants do not need to go online other than to send and receive email or browse optional online resources.

Advantages	Disadvantages / Challenges
• Flexibility of time and learning style • Equalises access to courses by rural communities of educators • Collaboration and sharing with teachers from other schools and possibly countries • Possible ongoing support	• Possible connectivity costs, although not in all forms of distance learning • Possible technical problems, especially with connectivity, if connectivity is required • Self-motivation – "loneliness of the long distance learner"

Option E: Online learning

Online learning is characterised by online content and course management systems. It is sometimes possible to download content, but a lot of the course value lies in the online interaction and the ability of tutors to manage the entire course online. This mode is distinguished from distance learning by the fact that all content and activity is online and that connectivity is a non-negotiable requirement for participation in the event. Online courses and e-conferences can be hybrid activities in that some time can be allocated to facilitator contact sessions, while the majority of the time is spent in tutored self-study mode. However, online learning is more characterised by little or no contact sessions, while online interaction and support is well-developed.

Advantages	Disadvantages / Challenges
• Flexibility of time and learning style • Equalises access to courses by rural communities of educators (provided connectivity costs do no act as a barrier) • Collaboration and sharing with teachers from other schools and possibly countries • Ongoing communities of practice provide ongoing support	• Connectivity costs • Possible technical problems, especially with connectivity • Culture of online learning needs to be developed

Funding for professional development

The National Department of Education is capacitated to take ongoing responsibility for negotiating package deals that will enable schools to take advantage of economies of scale in funding professional development opportunities. It has also developed and supported a framework to encourage and manage partnerships. Liaison with the provincial and district e-Learning Facilitators will provide the relevant information about funding and professional development strategies.

Sources of funding for teacher professional development include but are not restricted to:

- School budget;
- Donor funding associated with the course content;
- Donor funding raised by the school;
- Provincial budget available in the district;
- Budget from national initiatives;
- Provincial bursaries – normally allocated only for qualifications; and
- Self-funding from individuals (possibly with the assistance of personal loans).

For the purposes of whole school professional development, management of the school should determine allocation of budget according to the values and priorities expressed in the school technology plan. It may be necessary for the school to raise funds specifically for professional development.

It is advisable to foster cooperative working relationships with the district ICT facilitator (if applicable). These facilitators have access to funding at times and also often act as a conduit for donor funding by recommending deserving schools to donors.

Teachers seeking qualifications in Educational ICT can pursue provincial bursaries. Such self-pursued study toward a qualification is usually self-funded by teachers. On the other hand, Provincial Departments of Education have budgets to provide teacher professional development and liaison with the provinces will ensure that

there is synergy and synchronisation in the professional development programme at BNSDP schools.

Recognition and accreditation of professional development

Some issues to consider: The paper chase versus professional development

Teachers are paid on a salary scale according to their qualifications and experience. Teachers can only move to a higher salary category by upgrading their qualifications. Such qualifications can only be achieved through full- or part-time study at a higher education institution. Many in-service teachers pursue certificates and accreditation without being on learning pathways that lead to higher qualification. Some teachers are motivated purely by the award of a certificate, while others are motivated more intrinsically by the desire to improve themselves professionally. Some provinces embarked on expensive ICDL training for teachers purely because of its international recognition as a certificate course. However, the NQF level of the skills acquired in this qualification is at Level 2 which is far beneath the accreditation level that is appropriate for qualified professionals.

While many good courses carry no nationally recognised accreditation, many sub-standard courses do carry accreditation and vice versa. There are no unit standards for curriculum ICT integration and as a result no courses can be accredited by SAQA at the NQF levels 5 and 6. ICT in Education qualifications either use the generic ACE qualification or form part of other recognised higher education qualifications. Few recognise the importance of ICT integration and few integrate ICT into their own courses.

The proposed *Continuing Professional Teacher Development Framework*

The accreditation environment has been in a state of transition for some years however the proposed Continuing Professional Teacher Development (CPTD) system, intends to moderate and standardise the teacher professional development sector.

The new CPTD system will:

- Ensure that current initiatives devoted to professional development of teachers contribute more effective and directly to the improvement of the quality of teaching;
- Emphasize and reinforce the professional status of teaching;
- Provide teacher with clear guidance about which professional development activities will contribute to their professional growth;
- Protect teachers from fraudulent providers; and
- Expand the range of activities that contribute to the professional development of teachers.

Each teacher will be expected to earn a target number of professional development points in a three-year cycle. Once, the new system is operational, it will be most meaningful to define a professional development strategy using the CPTD points in tandem with the DoE Guidelines for Teacher Training and Professional Development in ICT.

In the interim it is advisable to apply the principles of the Guidelines document when identifying a teacher development strategy.

Options for staff access to ICT

Access to ICT is, other than time, the single biggest constraint facing teachers who wish to grow professionally with ICT. It is to some extent within the school's realm of responsibility to make ICT accessible to teachers.

Options for teacher access to ICT include:

Option A: Teacher ownership of personal device

There are moves afoot at national level to make it possible for teachers to own personal computers or laptops. An in-principle decision has been taken by the DoE to provide all teachers with laptops – it is expected that the details of this will be made known by the end of the year.

Advantages	Disadvantages / Challenges
• Teacher has unlimited access time • Teacher will develop appropriate skills more rapidly • Teacher productivity and efficiency could increase through more regular and personal access to ICT (assuming that some training has been provided) • Learners will benefit from ICT confident teachers • Teaching and learning could be enhanced if the teacher has more access to ICT and therefore time to explore and participate in professional growth activities	• Teacher carries total cost of ownership

Option B: Shared devices for teachers

One of the most common ways of teachers gaining access to ICT is the staff workroom. This is normally a small room in the school administration area, or attached to the school computer room. One would typically find up to 6 computers

in this room dedicated to access by the school teaching staff. It some cases it could be shared by the school administration staff or senior managers.

A variant of this option is for schools to make portable devices such as tablets or laptops (or even palmtop computers) available, which teachers can draw on and take home when necessary. During the school day the devices can be connected to the school network.

Advantages	Disadvantages / Challenges
• No cost to teachers • Flexibility of use • High percentage of usage – cost efficient • Teachers have fair access time • More regular users have more regular access – flexibility of access • Teacher will develop appropriate skills more rapidly through more regular access • Teacher productivity and efficiency could increase • Learners will benefit from ICT confident teachers • Teaching and learning could be enhanced • Easy to secure one venue	• Risk of damage or theft in transport • Insurance costs high • Total cost of ownership • Multiple users on one device – sense of ownership low • Scheduling clashes

Key points to consider

1. The *Guidelines for Teacher Training and Professional Development in ICT* should influence all decisions regarding teacher professional development in ICT integration.
2. A school's whole-school professional development strategy in ICT integration should align with its learning vision, which the school will require help in establishing. The detail of the strategy is dependent on such a learning vision being established.
3. The budget allocation to professional development should be at least 25% of the total budget for the project. Ideally the province should provide this training, but considering the extent to which the province may not have the capacity to do so, BNSDP should arrange this training.
4. The investment in professional development activities will be most effective if teachers have sufficient access to ICT during and after the interventions.

5. Reliable Internet connectivity will give rural teachers the opportunity to participate in professional development activities that are available online or include support by distance.

Technology Plan

A technology plan is a blueprint for implementing ICT in a school. It impacts in some way on every teacher, manager and learner in the school and it depends on their buy-in and common understanding and support for what it proposes. Developing a technology plan should be a broadly consultative process. While it typically maps a three-year view of development with ICT in the school, it should be reviewed annually.

Planning: What has to be thought about

A technology plan should include at least the following elements:

- A long-term vision for the school and defined purpose for the use of ICT in the school;
- Parameters for use of ICT by learners, teachers, school management and administration, and the wider community – this may be formulated as a policy for ICT use in the school and /or the community;
- A learning vision outlining how the school intends to use ICT to support teaching across grades and learning areas/subjects;
- A detailed list of technology and bandwidth requirements;
- Assessment of availability and suitability of space for locating and housing ICT – including consideration of necessary security arrangements
- Timetables outlining how the ICT resource will be integrated into the school day, and what levels of access will be made available to which grades of learners to ensure that resource use is optimized;
- Clear policies on how the resource will be used in the afternoon, weekend, and school holiday;
- An "audit" of available and necessary staff – both teachers and technical support staff needs to be considered;
- Professional development strategies planned
- School budget and strategies to raise money to cover continuing professional development, operating costs and replacement of ICT;
- Defined roles and responsibilities for school stakeholders; and
- Strategies for monitoring and evaluation.

Technical decisions

> "While educators who do not have technical backgrounds may consider it to be a daunting task to develop an understanding of technology, it is critical for the successful take-up of technologies that school leadership and teachers drive selection and deployment of technology and are empowered through the process to take ownership of the technology. When technology decisions are enforced on schools, it is usually not possible for the school community to

develop a sense of ownership of the technology they receive, which results in high levels of wastage."(NEPAD International Literature Review, Chap 3, p.94)

School leadership and teachers must make the final decisions about technology based, as far as possible, on educational grounds.

Local Area Network (LAN)

A local area network (LAN) connects the computers and other devices such as printers and scanners on a site so that these devices may be shared by all users on the network. Networks also make it easier to share information, files and applications with other users, a feature which is particularly useful in the teaching and learning environment. A network-wide internal "website" makes it possible for teachers to pre-research resources and make them available for access from any point on the network. A LAN also enables potentially all the users to access the Internet, although there are limitations on the number of users that can do so simultaneously depending on the bandwidth and network configuration.

At times it is necessary to secure information on the network from some users. Schools often have separate administrative and education networks, but it is also possible, depending on the network application being used, to assign rights and passwords to users so that some users have more limited access to the entire network's facilities.

Factors that will affect the decisions regarding the LAN include:
- The cost of equipment such as cable, routers, transmitters, boosting devices, and network cards;
- The geography of the location;
- The distribution of buildings; and
- The density of users.

There are two main ways to connect computers in a LAN:
- Cable LAN
- Wireless LAN

Option A: Cable LAN

A cabled LAN uses a network of Ethernet cables installed in the school and running between all the classrooms that have computers. Each computer would require a network point where it is plugged into the LAN using a network cable. Cables can generally reach up to 100m before the signal degrades.

Advantages	**Disadvantages**
• Faster than wireless • Less maintenance once installed	• Requires trained technicians to install • More complicated and time consuming

	to install • Requires drilling to install conduit and connecting of cables • Becomes expensive if there are many users or long distances

Option B: Wireless LAN

A wireless LAN uses radio waves to communicate between the computers. The technology is known as Wi-Fi. This will require an Access Point (AP) which sends and receives signals as well as a wireless adapter in each computer.

Advantages	Disadvantages
• Can be installed by computer user following step by step instructions. • Quick to install as only requires putting down a wireless access point and enabling wireless on the computers. • Becomes more affordable as number of users increase • More users added at no additional cost	• Becomes more complicated if wireless cards have to be installed in existing older computer computers. • Signal gets weaker with distance • Slower than cable at this stage

Connectivity options

Two options are discussed here. Dial up is not discussed as a viable option for network use because of its low bandwidth, and is only recommended if a school opts for Internet access for administrative purposes only. In this scenario, it is recommended that the telephone line be placed in a secure place so that it cannot be abused and generate unplanned and unwelcome high telephone bills. ADSL is not discussed because most schools are rural schools and not likely to be within close range of their telephone exchange. ADSL is only capable of supporting good transfer rates over telephone lines in good condition at line distances of up to 5km from the exchange and as such is a mainly urban option. If DSL lines are available this would be by far the cheapest access, which would negate the need to consider further options.

Option A: 3G

3G uses the cellular telephone network to provide a high-speed service. Some cellular handsets can be used to access the internet but most often, 3G cards are used in portable computers or laptops.

- **Vodacom coverage** is shown at: http://www.vodamap.net/3g/
- **MTN coverage** is shown at http://www.mtn.co.za/?pid=11789
- **iBurst** only covers certain urban areas in this country, see: http://coverage.iburst.co.za/coverage.html

All schools in the BNSDP pilot say that they have cell phone coverage.

Advantages	Disadvantages
• Can use cell phone as a modem (but 3G card preferable because of better bandwidth and usage contracts) • Can connect wherever cell phone signal can be found • Fast broadband speeds • No need for a Telkom line • Can share access in a computer room (requires router) • Always-on connection. • Fixed monthly cost • Range of cost options according to usage contracts, so an ideal solution can be found and costs can be capped.	• Obstructions such as trees and houses and certain weather conditions interfere with signal • Distance from repeater limits coverage. • Performance not always consistent.

Option B: VSAT

A Very Small Aperture Terminal (VSAT) is a satellite dish smaller than 2,4m in diameter which is used to receive signals from a satellite 35 000 kilometres above the earth in a geostationary position. Signals are transmitted from the satellite to the base station and on into the internet. In addition to the satellite dish, an indoor unit is also required.

Advantages	Disadvantages
• Greater reliability • Geographic independence • Fixed monthly costs • Zero line rental costs • Unrestricted access including remote areas • Always on connection • Generally no "capping" on usage	• Outdoor dish and indoor unit required • Security of outdoor equipment • Lack of mobility of equipment • Affected by weather • More expensive – installation fee of about R3000 and monthly fees of at least 3 times the cost of 3G.

• Fast broadband speeds • No need for a Telkom line	

Network configuration

There are basically two widely used options being used in South African schools. These can be referred to as:

- Fat client
- Thin client

If the decision is based on cost alone it is worth noting that many claims about cost savings from the use of "thin client solutions" in education have been made, but little reliable and/or persuasive hard cost data exist to support such assertions. (Trucano, 2005)

Option A: Fat Client

Fat client refers not to a network configuration, but to the type of devices connected to the network – fat clients include their own processing and memory capability, while thin client are typically 'dumb' terminals with no storage or processing capability, but – roughly speaking - just a keyboard, mouse, and monitor. Fat client is the more common configuration and is largely associated with new computers which have good technical specifications to run operating systems and application software on their own. While fat clients do not require networks they are discussed here in the context of a network. These computers (workstations) are connected to a server and other networks resources such as a printer by the network. Data created by the network's users is stored on the server, therefore making it possible for any user to access any resource and their own data from any workstation. Application software can be loaded on either the workstation or the server. Each workstation has its own operating system and could function as a stand alone computer if necessary.

Advantages	**Disadvantages**
• Can be converted to thin client after 3-5 years • If server breaks down the workstations computers can still be fully functional	• Each workstation is vulnerable to virus and to hardware breakdown, especially of moving parts such as hard drives • Software installed on each workstation

Option B: Thin Client

Thin client networks are normally associated with older computers, or refurbished computers which have less technical specifications however new thin client networks can also be purchased. The workstation (known as a terminal in this case) does not

have a hard drive and connects to the server, which houses all the software, including the operating system for the terminal. The server runs a terminal services operating system. The important feature here is that a very powerful server can provide relatively normal services to older and underpowered workstations, thus lengthening the useful lifespan of older computers.

Advantages	Disadvantages
• Terminals have no moving parts which reduces technical problems • Terminals are less sensitive to heat and dust • Lower initial setup cost if one is not buying a new thin client network • Lower maintenance and support requirements • No need to change terminals as operating systems and software advances • Terminals typically last between 5 to 7 years, whereas PCs generally last 3 to 5 years • When software is loaded in the school, it only needs to be loaded on the server instead of loading on various machines • Because a thin client terminal cannot operate without the server that it is attached to, it provides a security advantage as it cannot be resold by thieves (as long as thieves realise this before they steal it)	• Dependency on the server, if it is not working, the entire network is down • Some software may not be able to run multiple sessions thus the software that a school wants to run must be checked for compatibility with thin client before such a decision is taken. This is dependent on the type of thin client network chosen. • Teachers more dependent on network administrator for software installation and network issues

Key points to consider

1. Thin client networks can accommodate older computers thus giving them increased lifespan, but the relationship goes not further. Both thin client and old or refurbished computers require their own unique considerations before being accepted as viable options in their own right.

2. Given the isolated nature of rural schools and the relative lack of capacity to maintain a network, the simplest possible network installation may be more advisable initially.

3. Provision does need to be made for a trained network administrator to be available at the school.

To buy or not to buy refurbished computers?

Many projects using refurbished computers have failed, largely due to high rates of component breakdown and lack of an organised maintenance system. The perception is that refurbished computers are inferior and the efforts to find solutions to challenges are not always committed. Another perception is that refurbished computers are free or very cheap. The use of donated computer equipment contains many hidden costs that may make their usage more expensive over time than the purchase of new equipment. (Trucano 2005)

However, many projects using refurbished computers are successful. Shuttleworth Foundation's TuxLab Project has been involved in running refurbished computers with thin client. This project requires and benefits from ongoing technical support. SchoolNet Namibia runs refurbishment centres to support and maintain refurbished computers. It is important to set minimum specifications (for example SchoolNet Namibia accepts Pentium III onwards) for accepting second hand computers. Most successful projects only accept batches of proprietary machines from well-known manufacturers, so that the hardware configuration is the same for all computers in the batch. It is very difficult to cost-effectively set up and maintain refurbished computers that do not have uniform hardware configurations in a venue, with a source of spares of the same configuration.

It is critical to assess the risks when making use of refurbished computers. It would be wise for donors to accept refurbished computes only from credible refurbishment centres, and not to accept containers full of computers from sources that are not known to be fully functioning. It would not be advisable for a school to accept refurbished computers on its own unless it has a partnership with a refurbishment centre

Advantages	**Disadvantages**
• Cheaper than new computers, sometimes free	• Older computers harder to support technically • Schools need to be in contact with a refurbishment centre or credible technician • More regular maintenance required

Choosing an operating system

The choice of operating system is significant as it may exclude some applications from running on the system. Generally there are two operating systems that can be used in a school environment these include:

- Open Source operating systems (such as Linux) or
- Microsoft Windows.

Much is made of open source software being free, but this is not necessarily the case. One is free to amend and distribute open source software, but not all open source software is free. Once again, the criteria for selection of options must be applied; one needs to know the learning vision and purpose of the ICT resources and whether an open source operating system and applications will realise this vision.

Microsoft Windows	**Linux and its variations**
• Applications have wide range of features and are well supported • Currently free for schools in South Africa with educational licensing being phased in from 2010	• Not generally considered to be user friendly to set up • High stability and virtually no viruses at this point in time, however this could change with its increase in popularity • Requires greater technical ability to set up as processes are not always user friendly and intuitive • Does not offer the range of services (especially in software functionality and educational applications) that proprietary options may offer

NEPAD Business Plan, Annexure 1, Key Parameters Research

Hardware

As with most technical decisions, the selection of hardware should reflect the learning vision and technology plan of the school. The hardware required will also reflect the needs of the school and the stage of ICT use found at the school. This will have been established by consideration of the self-review framework, which should be revisited each year.

The decisions about the kind of end-user device are in some ways influenced by the network configuration and decisions that informed the selection of network configuration. These decisions could furthermore be influenced by physical environmental conditions such as dust and weather, and social conditions such as security and access for learners with special education needs.

Software

In addition to software that may support the use of hardware, and be provided with the hardware, it is advisable to install standard educational versions of *office suite* software, which includes an Internet browser. Microsoft Office is provided free to state schools in South Africa until 2010 under the Microsoft School Agreement (which each school needs to register for).

A good *encyclopaedia* is an important part of the software you offer learners. Microsoft Encarta is part of the School Agreement package (until 2010). It provides a safe starting point in searching for information, and does not require Internet access to work.

Anti-virus software is essential. It is possible to take advantage of the Symantec agreement with the national Department of Education which offers free anti-virus software to schools. As with all such agreement, this agreement may not be valid for an indefinite time span.

While the above software is regarded as generically essential to a school's needs, other options include:

Email software is usually provided with office software, but this is often redundant in a school situation which requires large numbers of users to access email through relatively few workstations. Resorting to online free email providers could provide false economies because the use of such email is relatively demanding on bandwidth and could adversely affect capped bandwidth (when the school has a limit to its monthly email usage). It could also affect other users on the network in that bandwidth will become restricted. Thurn (accompanied by PegasusMail) is free software that can give each learner, teacher and manager at the school an individual email address through the use of server-based email reading and writing. This would save bandwidth at the time of engaging with email.

Web authoring software would be useful if the school wishes to establish its own Web presence or create an internal "Web" for sharing resources and making then available to learners and colleagues on all workstations. By creating an internal “Web” teachers and learner in the school can collaborate and share resources and ideas. Teachers can setup e-learning resources and supporting documents that can be accessed from any point on the network.

Management software is used by the schools administration and management for administration and management. The National Department of Education has developed a free computer administration package (SA SAMS), which will provide the senior management teams of schools with administration support that will be extremely beneficial to the school. The school will benefit in the following ways:

- End of term report and schedules can be drawn up;
- The drawing up and printing of the Annual Programme of Assessment;
- Class lists, subject lists, educator lists, age lists, sport lists, etc. can be drawn up and printed;
- The drawing up of a school timetable can be facilitated;

- Financial management requirements can be facilitated;
- The management of school discipline can be supported;
- Information for the provincial EMIS directorate can be produced electronically;
- Provide registration details; and
- Absenteeism can be recorded and monitored.

Subject specific software will be specified by subject departments as and when they are able to define specific needs and ensure that access to ICT can justify the use of software according to the school's learning visions and technology plan. At times this software will include accompanying hardware. This could include, but not be limited to software such as:

- Accounting packages;
- Music software;
- Art and graphics software;
- Geographical Information Systems (GIS);
- Science experiments and analysis (including probes);
- Drill and practice software for numeracy and literacy; and
- Interactivity and simulation software.

Layout of computer rooms

The layout of computer rooms (also referred to as computer laboratories) has followed historical trends related to perceptions and approaches to teaching and learning. When the computer was first introduced into schools, it was a very technical device with few applications for the average person. Teaching about computers and how to programme was the focus of initial teaching activity with computers. The subject focus was extended to the computer classroom which reflected the average classroom of the day, row of desks being replaced by rows of desks with computers, all facing the teacher who stood in front and taught. To this day, many IT classes have the same configuration.

When views of teaching and learning started to move away from the traditional instructional mode and the benefits of a more learner centred and interactive approach became popularised, classroom configurations broke with the traditional rows and became more flexible. Even though it is possible to find some variation in Computer room configuration, more often than not, Computer rooms have not followed suit because of the difficulty with cabling. Configurations are generally dictated by technical aspects such as network cabling and electricity. The advent of wireless networking and portable laptops with long battery life has made it easier to implement more flexible classroom layouts in the computer room.

Language classes are known to most often reflect layouts that encourage group discussions while technical venues such as Science labs are more prone to infrastructural demands, although this does not necessarily mean that desks have to be built in rows. How do computer labs reflect an underlying learning vision?

For the purposes of demonstration, it may be useful to organise the classroom in rows as seen in this picture However, the scene depicted here is far from ideal, note that the learners have to look over the barriers posed by desktop hardware to try and see the whiteboard.

When lecturing, demonstration and explanations on the screen in front of the classroom are highly valued activities the computers tend to be arranged in rows with all users facing the front and the teacher standing in front. The teacher being able to move amongst the learners is not highly valued, because it is very difficult to move amongst these rows of computers. The teacher can also not see the screens of the learners. It is also possible that the teacher is replicating the contents of he big screen on the learners' monitors, making the row configuration less necessary because the teacher could as easily demonstrate on the learners' monitors by broadcasting his/her screen over the network.

The layout in this computer room provides the potential for greater manoeuvrability into open spaces. There is a lot of open space and the chairs have wheels and are therefore able to regroup noiselessly over the carpeted floor. This layout does not promote the view that the computer is they main focus, but rather the idea of the computer as just another resource in the classroom.

While it may very well be necessary to take into account the limitations of existing structures when creating computer rooms, some thought needs to be given to the lighting. For example in this picture, the lighting in the room is not favourable. Direct sunlight in the room is not considered good when using computers. The computers in the foreground have bright light behind the monitors while the computers on the far side will have high degrees of reflection of light off the monitors. If designing a computer room from scratch, it would be advisable for the lighting to be Indirect, so that rays of light do not fall directly on the screens.

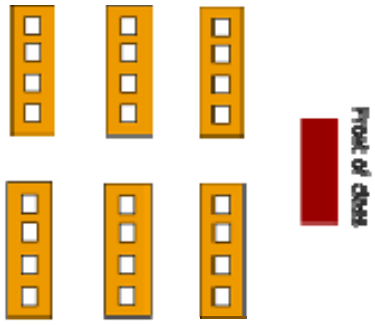
This layout does not encourage learners to communicate with or disturb each other at all. Whereas this is fine for a language laboratory, it is not aligned with most teaching and learning philosophies, especially those associated with outcomes based education and notions that learning is a social activity.

Analysis of layouts

In this analysis of layouts we will assume that:

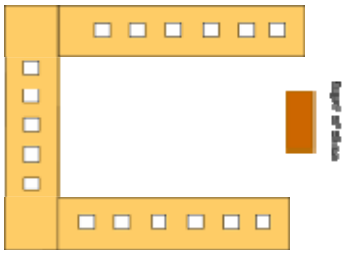
- wireless networking is possible in each venue
- computer processors (CPUs) are mounted beneath the desks
- monitors are at ergonomically appropriate levels on the desktop
- Keyboards are either on the desktop or available on a slide from beneath the desktop.

Option A: Rows facing the front



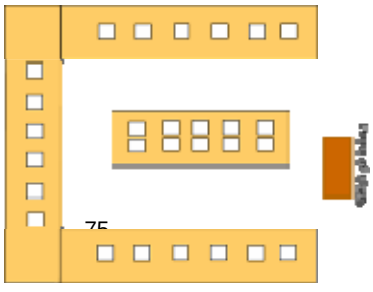
Advantages	Disadvantages / Challenges
• Teacher has learners' attention easily as they just need to look up • Easy to provide cabling • Can fit relatively large number of computers into the room	• Teacher cannot see what the learners are doing • Learners can be easily distracted by the content on their monitors while the teacher is talking, because the monitor is in the line of sight between the learner and the teacher when the teacher is standing in front of the class • Teacher has to walk to the back of the class in order to see all monitors • Teacher cannot easily move from one learner to the other in the average classroom with 24 computers • Learners cannot easily form groups

Option B: The U-shape



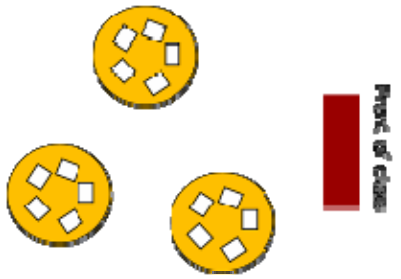
Advantages	Disadvantages / Challenges
• Teacher can see each monitor at a glance • Teacher can reach each leaner with equal ease • Learners can regroup in the middle of the class for non-ICT activities • Learners turn away from their monitors during whole class activities • Easy to provide electricity points	• Limits number of computers possible in the room • In order to pack computers in the available desktop space the width between workstations is often reduced to impractical levels • Backlighting from low windows a possible challenge

Option C: The E-shape



Advantages	Disadvantages / Challenges
• Teacher can see each monitor with relatively little movement by walking across the front of the class • Teacher can reach each learner with relative ease • Relatively large number of computers can fit into the room	• Learners cannot regroup in open spaces for non-ICT activities • Providing electricity points to the middle island • If the teacher moves around some learners will always have their backs to him/her

Option D: Clusters



Advantages	Disadvantages / Challenges
• Learners can easily regroup in open spaces for non-ICT activities • Space for small groups at workstation • Learners can collaborate in clusters	• Providing electricity points to the middle island • If the teacher moves around some learners will always have their backs to him/her • Teacher cannot see each monitor unless he/she walks around the class • Cannot fit in high number of computers

Key points to consider

1. Decisions about technical aspects of a school ICT facility should primarily be influenced by the school learning vision and how ICT can support that.

2. Thorough planning recorded in a school technology plan will be necessary before well-informed decisions can be taken.

3. Maintenance, support and training arrangements should be considered before deciding on specific hardware and software configurations.

Recommendations

1. Schools should make the technology decisions and understand the impact of these decisions.

2. The aim and purpose of ICT in the school should be thought through carefully before a technology model is selected;

3. The total cost of operating the technology that is selected must be considered before a final decision is taken; and

4. Proper technology planning must make provision for maintenance and support, managing software and anti-virus updates, controlling security on the school equipment and ensure that resources are available to maintain full functionality of the equipment.

Total cost of ownership

Total Cost of Ownership (TCO) is a method of identifying and understanding all of the costs associated with the acquisition, use, maintenance and support of ICT, with the aim of improving decision-making about future ICT investment and deployment. It is therefore short-sighted to consider the purchase of hardware and, to some extent, software as the one and only cost in the implementation of ICT in schools.

Total cost of ownership is often underestimated, sometimes grossly, when calculating costs of ICT in education initiatives. Estimates of initial costs to TCO vary widely; typically the cost of ownership beyond the initial costs could be between 10-25% of total cost over a 5 year period. (Trucano 2005)

One can illustrate this with an example of a data projector, a seemingly simple purchase. There are basically two options when purchasing a data projector: Digital Light Processing (DLP) and Liquid Crystal Display (LCD) projectors. The purchase price for the two is roughly equivalent. The large difference is found in maintenance. Since LCD projectors are open-image systems that use airflow to stay cool, they contain special dust filters that must be cleaned regularly (typically for every 100-200 hours of use) to prevent potential breakdown. Ceiling-mounted LCD projectors may require two people to clean the filter and the unit may have to be unmounted to access the filter. There are typically 40 school weeks a year. If the LCD projector is used five hours a day, five days a week, that's 25 hours. The filter has to be cleaned every 4 weeks, or 10 times a school year. At an average cost of, for example, R50-100 per cleaning, that's R500–R1000 per year. Over the five-year expected life of the LCD projector, the cost to clean the dust filter is R2500-R5000 per projector, which could represent about 50% of the cost to purchase a new one. If LCD filter maintenance is not followed, components such as lamps can fail prematurely. Lamps normally cost

well over R1000 and will need to be replaced several times in a five year period even in the best scenario conditions. By contrast, DLP projector components are sealed, so there is no dust filter to clean or replace. This appears to create a tremendous TCO advantage for DLP projectors. This apparent advantage is enhanced when considering that most rural school locations are likely to be dusty. For more information about other advantages and disadvantages of the two projectors see: http://www.projectorpoint.co.uk/ProjectorLCDvsDLP.htm

The point being made through this illustration is that maintenance and component replacement costs cannot be ignored and should be factored in to the initial costs and ongoing sustenance of the ICT facility and resources in a school. Cisco estimates that the TCO for rural schools can be up to 50% higher than urban schools. This is because of the greater environmental constraints (dust, lack of infrastructure) and location constraints (distance from regular service resources, security risk caused by isolation), amongst others factors. (CISCO 2008)

In assessing the TCO of computers in UK schools Becta identified "constituent ICT costs" as a percentage of the ICT budget (Becta 2006) as follows:

- User self-support (the time for user to teach themselves): 25%
- Formal support and training: 36%
- Consumables: 4%
- Network: 5%
- Hardware (including maintenance): 24%
- Software: 6%

Other constituent costs likely to be encountered in South African schools are:

- Insurance
- Security
- Technical support (probably to some extent replacing user self-support)

The value of understanding TCO is that it empowers the school leaders to reach and maintain sustainability. The use of TCO analysis can make a significant contribution to achieving this sustainability. School leaders need to:

- Assess the quality of facilities and services required by the school technology plan.
- Audit existing ICT equipment – age and costs.
- Identify the impact of existing ICT and practices on staff (and possibly learners') satisfaction, confidence and competence.
- Review staff training needs.
- Assess the quality of facilities and services needed to support the technology plan.
- Plan and introduce a rolling three-year whole school budget, allocating a realistic proportion to ICT. (Becta 2006)

Conclusion

There are many recorded instances of donor-funded ICT resources in schools that initially met with great excitement and expectation, but soon left school communities despondent and even upset at the lack of substance to the donation beyond the installation of ICT. BNSDP recognises the complexity of placing ICT in schools and this promises a long and fruitful relationship between the donors, provinces and schools involved.

Prior to installation capacity building is required so that school leaders fully understand the commitment and responsibility involved, but also so that decision makers can make informed decisions to which they would be prepared to commit on financial and educational grounds.

Being custodians of ICT resources requires schools to develop and execute a financial plan that can ensure financial sustainability. This may include a range of support structures such as partners from the public and private sector. Ultimately sustainability comes from with the organisation and reliance on others will always rob them of that security. This is especially challenging for rural schools in communities where unemployment and lack of services is high.

The impact on teaching and learning that support from BNSDP will provide these schools are potentially hugely promising for both the teacher and learners. However, to use the analogy of potential energy, it will never fully convert to kinetic energy because there will also be a loss due to heat and sound. It does take a catalyst like the force of gravity to make an object with potential energy fall. So too, it takes leadership to bring out the potential of the resources for teachers and learners. Realistically there will be resistance, deterring factors and challenges. The greater the leadership, the greater the potential can be unleashed.

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