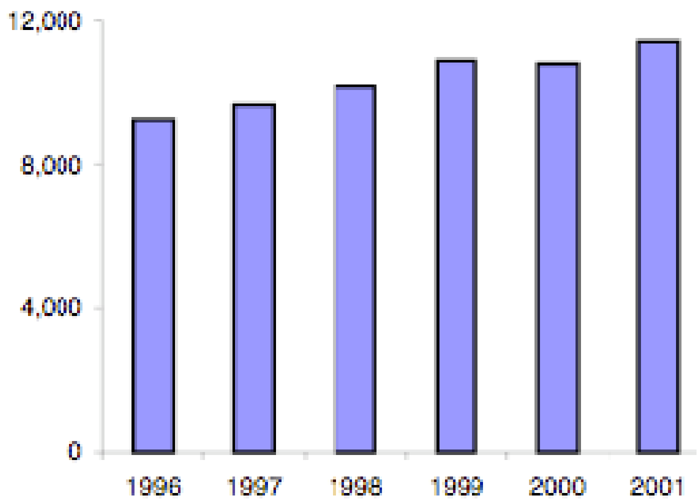
ICTs and teacher education in the global south: costing the benefits of learning.

Abstract

There is widespread commitment and investment in Information and Communication Technologies (ICTs) for education and development in the global south, in line with international commitments to the Millennium Development Goals. This paper contrasts two models of ICT implementation in these contexts – the most common format, where a suite of refurbished ICTs is installed in a fixed location; and the novel format used in the first phase of DEEP (the Digital Education Enhancement Programme), where teachers are provided with a smaller number of mobile digital tools. The latter model is often criticised on the basis of cost. This paper applies a standard model for calculating the Total Cost of Ownership to the two formats. The results of this analysis challenge some of the common assumptions about the costs of ICT for education in developing nations.

Introduction:

Over the last decade, the scale of investment in ICT and ICT infrastructure in developing nations has been huge, and it is increasing. Take for example, the two countries where the original DEEP research was located.



The World Bank (2003a) reported an expenditure of eleven thousand, four hundred and thirty million dollars on ICT in 2001, in South Africa alone.

This represents a annual spending on ICT of $268.7 for every person in South Africa (roughly equivalent to the cost of giving a new multi-media laptop to every household in South Africa, every year).

In 1995, South Africa was spending 5.7% of it's GDP on ICT; by 2001, this had risen to 9.2% of GDP; in all likelihood, it is still rising.

In Egypt, the investment in ICT is not as intense as South Africa, but at over two million dollars per annum in 2001, it is still substantial, and likewise, shows a similar progression over time (World Bank 2003b). From such investment, both countries show a substantial increases in ICT capacity.

However, despite this investment, ICTs tend to predominate in the most advantaged educational communities: universities, then secondary schools, before primary schools; affluent urban communities before poor rural ones. ICTs are most likely to be found in educational settings where the community members have already achieved some degree of educational or financial success (where educators and learners have already demonstrated the ability to succeed in examinations, and have had the financial and social capital that allowed them to continue their education).

Schools for young children in poor rural communities are amongst the least likely to provide ICT access for their teachers and pupils. Where ICTs are considered for such settings, they almost always take the form of a suite of old, often donated, desktop computers.

The reason most commonly given for both the lack of ICT within these communities on the one hand, and the kind of ICT offered to these communities on the other, is cost.

Thinking as Usual

There is a prevailing orthodoxy that, for teachers and pupils in poor communities, the only appropriate form of ICT, in fact *the only possible* form of ICT, is a suite of second-hand desktop computers.

There are variations (relating to provenance - freely donated or purchased; network structure - stand alone, or ‘thin client’; and software - whatever generation of proprietary software they came with, or ‘Open Source’) favoured by different groups, but the basic premise is the same - large numbers of cheap or free desktop machines is the only financially viable way provide any kind of ICT entitlement to poor communities.

We have come to call this orthodoxy *‘Thinking as Usual’*, as it seems to underpin most of the work on ICT in developing nations.

There are a number of defining features that cluster together to give shape to ‘thinking as usual’:

- computers = desktop computers
- computers discarded by previous owners (as obsolete), or may have been refurbished
- no multi-media facilities available, or multimedia used to ‘view’ content created elsewhere
- large numbers of computers (typically 12 – 24)
- computers located in a computer suite, or dedicated classroom
- computers made ‘secure’ by physically securing the room, windows and doors, to prevent theft of damage.

In addition to this, there are often subtler expectations about the purpose and uses of the equipment:

- the computers are for learning about computers (they are not used for learning in other subjects)
- the computers are for accessing information from the world outside (not for creating and sharing information with each other and the world outside)
- if teachers need training, it is in ‘computer skills’ (not in using ICT to support teaching and learning, or in their own subject knowledge)

The final feature of the prevailing orthodoxy is about the relationship between costs, teacher training and ICT equipment. In thinking as usual, ICT equipment is seen as being the main cost burden, with a small proportion of the overall cost being required to provide rudimentary ICT training for teachers.

	When people used to ‘thinking as usual’ about ICT consider DEEP, they tend to see first the ‘state-of-the art’ ICT equipment, which intuition tells them *must* be inappropriate for teachers serving some of the poorest communities. For these people, the notion that such ICTs *might* have a role to play in teacher education in developing nations is untenable because of costs. They tend to perceive that the ICT comes first, and the ‘teacher training’ is an ‘additional cost’ to the provision of equipment.

DEEP ICTs - abandoning the constraints of the orthodoxy

In DEEP, we sought to explore the potential of ICT for teacher professional development, and for classroom practice, where teachers were serving disadvantaged communities in Egypt and South Africa. Because the DEEP project was exploring *possibilities* and *potentials*, we did not start with a given picture of what the projects ICT would look like, but rather we thought about the educational practices and purposes we wanted the ICT to enable. The technical specification in appendix 5 of the *final report* (Leach 2005) gave a baseline requirement to enable the practices we wanted teachers to experiment with.

Chapter 5 of the DEEP *final report* gives numerous examples of positive outcomes for teachers, learners, and school communities. Many of these valuable activities could not have been achieved with a typical refurbished suite of basic computers.

ICT tool	Aspects of learning difficult to achieve with a basic PC suite	Aspects of learning impossible to achieve with a basic PC suite
laptop	• mobility - enabling use at classroom / home / workshops / church / hospital • multi-user accounts enable sense of ownership / personalization / collaboration • Integrates seamlessly into classroom setting (being moved around, brought into & out of play as required)	• viewing & creating multi-media curriculum resources: music; pictures; video & animations • learning in contexts where external power supplies are unavailable
handheld computer	• Allows time for personal learning outside school hours • Supports collaboration by allowing easy document sharing (e.g. teachers from different schools meeting at a workshop)	• viewing and recording multi-media curriculum resources • operating for extended periods without external power supply • recording photos / voice notes from interviews & field work • recording data from field work
digital cameras	• recording and displaying school learning beyond 'text', especially where adult literacy is poor • capturing and objectifying experiences to enable critical reflection	• live capture of field work / external events • exploring the genre of visual image
digital video cameras	• enables teachers and pupils to practice authentic roles (e.g. naturalist / journalist / interviewer / subject expert) • enables reflective evaluation of performance	• capture / editing / composing & sharing teacher & pupil videos • exploring genre of moving image
Printer / Scanner / Copier	• creation of visually rich physical media • income generation (e.g. obituary cards)	• scanning of physical objects (e.g. local herbs) • photocopying school documents

The relationship between the ICT tools and their use for teacher development & curriculum purposes is detailed in chapter 3 of the final report (specifically table 1, pages 45-49). The previous table draws out a few of these examples to show how achieving the same outcomes or flexible uses would be problematic with a typical suite of basic (non-multimedia) PCs.

The main functions supported by basic PCs reflect the office environment from which they derive: word processing, spreadsheets, ‘learning ICT’, browsing the internet & using email (when networked). Any of these activities can be engaged with in a very educationally meaningful way; but the opportunities are so much greater when learners and teachers have the ability to combine these functions with the images, objects, sounds and voices from their own environment - both inside and outside the classroom: combining ICT with story-telling, music, dance, drama, and the natural and cultural world in which the learning is taking place. Further, the integrated use of rich multi-media allows reflection, comparison and dialogue between the local and the wider contexts.

The use of powerful, multi-media ICTs afforded a much greater range of pedagogic possibilities than those that could have been achieved by ‘thinking as usual’. Because the ICTs were small and mobile, no longer bounded by a classroom and a cabled infrastructure, the nature and circumstances of use reported by teachers and pupils were far more richly diverse than the possibilities allowed by a suite of refurbished desktop computers.

We allowed ourselves the liberty of dropping the constraints of ‘thinking as usual’ in order to research what was possible, given the appropriate tools and support, for teachers and pupils in poor rural communities. The initial findings suggest that there are many possibilities for rural school educators and communities to effectively use ICT as a significant tool for personal, professional and community development.

For those used to ‘thinking as usual’, this is of no more than academic interest if the tools required are unrealistic in the circumstances - and the prevailing orthodoxy of ‘thinking as usual’ says any ICT costing more than marginally above ‘free’ is unrealistic for poor rural communities.

I will argue that some of the assumptions made in ‘thinking as usual’ need challenging, and that the models like that tried out in DEEP can render most of the orthodox cost analyses redundant. However, before getting involved in the figures, it is important to point out one final, fundamental difference between the approach to ICTs seen in DEEP, and that of the prevailing orthodoxy: the *purpose* of the ICT tools in DEEP is primarily to support and enable teacher professional development and dependant changes in classroom practice. DEEP is not primarily concerned with the provision of tools, but with professional development - the main costs are those of teacher training, and ‘providing the tools’ is a subset of the overall costs providing the training.

	In DEEP, the first priority is the professional transformation of teachers, and the learning opportunities afforded to pupils and communities; we look first to the learning and second to the equipment. The aim is to train teachers, and the provision of professional tools is an integral part of that process. This suggests that even 'state-of-the-art' equipment may be a relatively small component of the total costs of teacher training.

Total Costs of Ownership.

Power (2004) has costed the ICTs provided to a school participating in DEEP against the 'usual' ICTs, using a model of *Total Cost of Ownership (TCO)* put forward by Moses (2004).

Moses proposes the following key considerations for TCO calculation:

- Initial Purchase Price
- Maintenance
- Supplies
- Electricity
- Retrofitting (adapting a building)

> "It is interesting to note that, using the figures provided by Moses, and accepting those assumptions, the TCO over a 3 year period for accepting a free suite of donated computers may be in excess of four times more costly to a school than purchasing brand new 'state-of-the art' mobile technologies."
>
> (Power, 2004)

This economy is brought about mainly by using a much smaller number of much more powerful devices (a laptop and two hand-held computers, as well as cameras, rather than a 'suite' of computers).

	Thinking as usual		**Thinking DEEP**	
Cost type	Description	Cost	Description	Cost

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

The figures for maintenance costs for the DEEP model are much lower in this analysis simply because there are less machines to maintain. In actual fact, the maintenance figures for the DEEP model should be zero for the first one or two years, as new items are likely to be under warranty during this time. Perhaps further adjustment should be made because the older equipment is more likely to fail or require maintenance than the new equipment, however, it might also be argued that the replacement parts may be more expensive for the new equipment, so no bias has been applied to the figures for maintenance.

The figures for power consumption are very much lower for the DEEP model, as thinking as usual uses twenty times more computers, each of which consumes ten times the power of a laptop. Therefore, assuming equivalent usage, the DEEP model consumes 200 times less electricity than thinking as usual.

As well as cost issues, this also points to another pragmatic concern: with much lower power consumption in the DEEP model, the entire ICT equipment could comfortably run from a single solar panel, or could be charged off site, relying on battery power during school usage. As many of the project schools had no connection to the electricity grid, the DEEP model was the only option open to them. A suite of desktop computers would not be a viable option in many rural settings - simply on the basis of power consumption alone.

Powers calculations exclude the costs of retrofitting, as there are too many variables to suggest a figure for the cost of retrofitting a room to provide cabling, furnishing and security for a computer suite - however, these costs may be substantial when ‘thinking as usual’.

Bakia (2002) also acknowledges the difficulty in giving generic figures for retrofitting (into which she amalgamates the cost of providing internet access):

> Some of the costs necessary to prepare a building for connectivity would also be necessary for computer projects that did not have connectivity -- such as heating, ventilation and air conditioning as well as security and power requirements. We group them here under one heading because they are often inter-related. "Several studies [in the United States] have projected the cost of building local area networks and wiring classrooms to the Internet to be roughly about $500 per student per year. However, many factors, including the age of physical plant and previous technology investments, [school size and computer student ratio] will determine the precise figure," (Taking TCO to the Classroom, available at www.cosn.org/tco). Preparing a school for connectivity will often require renovations within a building.
>
> A building must have sufficient electrical capacity, from available power to number of outlets, adequate temperature control and ventilation, and security. These costs can often be reduced if they are considered when new buildings are being constructed. There are also a wide range of wireless solutions emerging (discussed in greater detail below), which could further reduce the burden of some wiring costs.

Bakia gives annualised costs for retrofitting ranging from $350 per school in Chile, through to $3,100 dollars per school in Egypt, and up to $85,000 per school in Barbados. This range represents an annual ongoing annual cost of between 3% - 19% of the entire ICT budget for adapting buildings and providing network access.

It is important to note that the cost of retrofitting buildings *only* applies to 'thinking as usual'. The DEEP model has not required *any* retrofitting costs in *any* of the schools where it has been applied, as the equipment fits into the normal classroom context, and is secured not by steel bars, but by a sense of ownership in the local community, and the mobility that allows the equipment to move with it's users.

Discussion

These figures would suggest that however one might tinker with the different variables of Moses' TCO framework, the DEEP model is likely to be *at least* as cheap thinking as usual. In fact, a rudimentary analysis like this suggests that even when you compare buying the DEEP equipment new with being given the old computers for free, it may cost you over four times more to maintain and run the old computers for three years, than to buy, maintain and run the DEEP equipment.

Is this a sleight of hand?

No. The DEEP model *would* be much more expensive than free computers *if* the only thing you changed was to substitute a new laptop in place of each old desktop. But in that case, you would just be 'thinking as usual' - about a suite of computers.

DEEP has demonstrated the potential of relatively small numbers of digital tools to enable substantial changes in practice and outcomes for relatively large numbers of teachers and pupils. It achieved this by dropping many of the assumptions that underpin 'thinking as usual about ICT' - assumptions about:

- the number of computers required;
- the physical environment in which the computers must be located;
- the purposes they are going to serve;
- the practices they are going to enable, and
- the communities that are going to participate.

By breaking the often implicit assumptions of ‘thinking as usual’, the DEEP model also breaks the common sense cost analysis (new ‘state of the art’ tools must be more expensive than old obsolete ones) because it does not make this one-for-one substitution of one new laptop for one old desktop, with everything else staying the same.

The difference between DEEP and the prevailing orthodoxy goes much deeper (no pun intended) than the difference between ‘new computers’ and ‘old computers’ - it is predicated on a completely different set of assumptions about the forms ICT might take, the purposes it might serve, and the ways and places in which it might be used.

The power of the TCO model given by Moses is that it provides a means to demonstrate that cost is not a valid objection to the forms of ICT used in DEEP. Small numbers of ‘state of the art’ computers are more cost effective over time than large numbers of ‘free’ computers.

The weakness of the TCO model given by Moses is that the TCO it suggests for ‘thinking as usual’ is clearly nonsensical - rural schools in Sub-Saharan Africa *do not* spend $6,000 per year running their ‘free’ suites of donated computers for the simple reason that they do not have $6,000 a year to spend. This is not a problem with Moses’ model as such - the percentages for maintenance and supplies ring true with every ICT technician and SysAdmin I have asked about them. The problem is that it *does* cost this amount of money to use and maintain a suite of computers - even (perhaps especially) if they are old and given as ‘free’. And rural schools do not have this kind of money.

So what does such a mismatch suggest? It is that, at least in poor rural communities without the benefit of external funding, the use of ‘free’ suites of computers is suffering from one or more of the following problems:

- falling into mis-repair due to lack of maintenance
- not being supported by sufficient supplies (e.g. for printing, or sharing data)
- not being used anywhere near as many hours per year as proponents suggest

Indeed, the purpose of Moses contribution may have been precisely to show that ‘free’ ICT suites are not as cheap as popular wisdom would suggest. However, it also inadvertently demonstrates very well that the issue of costs is much more problematic for the prevailing orthodoxy of ‘low cost’ suites of desktops computers than it is for the forms of ICT used in DEEP.

Conclusions

Much of the policy, practice and research relating to ICTs for education rests on a set of often un-stated assumptions that, taken together, we have labelled ‘thinking as usual’ about ICT. One outcome of ‘thinking as usual’ is that donated (possibly refurbished) suites of desktop computers are often perceived as being the only financially viable form of ICTs for education in poor rural communities.

The DEEP model of ICTs does not conform to the assumptions of ‘thinking as usual’.

Consideration of TCO shows that the DEEP model - buying and using a small number of ‘state of the art computers’ may be *at least* as cheap as using ‘free’ ICT suites over a period of three years.

This suggests that the assumptions that cluster to give rise to ‘thinking as usual’ need making explicit and open to challenge, not just in consideration of costs, but in any consideration of ICTs for education.

Unfortunately, ‘thinking as usual’ is so ingrained that practitioners, researchers or policy are still reluctant to leave it’s comforting familiarity - even when they are aware that, both in terms of costs and benefits, thinking as usual may be built on foundations of sand.

> “Some practitioners have argued that the total cost of ownership of a refurbished PC could be higher than that of a new PC owing to its additional maintenance costs and shorter lifespan...
>
> ...the view from the Botswana workshop was nonetheless that African schoolnets should be encouraged to consider the use of second-hand and refurbished computers, as part of an educational technology solution on the basis that they make the provision of ICTs in schools more potentially more affordable. Until it can be proven beyond doubt that the total cost of ownership of a new PC is less than that of a refurb, most schoolnets are committed to continuing to use refurbs in schools, while continuing to figure out how to make them more effective.”

(School Net Africa, 2003)

Epilogue - anecdotes from practice

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

(Osin 1998)

There are three examples of 'thinking as usual' encountered by the project team during research visits to schools in South Africa.

In one, a school had been donated a suite of new computers, but teachers had received no training in how to use them. Two years later, when the team visited this school, the computers were still in plastic wrap. They were in the deputy principals office. Teachers said they were kept here because the computers conferred status, and impressed parents. None of the teachers had used the computers, because they saw no use for them in their teaching. (This situation has subsequently changed).

In another, a large number of very old computers had been given (amidst celebratory articles in the local press) by a company to a rural primary school. Most of the cables and interconnects were missing, such that only three computers could be made to function without the school making further purchases. Without any multi-media capability, these three computers were briefly used for keyboard skills. The governors were then worried about theft (the school did not have the money to retrofit a classroom), so the computer components were found safe keeping in various homes across the community. (This situation remains).

In a final example, one repeated many times over, an enterprising entrepreneur had set up a company to provide ICT to poor schools. The offer was this: the enterprise would lease to the school fifteen refurbished computers, loaded with 'educational software', and maintain these for two years. In return the school had to get each pupil to pay R30 (approximately £3) per term to the company.

Several school governing bodies we met were seriously considering this proposal in 2004. Many local schools had signed up for this.

We helped one school do the maths:

R30 per pupil, at 560 pupils = R16,800 per term.

Over two years, six terms = R100,800 (Approximately £10,000)

Cost per computer = R100,800 / 15 = R6720 (Approx. £670).

For this amount of money they could have bought 15 brand new multi-media desktops. Equally, this would have been enough to buy the DEEP set of equipment three or four times over. Either way, they could have had new equipment with two years warranty.

References

Bakia (2002) ‘The cost of computers in classrooms: data from developing countries.’ Techknowlogia 4 (1): p63-68

Leach, J. (2005) ‘DEEP Impact: an investigation of the use of information and communication technologies for teacher education in the global south’ Researching the Issues, DFID UK. (The final report of the DEEP project).

McCormick, R and Scrimshaw, P. (2001) ‘ICT, Knowledge and Pedagogy’ in Education, Communication and Information, Vol.1. No.1 [http://www.open.ac.uk/eci]

Moses (2004) ‘Educational computer system maintainance and support: they cost more thank you think’ in ‘Policy and Practice for Open and Distance Learning’ H. Perraton & H. Lentell. London / New York. Routledge / Commonwealth of Learning.

Osin (1998) ‘Computers in Education in Developing Countries: Why and How?’ Education & Technology Notes 3 (1) http://wbln0018.worldbank.org/HDNet/HDdocs.nsf/C11FBFF6C1B77F9985256686006DC949/9F0209063ADBE47085256755005274A6/$FILE/v3n1.pdf

Power, T. (2004) ‘ICT And Teacher Education In The Global South: Costing The Benefits Of Learning’, Third Pan Commonwealth Forum on Open Learning, Dunedin, 4-8 July 2004

School Net Africa (2003) ‘'Treat refurbs and Africa with respect'. Framework on refurbished computers for African Schools. A research report by SchoolNet Africa. http://www.schoolnetafrica.net/1297.0.html

World Bank (2003a) ‘ICT at a Glance - South Africa’ (Development Data Group).

World Bank (2003b) ‘ICT at a Glance - Egypt, Arab Repub.’ (Development Data Group).