CURIOSITY CURES THE KNOWLEDGE GAP - CWILI TOWNSHIP DIGITAL DOORWAY PROJECT: A CASE STUDY

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ABSTRACT

Harnessing ICT for development is hampered by the lack of end-user capacity, technology illiteracy and lack of confidence to use the technology. The Digital Doorway suggests a unique approach to promoting functional computer literacy, overcoming the hurdles of technology use and unfamiliarity. We report on the initial results and learning of a Digital Doorway installation in a rural community in South Africa, and discus the way forward. It appears that children and young adults can teach themselves to use computers fluently. Language, formal education and lack of formal supervision and instruction do not seem to have a significant influence.

INTRODUCTION

President Thabo Mbeki's introduction to South Africa's National Research and Development Strategy sets the context for the Digital Doorway project:

"… We have to ensure that as many of our people as possible master modern technologies and integrate them in their social activities, including education, delivery of services and economic activity. This relates in particular to communication and information technology …" (South Africa's National R&D Strategy 2002)

Information and communication technology (ICT) has been widely recognised as an enabler to achieve these objectives. The technological gains and applications of ICT have become tremendous engines for economic growth and productivity. The reality however, is that the developed world is reaping the vast majority of these gains, while 80% of the world's population live in the developing world (Harvard University 2003).

There have been a number of initiatives aimed at harnessing ICTs for development: telemedicine programmes, distance education programmes, initiatives to increase access to basic telecommunications services, and e-government. These initiatives however, are hampered by the lack of end-user capacity, technology illiteracy, the intimidating nature of new technology and the lack of confidence to use the technology. In response, the Digital Doorway project suggests a unique approach to promoting functional computer literacy and learning through minimally invasive education (MIE).

This paper provides a theoretical basis for the role of ICT in education, discusses the motivation for unassisted learning and gives an example of how MIE worked successfully in a remote rural village in South Africa.

THEORETICAL BASIS

The evidence of the positive contribution ICT can make to education is plentiful. However, developing countries face numerous obstacles to realising these benefits. There have been suggestions that the work done on unassisted learning by people such as Seymour Papert can go a long way to addressing these obstacles. A hundred years ago, John Dewey began arguing that schools should move away from authoritarian classrooms with abstract notions to environments in which learning is achieved through experimentation, practice and exposure to the real world.

In a position paper on e-learning in developing countries, Detecon (2002) states that the potential of e-technology for developing countries is breathtaking, but however potent the technology may be, it still needs to be put to use and made available to all those people in a way that they can indeed start sharing and participating.

According to Mitra and Steffensmeier (2000), the pedagogic usefulness of computers has taken on great importance in an increasingly technology-focused world. They showed that a computer-enriched environment is positively correlated with students' attitudes toward computers in general, their role in teaching and learning, and their ability to facilitate communication. Students who have easy access to computers develop a positive attitude towards computers and learning.

According to Appel and O'Gara (2001), interest in using personal computer (PC) technology as an instructional medium with young children is growing around the world. Many parents, teachers and even national governments are convinced that early interaction with technology stimulates learning and gives children a head start to success in the technological world of the future. According to the National Association for Young Children (1996), appropriate use of technology can enhance children's cognitive and social abilities. Current literature supports claims that appropriate computer use will stimulate language development, social and emotional development, and fine and gross motor skills among young children (Appel *et al* 2001, Early Connections 2001, Van Scoter 2001, Ellis & Railsback 2001).

Literature dealing with the role of technology in the development of children addresses two major themes, namely socialisation and language opportunities, and software (Appel *et al* 2001). The socialisation and language opportunities theme suggests that the environment should be set up to maximise the social interaction of children at and around the computer, providing ample room there to enable children to work together. The software theme highlights the important distinction between active and passive use of software, with active use being preferable. Children must control the pace, yet be encouraged to explore. The software needs to allow decision-making, experimentation, risk taking, and problem solving.

Lewin (2000) is of the opinion that developing countries are most likely to experience marginalisation and dependence from many of the benefits that ICTs can provide. The challenge is to imagine, demonstrate and finance ways in which ICTs can permeate learning opportunities and infrastructure to lessen dependence, democratise access, and promote the kinds of knowledge acquisition that are at the core of development. The impact of ICTs on educational services is growing. Initial attempts to introduce computer-based technologies into schools and higher education were hampered by cost, constraints on information processing, and lack of connectivity. These obstacles have largely been removed in richer countries but are still being battled by developing countries. The opportunities and benefits associated with ICTs and their impact on education and learning are many. Lewin (2000) continues that ICTs that require frequent and individualised access to a wider user group are unlikely to be feasible in developing countries in the near future, where only small pockets of users can be created that are connected reliably.

Lewin (2000) states that the new ICTs will indeed transform access to information and educational services and the way knowledge is generated and shared. It is however, unlikely that most of these will be realised for the majority of the population in many developing countries over the next decade due to the lack of easy and convenient access to ICTs.

In education, the theory of constructivism has as its fundamental premise that people actively construct their own knowledge and understanding rather than simply absorbing ideas spoken at them by teachers and instructors – people actually invent their own ideas and modify their current understanding in the light of new data (Salt 2003). Constructivism holds that play and experimentation are valuable forms of learning (Daitue 1989, Garvey 1977, Herron & Sutton-Smith 1971).

The research of Rysavy and Sales (1991) on collaborative and cooperative learning demonstrated the benefits of children working with other children in collective learning efforts. They showed that when children collaborate, they share the process of constructing their ideas, instead of simply labouring individually.

It is clear that ICTs can play a huge role in education and the promotion of computer literacy, if ways can be found to make computers easily accessible to potential learners and create an environment in which they can learn through experimentation.

MINIMALLY INVASIVE EDUCATION

Mitra and Pawar (1982) first formulated the concepts of unsupervised learning in a paper on the use of diagnostics and debugging as a learning tool. Mitra (1988) later expanded this concept to include the hypothesis that the unsupervised use of computers could lead to accelerated learning of skills in children. This hypothesis was tested and confirmed in two experiments conducted in India in the village of Udang in the state of West Bengal (Zielenziger 1995) and New Delhi (Ahuja, Mitra, Kumar & Singh 1995).

The concept of *minimally invasive education (MIE)* flowed out of this work. 'MIE is a pedagogic method that uses the learning environment to generate an adequate level of motivation to induce learning in groups of children, with minimal, or no, intervention by a teacher' (Mitra 2003). MIE derives its name partly from the medical term *minimally invasive surgery* and is based on the belief that the acquisition of basic computing skills by any set of learners can be achieved through incidental learning, provided the learners are given access to a suitable computing facility, with entertaining and motivating content, and some minimal human guidance (Mitra 2000, Mitra & Rana 2001).

Prof. Mitra launched the *Hole in the Wall* experiment to test his hypothesis. He embedded a PC connected to a high-speed network connection in a concrete wall next to NIIT's headquarters in southern New Delhi. The wall separates the company's grounds from a local slum. Mitra simply left on the computer with its Internet connection, and allowed any passer-by to play with it. He monitored activity on the PC using a remote computer and a video camera mounted in a nearby tree. He discovered that the most avid users of the machine were ghetto kids aged 6 to 12, most of whom have only the most rudimentary education and little knowledge of English. Within days, the kids had taught themselves to draw on the computer and browse the Internet.

The experiment proved to be extremely successful and to date approximately 60 *Holes in the Wall* have been deployed in India with the intention of increasing this number to at least 100.

DIGITAL DOORWAY PROJECT

Given these results and the importance of such experiments to find the best, cheapest and most innovative methods of meeting the technological needs of developing countries and providing people with access to information in order to 'bridge the digital divide', the CSIR with our experience in ICT for development, together with the Department of Science and Technology (DST), believed South Africa would have similar success in employing a minimally invasive approach to technology literacy. We decided to replicate the experiment in South Africa, taking into consideration the unique demographic, social and cultural issues that make South Africa different from India. We selected our information kiosk as the platform, as it is resistant to the weather, theft and vandalism, and has been proven to work around South Africa.

Aims

The Digital Doorway project aims to introduce computer literacy into the ambit and experience of all South Africans through the implementation of MIE, to provide people in rural and disadvantaged areas with computer equipment, allowing them to experiment and learn without formal training and with minimal external input.

The initiative seeks to verify results in the South African context, of the research conducted in India by Prof. Mitra. Similar findings in South Africa could serve to inform policies and methodologies to introduce alternative mechanisms for computer literacy. They could also suggest other pathways towards building human capacity in support of the advancement of the information society in South Africa and its neighbouring countries.

Specific objects

The objectives of the project are to:

1. Test the viability of minimally invasive education as an alternative mechanism for large-scale computer literacy in South Africa.
2. Determine the efficiency of the Digital Doorway concept as a delivery mechanism for PC literacy as well as information and service delivery in South Africa.
3. Determine whether potential users in a rural community in South Africa will use a PC-based outdoor kiosk without any instruction.
4. Determine whether a PC-based kiosk can operate without supervision in an outdoor location in South Africa.
5. Provide a platform for the evaluation of appropriate technology solutions, open source, applications and human language technology.
6. Use the infrastructure established as a test bed for culturally sensitive computing, human computer interfaces and the role of human language in computer interaction.

Cwili Experiment

We started by identifying an appropriate community for the project, in consultation with the Department of Science and Technology, co-sponsors of the project. We selected the remote rural village of Cwili, situated near Kei Mouth in the Eastern Cape Province, South Africa. Cwili can be reached only by using a 4X4 vehicle over a difficult dirt road. The community has about 2600 inhabitants and unemployment is a serious problem. The main language used there is Xhosa, and the illiteracy rate is high. The village is underdeveloped socially, economically and technologically. At the start of the project, only four young adults in the community were able to use a computer, even for straightforward activities such as writing a letter. The schools reported no computer literacy among their learners and the level of computer awareness was very low.

Methodology

After selecting Cwili, we met with the community leaders to obtain their support. A key part of the Digital Doorway concept is keeping it readily accessible and available 24 hours per day. The most appropriate site was identified as being the veranda of the community hall, the first building encountered when entering the village. The hall is next to a clinic and a crèche, and is used by the community for meetings, social occasions, club gatherings and a small job-creation project (sewing garments).

We conducted a site inspection and using the information gathered, designed the kiosk and server, and identified and procured the required hardware and software. The kiosk was installed and commissioned in early November 2002 and was fully operational by 8 November 2002.

Prof. Denzil Russell, professor emeritus of adult education at the University of the Witwatersrand, who is based in Kei Mouth, was contracted to monitor and evaluate the project. Prof. Russell and Mr. Julius Phlepu, a community leader and the kiosk monitor, were given training to enable them to take basic corrective action (e.g. restart the machine) and retrieve observation data and pictures from the server. User activities were observed and captured using a CCTV camera, data capturing software and personal observation. The CSIR technical team provide follow-up support as required.

Configuration

The installation at Cwili consisted of a freestanding kiosk housing the multimedia PC to be used by the community, and a separate fileserver running the video and data capturing applications. Internet access is via a GPRS connection. A video camera is situated in the ceiling of the veranda to record activity at the kiosk, and activity on the PC is monitored from the server through data capturing software on the PC. The kiosk was built to withstand the rigors of continuous exposure to the elements.

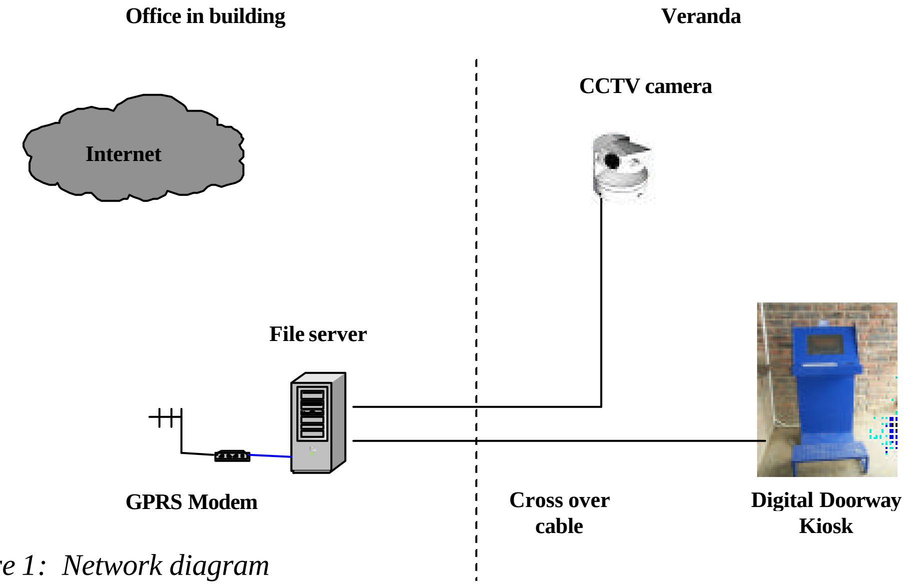

Figure 1: Network diagram

The kiosk consists of a 15" flat LCD monitor; locking mechanism; Intel Celeron 1700Mhz CPU; 20GB hard drive; onboard sound, VGA and LAN; 128MB RAM; 1.44 diskette drive; CD-ROM drive; vandal resistant keyboard and touchpad; PC USB web cam and a 600 VA UPS. The video server consists of a 1.8GHz Pentium 4 PC with 256MB Ram; 80GB hard drive; CD-writer; 1.44 diskette drive; network card and a four-channel DVR video capture card. Both PCs used the MS Windows operating system. Additional equipment includes a high-resolution colour dome camera; camera cable & power supply and a GPRS modem for Internet access. Figure 1 gives a diagrammatic representation of the network in Cwili.

Observations

Prof. Russell's observations of the kiosk utilisation started on 22 November 2003 and included informal interviews, analyses of computer captured data, group discussions with users and non-users and systematic debriefings of the kiosk monitor, Mr Phlepu, and others. His observations indicate that without any formal instruction, these underprivileged children succeeded in achieving a certain level of computer literacy. They were able to teach themselves and to obtain help from their colleagues when needed. Prof. Russell made the following observations:

- The kiosk is used almost continuously from as early as 4:15am to around midnight and even later.
- Group size varied: normally from four to twelve.
- There is always intense vocal activity, music and constant jostling for position.
- Random exploration was initially very prominent but this rapidly turned into confident, deliberate application.
- The seven to sixteen age group also acquired some general knowledge and English usage.
- Peer learning – about 60% of the township's children have already taught each other basic computer functions, including the ability to drag icons, re-arrange windows, open applications and access the Internet.
- Most of the programmes used are educational games. Also popular are writing letters, e-mail, Paint and Internet surfing.
- The seven to sixteen age group rapidly acquired the relevant touch pad computer skills.
- Estimated 8,300 user-visits in 3,3 months (regular user-visits 60%; occasional 40%).

- Age of users range from 7 to 56 (most users in the range of 10 to 19).
- Gender distribution about equal (but more girls are regular users).
- Although intimidated and 'possibly embarrassed' by the crowds of more knowledgeable children, older residents are using the computer at 'ridiculous hours' when the kiosk is free.
- The vast majority of users during daylight hours were school children. Young adults (20 to 30 years) tended to use the computer very early in the morning and in the evening.
- A small group of users found out how to keep the computer to themselves by using a piece of wire to switch it off through a concealed hole at the side of the kiosk leading to the power switch – Their thinking being that other users will get fed-up and leave if the kiosk keeps on 'resetting itself'.
- The children learned from each other as well as purely by trial and error and experimentation. The speed with which the basic skills were mastered was phenomenal and children were displaying confidence in using the computer within days of it being installed (Russell 2003).

These observations are markedly similar to those of Prof. Mitra in India (Mitra, 2000; Mitra & Rana, 2001). One area where our results differed is that in India, adults (both men and women) did not make any attempt to learn how to use the kiosk. Parents felt that they could not learn the operation of the kiosk nor did they see its need. However in Cwili, adults used the kiosk as well and they were very aware of its benefit to both themselves and their children. The way in which the child learned and taught themselves and others computer skills was also very similar to the MIE learning process Professors Mitra and Rana describe for the Indian Hole in the Wall experiment (Mitra *et al* 2001).

Kiosk usage

The number of kiosk user-visits (excluding substantial numbers of curious bystanders, those who appear to be just looking on, those dancing to the music and those simply milling around) has been conservatively estimated from very regular direct observation at the kiosk at non-scheduled times of the day and from computer-captured camera data. Prof. Russell reported the following user-visits to the kiosk, which should be viewed in relation to the total population of Cwili, approximately 2600 people. These figures refer to user-visits and not to individual users: the same individual may visit the kiosk several times a day, and each such visit is recorded as a separate user-visit.

Regular users accounted for about 60% of the user-visits while occasional users accounted for the remaining 40%. The rapid decline of user-visits in January 2003 can be attributed to the re-opening of the schools on 23 January 2003.

Learning gained

Following the installation of the Digital Doorway site in Cwili, a number of important lessons were learnt regarding hardware, software, connectivity, socialising and security that will inform subsequent installations:

Location – Locating the kiosk on the veranda of the community centre proved the correct decision as it succeeded in providing unrestricted access the machine. Concerns that the kiosk would be vandalised or stolen proved unfounded. The centre is on a dusty road, so a screen was constructed to protect the kiosk from dust and rain. Nevertheless, the kiosk was visible enough to passers-by, and

November (9 days only)	600 user-visits	(38% in am and 62% in pm)
December 2002	4000 user-visits	(37% in am and 63% in pm)
January 2003	2300 user-visits	(40% in am and 60% in pm)
February 2003	1400 user-visits	(31% in am and 69% in pm)
TOTAL NUMBER OF USER-VISITS		8,300 IN 3,3 MONTHS

the small enclosure is regularly packed to capacity. Both the screen and the kiosk were constructed securely and can withstand the constant use.

Kiosk – A vandal-proof keyboard and touch pad are prerequisites to prevent vandalism and withstand dust. Installing an extra layer of Plexiglas in front of the screen improved its protection. Mounting bolts in the base of the kiosk secured it to the concrete floor, preventing any attempts to remove it. The speakers inside the kiosk proved clumsy and could have been mounted against the sides of the kiosk, with perhaps an additional volume knob accessible from outside the kiosk. The reset switch, originally a hole in the side of the kiosk, has been changed to a key switch located under the keyboard.

Server – The server was used to capture and record video information from the security camera. It was valuable having the server handle the high processing power required to do video capture.

CCTV Camera – The CCTV camera capture worked well, but it was necessary to provide adequate illumination above the kiosk for video of night-time usage to be viewable. A useful feature to consider for the next installation is a zoom camera, controllable remotely, to allow the camera controller to zoom in on the screen to see which programs are being used.

Operating System – The Windows operating systems (XP and Windows 2000) used in the kiosk and server proved adequate but presented challenges that can be overcome with Unix based operating systems such as Linux and FreeBSD. In particular, the operating systems were expensive and could not easily perform server functions such as allowing remote access and control. For maintenance and monitoring purposes, FreeBSD or Linux would perform well.

Applications – The bulk of the content was aimed at children, and it was found that after a number of months the programs had become familiar and popularity declined. There is a need for continual updating of content for both children and adults. Quiz games where there was competition between children proved the most popular. The Internet and web-based e-mail also proved popular. No site-control software was used in the initial installation and this did not prove necessary, however in future it may be a good idea to install site control software to prevent unsavoury usage.

Server-kiosk connections – The crossover LAN cable between the kiosk and server performed adequately and allowed the kiosk to use the GPRS modem located on the server.

GPRS Modem – The GPRS link to the Internet performed well.

Remote Access – The GPRS link uses an IP address assigned by the mobile operator's network. Because this not a fixed IP address it makes it difficult to connect via IP to the server from a remote location. Attempts to use port forwarding proved only marginally successful, with the main problem being the manual intervention required by the software following a computer restart. The speed of the GPRS link was too slow to allow the download of the video content from the server to the CSIR.

Security – Five months after the installation the office housing the server was broken into and the server was stolen. The kiosk was reconfigured to be a standalone unit with the user PC, server, GPRS modem and UPS contained within the kiosk. With high bandwidth connections, live video could be streamed from the security camera to a remote site, which would improve security. There was no sign of attempts to break into the kiosk, although the touch pad and Perspex covering the screen were badly scratched.

SUMMARY

At this stage of the Digital Doorway project, no firm conclusion can be reached about the level and extent of computer literacy the people of Cwili now possess. Plans are in progress to conduct a test devised by NIIT to gauge the level of learning. According to Prof. Russell, one thing is certain and that is that all kiosk users, both children and adults, have moved from an initial state of complete computer illiteracy to a state where the computer is approached with great confidence and an awareness of some of its exciting multiple uses. Most of the users, and certainly all of the regular users, have acquired at least the computer literacy skills embedded in the playing of the most popular games they could access. They have taught themselves and each other basic computer functions. There can be no doubt that the users (who represent about 80% of the potential computer user population in Cwili) have voluntarily and by their own efforts acquired a most useful range of transferable computer literacy head-start skills.

CONCLUSION

ICT will continue to play an increasingly important role in education, unfortunately developing countries are missing out on many of the advantages afforded by ICT. This is largely due to the lack of facilities and teachers trained in ICT. Unsupervised learning, or in the words of Prof. Sugata Mitra, minimally invasive education (MIE), provides a mechanism to promote mass computer literacy in developing countries.

This project proved to be an interesting challenge. The team learnt a lot about the innovative use of technology, but even more about the social and cultural aspects that accompany the introduction of ICTs in rural South Africa. We also saw the difference access to information can make in peoples' lives.

It is imperative to repeat this experiment in other locations before we can generalise these observations or come to any conclusions regarding the appropriateness and benefits of MIE in the South African context.

While generalisations cannot be made based on a project of limited scope, the following observations and future action plans can be formulated from the above:

- It is possible to design a PC kiosk that can operate outdoors in the harsh environment of rural South Africa. It is important that the kiosk be protected against humidity, rain, dust and sand.
- Mechanisms to enable remote management and software maintenance must be designed and implemented.
- Several experiments need to be conducted in different areas to investigate whether self-learning will occur in different geographic and demographic areas.
- Experiments will also have to be designed to assess the efficacy of various educational applications and perhaps design learning material specifically to be used on the Digital Doorway

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