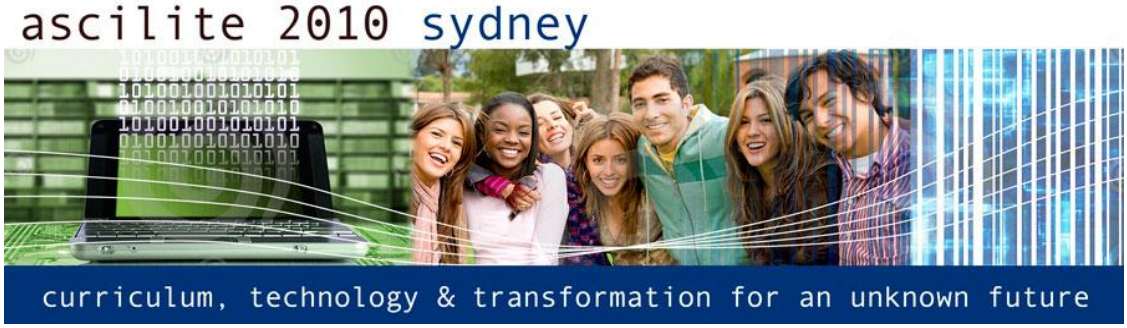

Building ICT literate human capital in the third world: A cost effective, environmentally friendly option

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Continually dropping prices of information and communications technology (ICT), and continually increasing ubiquitous ICT power, have created an environment where ICT literacy is vital for competing effectively in a globalised world. In the past, nations have developed through technologies that are expensive and environmentally destructive. However, ICT promises a new development model that is relatively inexpensive and environmentally friendly. This model provides a means for relatively poor third world nations to be able to compete effectively in a globalised world, without sacrificing their environment. A key tenet for such a model to work effectively is the establishing of ICT literate human capital, on a large scale, that is able to take full advantage of the opportunities provided by the ICT revolution. Hence, third world countries need to work on a cost effective model to promote large scale ICT literacy at the national level, in order to be able to run ICT based systems that will enable them to compete effectively in this ICT driven world. One solution is to open up large numbers of computer labs that will help to lift the ICT literacy levels nationwide, just as in the developed nations. However, the lack of funds and expertise in third world nations make this option, which involves environmentally unfriendly large scale construction, difficult. This paper suggests an environmentally friendly alternative that helps addresses both the financial constraints and the problems of limited expertise, particularly in the need to continuously upgrade ICT systems.

Keywords: human capital, information and communications technology, ICT literacy, third world nations

Introduction

The theory of technoeconomic paradigms (TEPs) maintains that various technological innovations drove growth of nations in the past, which has led to the developed nations of today (Daniels, 2005; Göransson and Söderberg, 2005). Such models had unintended consequences, including large scale pollution and destruction of the environment. However, an emerging green TEP provides a means to pursue growth minus the environmental destruction (Daniels, 2005). For third world nations, the advent of ICT compels attention to ICT literacy, because that lack of the ability to take full advantage of ICT will lead to poorer nations falling behind the developed nations in their ability to compete in a globalised world. Göransson (2005) mentions that when the poorer nations are not able to catch-up on the ICT knowledge, the gap between the incomes of poor and rich nations will widen.

A potential approach for improving ICT literacy is via establishing locations that house computers and the supporting technological infrastructure. For instance, such an approach is indicated in some case studies in Laos Göransson (2005). However, such an approach has the limitations of geographical reach (it becomes available to only a select number of people who are able to physically visit this location). Other issues include funding (this becomes relatively expensive from the perspective of cost per user). Moreover, large scale programs of this nature will require the building of large labs in the poor villages and environmentally pristine remote locations, which have a negative impact on the environment.

An alternative, but relatively little explored, approach to building ICT literacy in poor nations is also suggested in the literature. For instance, Samudhram (2000) describes the use of a refurbished school bus, equipped with the necessary computer equipment, which brought ICT literacy to children in the poorer districts in the USA. A similar program in Malaysia entailed the use of Mobile Internet Units, consisting of several busses that were outfitted as mobile computer labs, to provide ICT literacy to students in poorer locations (Zaitun and Crump, 2005).

Harris (2004) offers a theoretical framework for building ICT literate human capital in poorer communities. This paper expands the infrastructure aspect of this framework, and offers the perspective that the use of mobile computer labs (rather than fixed labs), equipped with free software such as Linux, enables a practical, cost effective solution for building much needed large scale ICT literacy in poorer nations. Furthermore, this solution is also environmentally friendly.

The rest of this paper is organized as follows. The next part discusses the emergence of various TEPs. This is followed by a discussion of the ICT framework for poverty eradication. The incorporation of a network of mobile computer labs is then discussed, together with a strategy for building the necessary teaching manpower and expertise in maintaining and continuously upgrading such labs. The final part concludes.

Technoeconomic paradigms

The technoeconomic paradigm views the economic growth in developed nations to have been propelled by innovations in technology that had the effect of increasing productivity over large swathes of the economy, which in turn generated wealth. There are several viewpoints regarding TEP, and Table 1 indicates some of these viewpoints. Freeman and Peréz (1988) consider that the emergence of industries related to cotton and iron drove economic growth in the late 1700s to early 1800s, coal and transport based activities propelled growth till the 1880s, while steel and oil, respectively, drove growth in the early and late 1990s and the microchip drove growth after 1990s. The other authors indicated in Table 1 concur with the idea that different technological innovations drove growth in different periods, but differ in the list of specific innovations that drove economic growth in various time periods.

Table 1: Technoeconomic paradigms in published literature[1]

Author (s)	TEP1 Period Innovation	TEP 2 Period Innovation	TEP 3 Period Innovation	TEP 4 Period Innovation	TEP 5 Period Innovation
Freeman and Peréz (1988)	1770s – 1830s Cotton, Iron	1840s – 1880s Coal, transport	1890s – 1930s Steel	1940s - 1990s Oil	1990s – Microchip

[1] Various authors have used different terms, such as TEP and long wave theory, to describe the concept of economic growth driven by innovations. In this study, TEP is employed as a synonym for the different terms.

Grubler and Nowotny (1990)	1770s – early 1800s Water power, canals, ships	Early 1800s to late 1800s Coal and steam power, railway, machines	Late 1800s to mid-1900s Roads, cars, chemical industry, metallurgy	Mid-1900s to late 1900s Electricity, oil, air transport, radio, TV, instruments	Late 1900s to mid-2000s Telecommunications, gas, nuclear power, information technology
Ayres (1988)	1770s to early 1800s Charcoal to coal	Early 1800s to mid-1800s Coal to steam	Mid 1800s to early 1900s Steel, illumination, telephones, machines, combustion engines	Early 1900s to mid-1900s Synthetic materials, electronics	Late 1900s – Convergence: computer and telecommunications

Although various proponents of the TEP theory (including those listed above) differ in the details, there are two points of concurrence, namely:

- Several waves of technological innovations have occurred
- Each was characterized by innovations with widespread applications.

Daniels (2005) summarized the perspectives of various TEP theorists (Table 2), and noted that ICT differs in remarkable ways from the innovations behind the earlier TEPs. He mentions that ICT is much more environmentally friendly, and thus offers a way to pursue economic growth in a manner that does not damage the environment. Indeed, compared with the infrastructures needed to support the previous innovations, including railroads, airports and huge factories that required large scale, environmentally damaging construction, it is possible to use ICT to promote growth with limited intrusion on the environment. Today, with the advent of wireless technologies and powerful battery operated systems, it is possible to run ICT systems for education, work and play, even in remote locations with limited power supply and wired infrastructures. As such, ICT based educational system specifically designed to uplift the ICT literacy of the human capital of poorer nations that have not yet acquired extensive infrastructures, is possible via mobile labs and strategic planning of teaching and ICT systems maintenance. Many nations, such as Qatar and Brunei, are establishing ICT literacy programs for their citizens, underscoring the importance of ICT today (Qatar, 2009).

Table 2: A summary of critical technologies and TEPs (Source: Daniels, 2005)

TEP 2	Coal, steam, factory establishments, company ownership (industrial revolution)
TEP 3	Steel, electricity, railways
TEP 4	Oil, petrochemicals, Fordist mass production methods (1930s – 1980s)
TEP 5	ICT, microelectronics, just-in-time and lead production methods since 1980s

ICT and eradication of poverty

ICT has been viewed as a system that is able to play an important role in the eradication of poverty (e.g. Harris, 2004; Göransson, 2005; Zaiton and Crump, 2005). Harris (2004) provides a framework for using ICT to fight poverty (Figure 1).

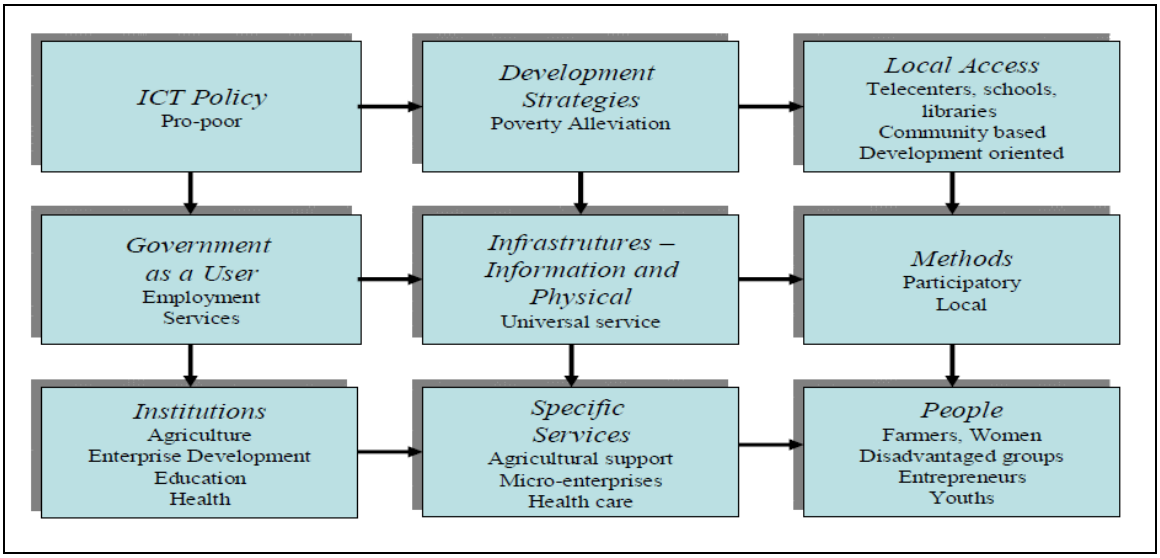

Figure 1: Using ICT to fight poverty – a framework by Harris (2004)

This framework envisages overall ICT policies that are specifically concerned with marshalling ICT to support the economically disadvantaged and uplift the poorer communities. Governments and key institutions could help in promoting the use of ICT. Various development strategies should include providing access to economically disadvantaged locals. In many cases, such access has been seen to involve the building of some infrastructure that can support ICT (e.g. Göransson, 2005; Zaiton and Crump, 2005). For instance, in Malaysia, ICT literacy was promoted by bussing large numbers of people from rural locations to centers in the city in the e-Melaka project (Zaiton and Crump, 2005).

In essence, ICT is seen as a means to combat poverty, and the ability to use ICT is regarded as an essential pre-condition to for this strategy to work in rural communities. This the building of ICT literacy is important for poverty eradication, where ICT literacy is defined as the skills and abilities that will enable the use of computers and related information technologies to meet personal, educational and labour market goals, following Lowe and McAuley (2000). Nevertheless the solutions using fixed locations to promote literacy, particularly to rural constituents in remote locations, have several limitations.

One of these is that of transporting large numbers of people, a number of whom may need to spend more hours travelling than productively working on their ICT literacy. Another is that staff needed to maintain the ICT systems will need to be dispersed to the different learning labs, and again travelling to the different labs for maintenance and upgrading exercises would take up a lot of unproductive time. In situations where such expertise is limited, the need for limited staff to have to travel to the different locations for trouble shooting and upgrading will result in bottle necks whenever maintenance problems arise, creating downtime that reduces the productivity of the systems.

The alternative of creating and deploying mobile labs overcomes these problems.

An alternative: Mobile labs

The idea of employing mobile labs is not new; such labs have been used to promote ICT literacy in economically disadvantaged locations in the US and Malaysia, with supporting funding from the UNDP in the latter (e.g. Samudhram, 2000; Zaiton and Crump, 2005). However, this alternative has not been viewed and studied within a larger strategic framework as a viable option for providing access to large portions of the remotely located rural populations, who need such support the most, to combat poverty. Moreover,

there has been little exploration of this alternative in providing additional support for fulfilling the ICT needs of employers and businesses in economically challenged areas that could benefit from the vast productivity options that ICT offers. This option, when employed strategically, is also able to address the problems of limited expertise in maintaining and upgrading ICT systems in third world nations and the lack of manpower for teaching ICT literacy. These advantages are explored below.

Providing access to ICT for education and business

The deployment of mobile labs, which are essentially busses fitted with computer equipment and learning facilities, results in a nimble and scalable solution for promoting ICT literacy. These buses may be driven to schools, town halls, and other locations on certain days (e.g. location 1 every Monday, location 2 every Tuesday, and so on), where school children and adults may use the facilities to improve their ICT literacy. Furthermore, features such as e-mail options may be used for work and business purposes. This option transports ICT access to the rural population. In contrast to getting this rural population to travel to ICT centres, this option reduces the time wasted in travelling and allows the rural constituents to use time more productively in employing ICT for their education, employment and business needs.

Overcoming shortage of ICT expertise in maintenance, trouble shooting and upgrading

ICT based systems need experts for maintenance, trouble shooting and upgrading over time. When a large number of fixed locations are built in nation that has limited expertise, the limited manpower will need to spend enormous amounts of time travelling to these locations for solving the issues that arise. This will create a bottleneck in the service and many centres may end up with computer systems that may not be in the best working condition. When mobile labs are deployed, however, the mobile labs can be driven by any licensed driver to an ICT centre where the computers can be maintained and upgraded by experts, before they are sent off to the different rural locations. As such, the limited ICT expertise could be located at this centre to trouble shoot the systems in the labs, and time wasted by the ICT experts in travelling to different locations would be eliminated.

Building manpower for teaching ICT

The mobile labs could be strategically used to first build a pool of ICT teachers and trainers, who would then teach the rest of the population. The labs could be driven to selected rural centres on certain days to conduct the "train the trainer" program. Once a sustainable pool of such trainers have been built up, these trainers can then conduct further training for others, creating a large pool of well trained manpower that can effectively spread ICT literacy to the rest of the population.

Strategic planning – some proposals

This paper proposes the idea that third world nations may develop a cost effective, environmentally friendly, comprehensive and complete ICT literacy program that, when well planned, be sufficient to provide opportunities for providing relevant ICT literacy for every citizen. Such planning, based on mobile ICT labs, will be able to address the issues of limited ICT based manpower for both teaching and systems maintenance. Moreover, cost issues can be addressed by exploring free software such as Linus for running the systems.

An underlying theme that can be exploited in these strategies is recycling used equipment and machinery, which would provide help in waste reduction.

Deployment of mobile labs

In essence, mobile labs are vehicles such as buses that are equipped with ICT facilities for education, jobs and business use. It is possible to refurbish second hand busses in cash strapped third world nations for this purpose. Furthermore, it also possible to utilise used computers, that are presently thrown away. These computers should be upgraded with software that simply does the basic functions such as word processing, spreadsheets and e-mailing, which is sufficient for teaching ICT literacy and addressing basic business

needs. Such a strategy cuts costs while providing the core services required for building ICT literacy. Moreover, partnerships with private businesses and funding from international agencies, such as the UNDP, may be sought for the development of the ICT literate human capital base.

National level ICT policies and programs

These initiatives will need to be supported by a national level ICT literacy program that takes a long-term view. Such a policy will need to identify all the locations in the nation that do not have ICT facilities, and then commence with planning for mobile ICT labs in sufficient numbers to provide ICT training and access at all of these locations. In essence, this strategy will require the following considerations:

- Listing the areas that need general ICT training and access
- Establishing centres of ICT service that will house the ICT experts for trouble shooting and upgrading the mobile labs on an ongoing basis. Such centres would also help in customising software for local needs, such as translating the software to the local language.
- Building mobile labs, using second hand material wherever possible and free software such as Linus to contain costs
- Creating a "train the trainer" system, whereby a pool of trainers/teachers will be established at the remote locations to man the labs and deliver the ICT literacy programmes
- Create a timetable that will allocate the mobile labs to different areas at different times, so limited the resources are efficiently deployed to provide every citizen the opportunities for at least basic ICT literacy, that can help them to take advantage of important ICT based options such as e-mails.

Costs, controls and assessment

A key idea in the deployment is that costs are controlled via different means, such as using refurbished material, training local users and establishing trainers within each community rather than hiring expensive labour for this purpose. An added advantage of this strategy is that small businesses would be able to use ICT to effectively communicate with various stakeholders, including suppliers and customers, to take advantage of the productivity that ICT offers.

The effectiveness of this strategy in improving ICT literacy, ICT use and access cannot be meaningfully measures in general terms that are used today, such as numbers of personal computers per unit of population or numbers of internet connections per person, since these facilities are now shared amongst the populations. Rather, new measures will need to be explored and worked out. This includes, at a very basic level, the numbers of users utilising the mobile labs per location, the percentage of the target population (i.e. those without proper ICT training and access) that are using the mobile facilities, and the numbers of educational, job related and business users. A nominal fee may also be charged for businesses, which would be willing to pay as long as the costs exceed the benefits. The revenue from such fees would also be a good indicator the effectiveness of the mobile labs.

Future research

Further research in this area could consist of computing the costs of providing creating mobile labs and setting up the ICT centres, as well as the costs of providing the ICT access and training to various remote locations. Pilot studies may also be conducted by private organisations and centres of higher learning to explore the effectiveness of large scale deployment of mobile labs in poor constituencies. Further work is also needed in generating the unique measures that will indicate the effectiveness of this strategy in serving the ICT based educational, job related and business needs of the poorer communities.

Conclusions

The latest TEP is based on exploiting ICT to promote economic development. ICT offers many opportunities for developing nations to compete on the global stage. However, the lack of ICT literacy and access constitutes a setback, where developing nations lose out to developed nations in productivity and

competitiveness. It is important for developing nations to consider key strategies to uplift the ICT literacy of the populations, and also provide inexpensive access to ICT so the nations can take advantage of ICT to improve their overall productivity.

This paper offers the idea that strategically built and deployed mobile ICT labs are able to offer a cost effective, practical and environmentally friendly solution to the needs of economically disadvantaged populations. It suggests further research in cost benefits analyses, pilot tests and metrics to measure the effectiveness of the strategy.

In essence, a carefully crafted national level ICT literacy strategy will be able to build a pool of ICT savvy human capital in developing nations that will be able to take full advantage of cutting edge ICT. These skills will help the nation to compete effectively in a globalised world, without being left behind in a fast moving technological environment.

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