A Report Card for One Laptop Per Child

Closing the Digital Divide via ICTs and Education:

Successes and Failures

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Introduction

Information communication technologies (ICTs) have become increasingly important factors contributing towards the growth of national economic systems. Developed, industrialized countries have integrated ICTs into their complex economic systems both vertically and horizontally. When viewed as a whole, these nations have experienced continuous and expansive economic growth in the global marketplace over the past twenty years. However, developing nations with more immediate economic priorities than spending scarce funds on ICTs and ICT infrastructure have been unable to adopt and integrate ICTs to the same degree as developed nations during the same period. As a result, a noteworthy ICT and macroeconomic disparity has developed between richer and poorer nations, commonly known as the digital divide. Development advocates maintain that mitigating the digital divide is an important component of larger more holistic development initiatives. Incorporating ICTs into educational development is an effective way to bridge the growing gap between developed and developing nations by stimulating human capital development. In a world which has become increasingly complex and integrated, a more globalized economy based upon the transfer and retention of tacit knowledge has begun to develop. Because this knowledge-based global economy is increasingly dependent on skilled individuals using ICTs rather than exploiting natural resources, learning how to apply these technologies in an academic setting will encourage students to utilize ICTs in meaningful and academically enriching ways.

A new, high-profile development project focusing on integrating information technologies in education is the One Laptop per Child (OLPC) program. The OLPC Foundation, headed by Nicholas Negroponte of MIT's Media Lab, is developing a low-cost educational laptop provided to children through schools in developing countries. The laptop, with a target

price of $100 USD, requires a minimum order of one million units per country to enable the laptop's producers to take advantage of economies of scale in component production. Once the children possess the laptops, OLPC project leaders maintain that they will enable the students to facilitate their own educational development. Based on constructivist models of educational development, the laptops will allow the students to "learn how to learn".

Unlike educational development projects that encourage locally-driven solutions requiring the input and collaboration of educators such as the Global Learning Portal (GLP), the OLPC project is driven by top-down policies required by their manufacturing economies of scale. Simultaneously, the OLPC Foundation questions the importance of both the bottom-up practices that bring about sustained, transformative development as well as the standard processes of diffusion through early adopters and their mediation of new technologies through local networks. Development theory tends to emphasize the importance of both the local ownership of projects and content from the start. The recipient community should be involved in assessing needs, planning, and executing a development project to engender long-term sustainability of use. Ultimately, the larger and more uniform an approach is (cost-effective cookie-cutter strategies), the less likely it will be in successfully changing social infrastructures and local institutions thereby achieving long-term transformational development. A balance between generalized best practices and taking advantage of local knowledge and context must be achieved by all development projects. The OLPC push model of development seems to exemplify the one-size-fits-all strategy that contradicts more effective grassroots development approaches, which seek to pull both mission and content from the local community.

The OLPC project is a bold attempt to bridge the digital divide with its stated goal "to ensure that every school-aged child in the lesser-developed parts of the world owns their own

personal laptop that they can use to learn and to learn about learning" (OLPC, 2007). Using the nuanced digital inequality approach of Hargittai, Warschauer and other noted scholars in the field, this paper compares the OLPC model to other centralized digital divide educational initiatives such as the GLP, as well as more decentralized and grassroots projects. We offer alternative policy recommendations for the governments of developing nations based upon the unique differences of the OLPC project in comparison to other holistic digital divide mitigation efforts.

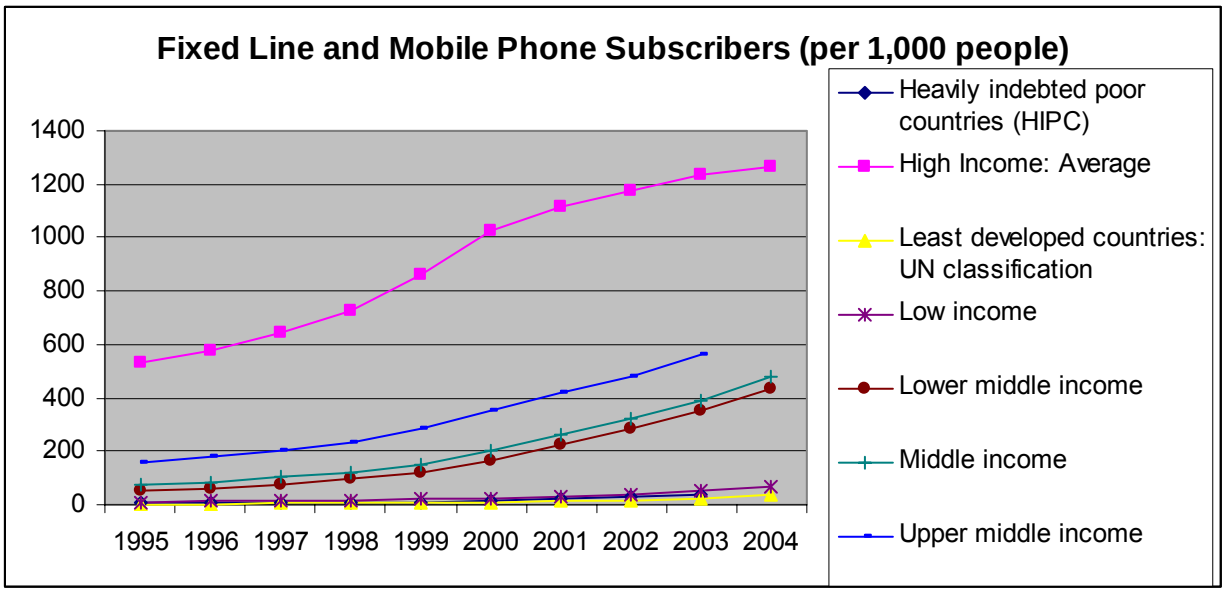
Digital Divide and Digital Inequality

Before analyzing the OLPC program and comparing it with other ICT initiatives, it is important to understand the developmental issues all of these programs aim to resolve. While these programs address multiple socioeconomic problems, they most broadly mitigate the digital divide. Much has been written about the characteristics and issues stemming from the digital divide over the past decade. In general, “The term ‘digital divide’ is most frequently used to describe unequal ICT access patterns across nations” (Fink and Kenny, 2003). However, this phenomenon is not only witnessed between rich and poor nations. The digital divide also encompasses unequal ICT access patterns within countries, such as the divide between rich and poor, or urban and rural citizens (Fink and Kenny, 2003).

Many important social, technological, and economic metrics characterize the international digital divide. At the most basic level, the digital divide describes the gap between developing and developed countries in ICT access; the ability to use ICTs; the amount of ICT usage; and the economic impact of ICTs (Fink and Kenny, 2003). Mark Warschauer, an expert in the role of education to limit the digital divide, expands on this idea stating digital inequality encompasses five main variables: technical means (inequality of bandwidth); autonomy (whether

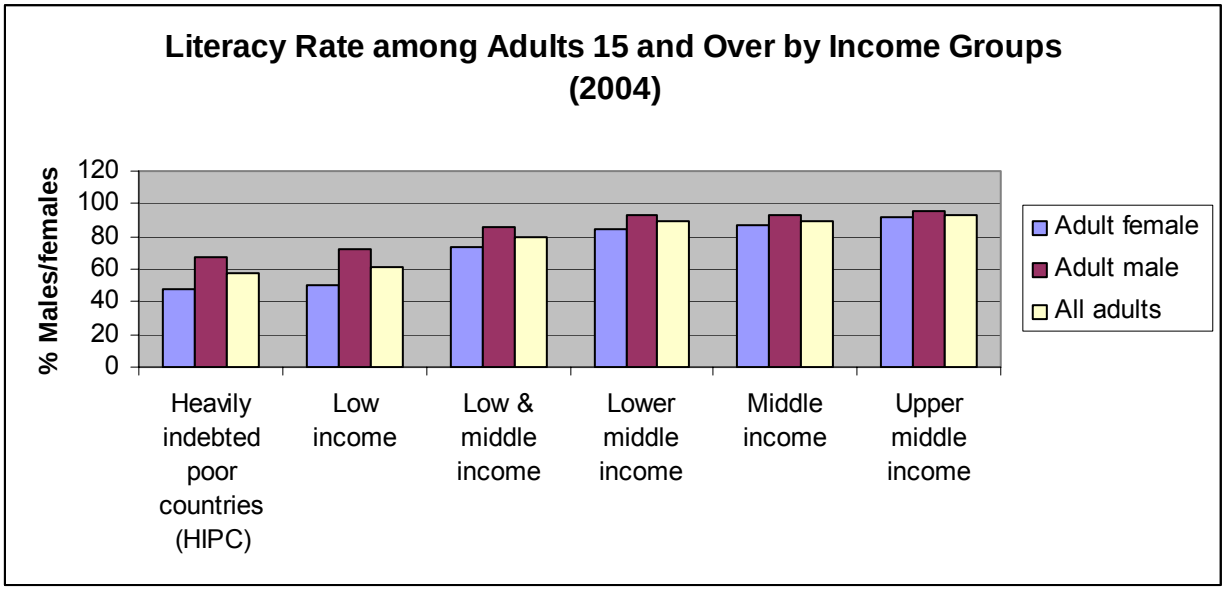
users log on from home or at work, monitored or unmonitored, during limited times or at will); skill (knowledge of how to search for or download information); social support (access to advice from more experienced users); and purpose (whether they use the Internet for increase of economic productivity, improvement of social capital, or consumption and entertainment) (Warschauer, 2003). There is a wealth of data demonstrating the striking gap between developing countries and more developed nations in terms of ICT equipment and users. The graphs below and in Appendix A highlight only a few of the many important metrics scholars utilize when quantifying the digital divide.

The following graph demonstrates the disparity in ICT access. There are a number of indicators for this variable including Internet hosts, number of mobile telephones. This particular graph shows the number of fixed and mobile phone subscribers per 1,000. The country groups in this graph, and all other graphs, are separated by income group. Wealthier nations have a more robust telecommunications infrastructure than developing nations.

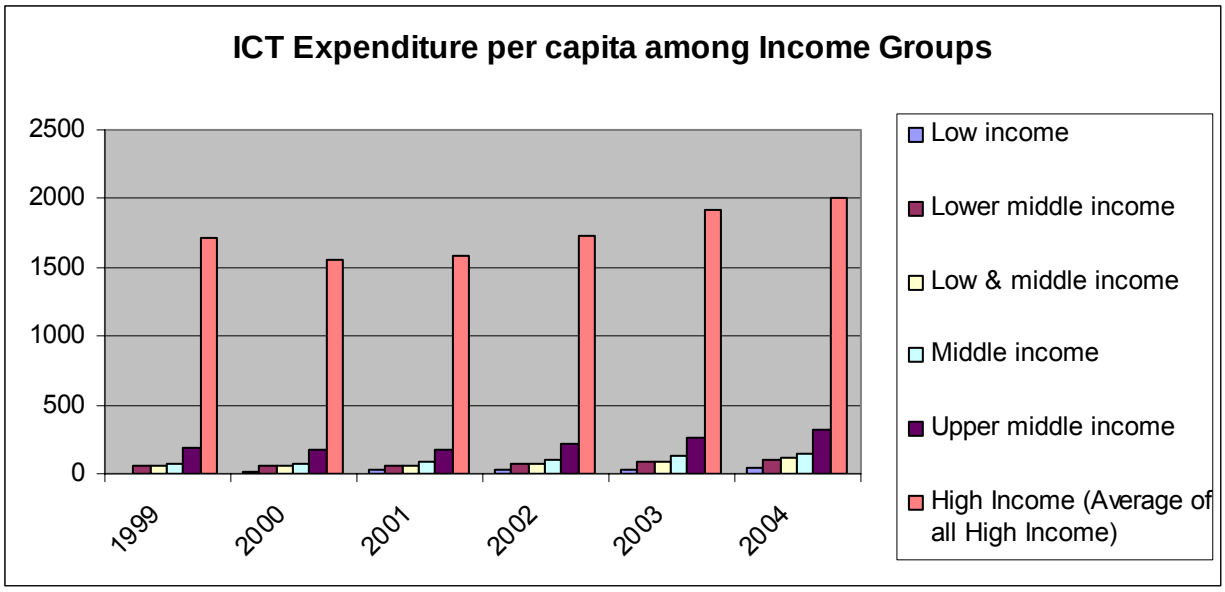


Source: World Bank Development Indicators

The graphs below demonstrate the gap among countries in their ability to use ICTs. Effectively using ICTs such as the Internet requires high rates of literacy. The graph below illustrates how the most impoverished countries have lower literacy rates than wealthier nations. In the following graph, ICT expenditure per capita is referenced as a rough metric to gauge the resources countries allocate towards ICT development.

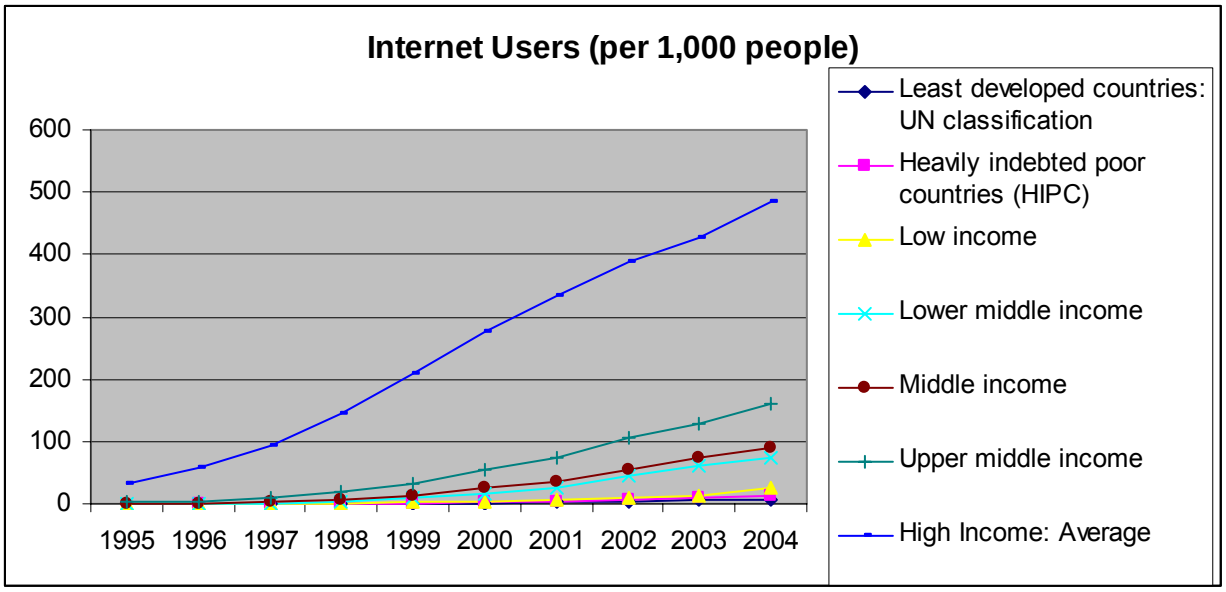


Source: World Bank Development Indicators



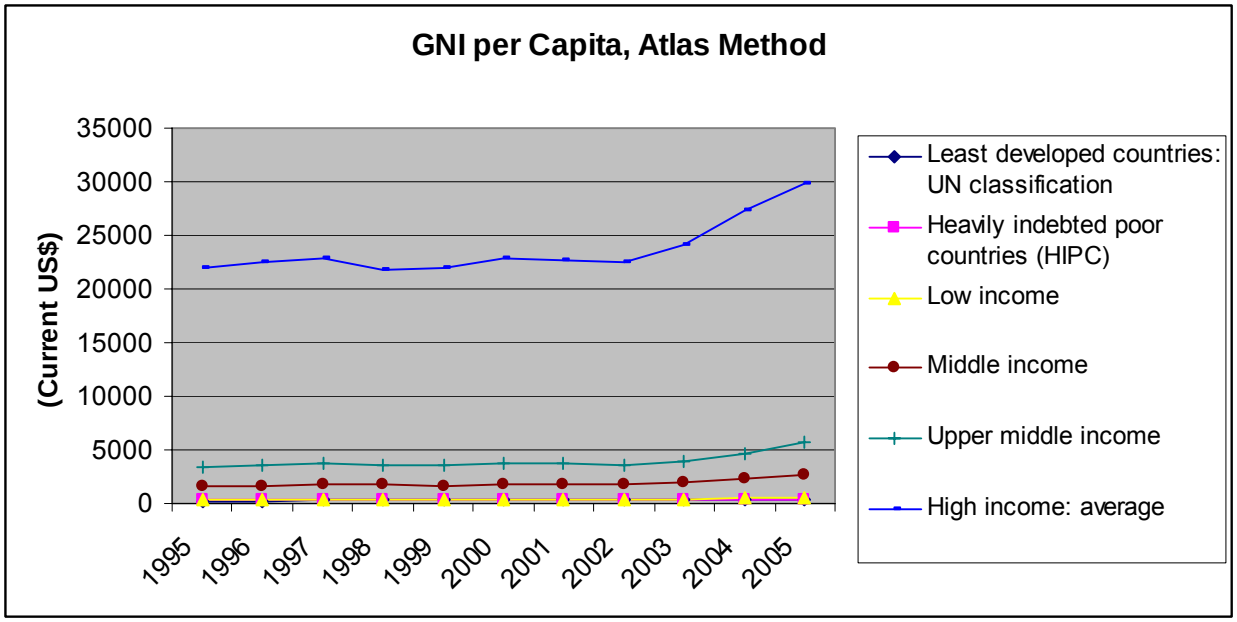
Source: World Bank Development Indicators

The following graph highlights the difference in actual ICT use time among countries and regions. The primary metrics to quantify this aspect of the digital divide include the number and time online of users, and the number of personal computers.



Source: World Bank Development Indicators

Ultimately, it is the gap in the economic impact that characterizes the international digital divide. Most commonly, this is measured by the financial and economic returns, such as gross domestic product (GDP), gross national income (GNI), and GNI per capita.



Source: World Bank Development Indicators

The preceding graphs clearly illustrate how developing countries lag significantly behind developed countries in several technological and economic categories. These statistical revelations coupled with the disparate macroeconomic indicators such as GNI and GNI per capita between developing and developed countries have convinced scholars that minimizing the technical divide will consequently minimize the economic divide that exists between these groups of nations. The growing digital divide is an alarming trend because, according to digital divide scholars, ICT access and usage drives innovation and economic growth. Yochai Benkler notes, "The availability of free information resources makes participating in the economy less dependent on surmounting access barriers to financing and social-transactional networks that made working out of poverty difficult in industrial economies" (Benkler, 2006). While it is still not entirely clear whether digital equality translates to greater socioeconomic equality, many advocates of mitigating the digital divide have "successfully created the public perception that

access to computers and computing skills is a new necessity for the Information Age" (Light, 2001).

Many economists recognize the importance of ICTs and innovation in promoting economic growth and development. The theories behind technological innovation driving economic growth are as varied as the technologies themselves. However, most economists cite the rapid economic growth of developed countries during the latter half of the twentieth century as evidence that such a relationship exists. Rosenberg recognizes this idea noting that many observers believe the growth of Western technology and economic growth have expanded in roughly the same geometric pattern (Rosenberg and Birdzell, 1986). As a result, many economists increasingly draw on the economic theories of Joseph Schumpeter to explain this growth rather than the classical market-oriented approach championed by Adam Smith. In the typical Adam Smith economy, decentralized market economies primarily drive wealth creation, provided that the distribution of wealth in society is satisfactory (Delong and Summers, 2001). This is largely the case because goods are excludable, meaning only one entity can use a good at any given time given the establishment of clearly defined property rights. While previous economic growth theories are still valid, the correlation between technology and economic growth cannot be ignored based on the economic success of countries that produce knowledge and develop practical technological innovations.

In the innovation-based Schumpeterian economy, named after 20th Century Austrian economist Joseph Schumpeter, "Growth is primarily driven by a sequence of quality-improving innovations each of which destroys the rents generated by previous innovations" (Aghion, 2002). This causal loop pattern of innovation, destruction, and re-innovation is often called creative destruction. While this paper cannot fully describe Schumpeter's canon of economic theories, or

the bevy of new growth theory economic models, it is only necessary to understand that innovation is widely recognized as a principle source of wealth and prosperity for many nations. Foundational to the success of innovation-based economy is human capital development. The ability to understand advanced concepts in disciplines such as science, engineering, and mathematics are fundamental in understanding technological innovations, and then adapting them to fulfill other practical needs or functions. As nations create the needed infrastructure to promote economic growth through innovation rather than natural resource exploitation, education and ICT-based education become critical elements towards long-term economic development.

It is the hope of developing countries that adopting and innovating ICTs will facilitate their success in the global information economy as it has for developed countries. This idea is reinforced by Yochai Benkler stating, "Information, knowledge, and information-rich goods and tools play a significant role in economic opportunity and human development." (Benkler, 2006, pp. 14). However, simply expanding ICT usage within outdated or ineffective education systems to reach more students will not translate to growth in the knowledge economy particularly for developing countries. In Nelson's examination of the United States' development into a technological leader after World War II, he acknowledges this idea. He posits "the effectiveness with which that training is integrated into the process of improving the technology of operating firms" will promote the linkages among education, innovation, and economic growth (Nelson, 1992). It is therefore critical to understand how education can promote ICTs among students at all levels, and how the integration of ICTs into educational infrastructure can improve students' educational development. Ultimately, a development project's ability to fulfill both requirements will significantly magnify its positive long-term affect.

Education, ICTs and Current Approaches to Development

The success of development programs among developing countries often depends on their ability to utilize scientific and technological knowledge that is already available. Often, developing countries cannot adopt technologies created abroad because they do not suit the new conditions particularly well (Boas, Dunning, and Bussell, 2005). Since this technology transfer drives economic growth, it is reasonable to assume that human capital cultivation with a focus on ICTs will become increasingly prevalent among development initiatives. Therefore, development initiatives should maintain an educational focus that prepares the human capital to deal with such transfers. Improving primary, secondary, and eventually higher level education is fundamental to increasing economic opportunities and human development, by facilitating technology transfer and innovation in the long-term. For successful realization of technology transfer, "it seems that development tools imported from abroad need to be adapted to be most effective in countries of the South. At best, they may be designed from the ground up to suit local conditions" (Boas, Dunning, and Bussell, 2005). Having trained and capable workers that can understand foreign technology and manipulate it in a practical way is an important reason for developing countries to invest in education and ICT literacy.

Access to educational opportunities is not only important for adopting and adapting ICTs to promote economic growth, but ICTs can also improve the quality of education a country provides. Theoretically, Warschauer notes many similarities between traditional literacy and ICT literacy. Both share many important characteristics in the process of human capital development, which is paramount in succeeding in the knowledge economy. Both literacy and ICT access are essential to human communication and knowledge production. Furthermore, "Literacy acquisition obviously requires the development of a variety of skills, knowledge, and

attitude, including cognitive processing skills; background knowledge about the world; and the motivation, desire, and confidence to read – and this has important parallels to the kind of skills, knowledge, and attitudes necessary to make meaningful use of ICT" (Warschauer, 2002). In addition to important pedagogical ties, ICT initiatives in education typically emphasize the provision of technology resources to both teachers and students. Currently, several international programs such as the World Links program and the Global Learning Portal instruct teachers in ICTs competency and encourage them to use them in their own classrooms. Otherwise, most programs encourage placing Internet-enabled computers in schools and learning centers to allow specialized learning opportunities. In the future, it is feasible that ICTs will foster global educational opportunities. For example, Pippa Norris, a noted digital divide scholar portends that increased Internet access can, "widen access to training and education" particularly through distance learning programs (2000). Ultimately, ICTs can potentially expand and improve educational opportunities for developing countries seeking entrance into the global knowledge economy.

While the interplay of ICTs in education seems primordial to international development, integrating ICTs into deeply-entrenched educational systems is no easy task. As we learn more about the nature and impact of the digital divide, development experts will continue to develop more comprehensive and holistic approaches for mitigating the digital divide. The aforementioned digital divide metrics are practical indices for describing this phenomenon, however, "It is important to consider more than mere access to the network when studying the differential spread of the Internet across the population and inequities in people's use of the medium" (Hargittai, 2002). Technologies are distinctly intertwined with the societies that use them. "Their array of interactions with different people, organizations, institutions, and cultures

– such as individual teachers, schools, or academic subjects – makes it difficult for any particular technology to have uniform or even entirely predictable effects (Light, 2001). Introducing new technologies among developing nations must consider their particular social context, designed to address specific socio-economic issues, particularly when integrating them into established educational systems. As Boas, Dunning and Russell conclude, "Ultimately, whether the Digital Revolution implies a revolution in development will depend in a number of factors [including] the degree to which new technological applications can be customized to thrive in local conditions, and, above all, the relative strength of organized interests favoring different ways of organizing and governing the global political economy" (2005).

Education and the Digital Divide

Throughout the most recent decade of American public education, there has been an increasing emphasis placed upon the usage of so-called "enabling technologies". Mainstream educational theory dictates that these technologies may assist children in the learning of complex concepts as well as helping them develop critical thinking and problem solving techniques (Cuban, 1986). Technologies ranging from the simple pocket calculator to the Internet-enabled personal computer are quickly becoming as ubiquitous in the classroom as are the pen and paper. Looking at currently emerging national education policies, a clear mandate to increase the role technology has to play in the classroom becomes apparent (AETI, 2003). As such, many of our foreign policies geared towards assisting in the educational progress of developing countries have also taken on a decidedly technocratic tone.

This is all based around the premise that children with greater access to advanced technologies such as computers and the Internet will have a better chance of succeeding as adults in the emerging information economy. However, as the premise is extended to an international

student population, some with little to no access to basic utilities such as clean water and electricity, many of the common practices in the United States used to help bridge the digital divide fall short. A lack of community resources is not the only issue that affects technology-enabled education in developing countries however. Even in the United States, the issues of acceptance and adoption have proven to be difficult hurdles to overcome.

The introduction of new technologies even as seemingly ubiquitous today as adding machines and pocket calculators originally met with a great deal of resistance. There was a feeling of discomfort with the idea of moving away from pencil and paper amongst the mathematics community, and especially amongst educators. Even at this early stage, there was the notion that such technologies might produce students who were incapable of performing the work without assistance. At the same time though, these new technologies were strongly supported by technologists and school administrators (Postman, 1993). This type of battle between the 'old guard' in an educational discipline and the policy makers at the state and national levels is a recurring theme in American educational technology policy development.

It must be noted that these technological changes occurred within the United States over a longer period of time than is often expected in judging the success of an international development program. Personal computers are still far from standard equipment in more rural American school districts many years after their introduction into the school system, and many more since their introduction into the mainstream commercial marketplace. Educational market uptake has occurred over decades and with varying levels of resistance from educators and administrators (ED, 2007). With the time required for user acceptance being an unknown variable in many regions throughout the developing world, the metrics for the success of a technology-centric educational development program remain unclear.

While the merits and failures of enabling technology usage in the classroom are still debated, the developed world has also begun to export these technologies abroad for usage in foreign aid projects and domestic education programs within developing countries to varying levels of measurable success.

GLP Technology and Application

One such project is the Global Learning Portal (GLP), a project which is managed by the private non-profit organization Academy for Educational Development (AED). Beginning in 2001 and funded in part by the U.S. Agency for International Development (USAID), the GLP was launched with the mission of providing a connection for teachers and educational administrators around the world to collaborate and share educational materials. This learning community has also drawn upon resources from industry, garnering support from the likes of Sun Microsystems, which provides free customized copies of its productivity suite, Star Office for the GLP.

While this system of teaching and administrative collaboration may not seem to benefit children as directly as a project like OLPC, the GLP has its roots in the foundations of the digital divide. GLP Director of Technology, Bruce Geisert, has noted that the issue of educational infrastructure is gets at the very core of bridging the digital divide. As such, many educational theorists have begun to examine educational development as something which must be built from the ground up, rather than from the top down. Even the modern American educational system would falter without the consensus and planning developed by its relatively closely-knit network of teachers and administrators. The GLP is currently being used in collaborative activities to develop such an infrastructure in nations such as Afghanistan, Brazil, Egypt, Kenya, Mexico, and the Philippines.

However, even within a program which has received support from governments both foreign and domestic as well as both commercial and non-profit organizations, the metrics for success and failure are hard to come by. While it is easy enough to use the U.S. or other countries in the developed world as an example by which to compare the progress of developing countries, this comparison may be odious in nature. American students and teachers will undoubtedly have differing goals and priorities from their counterparts in the developing world. As such, the most common metric currently used to measure success within the GLP is the development of localized standards which an individual nation or community may agree upon (Geisert, 2007 - pending confirmation of ability to publish). Here, the issues of acceptance and adoption are at least partially mitigated by utilizing this bottom-up demand-driven method of educational development. Different countries have developed varying degrees and ways of using the GLP, ranging from actually having 240 teachers trained online in the Philippines to a simple online repository of educational policy documents shared by the U.S. and Mexico as part of the broader Training, Internships, Exchanges, and Scholarships (TIES) program (GLP, 2007). These programs show that the GLP has shown at least some ability to generate new success metrics based upon increasing the level of market acceptance for educational technologies by not only providing computers and the training to use them, but also by looking at localized areas and coming in to help solve some of the specific problems teachers and administrators face. As such, while USAID funding for the GLP project is set to expire in 2011 (USAID, 2007), there can be a good deal of hope that funding for the project will continue.

With a financial future that seems to be relatively secure, the GLP is poised to become an international educational ICT development program that can utilize longer-term metrics of success. These metrics include analyzing trends in literacy rates, and basic math skills within a

local region. Other metrics include the analysis of ICT aptitude amongst that population's workforce, and eventually observing the potential increases or decreases in overall economic productivity. Even though these are the some of the most effective metrics currently available by many standards, educators and policy-makers alike will be unable to analyze them in the short-term due to the lengthy time commitment all of these metrics require to be of any use. Creating metrics like these in conjunction with the rapid turnover rate in cutting-edge and less-expensive would enhance future projects within this field. If international development efforts such as the GLP, and demand-driven grassroots programs like Grameen Phone and Gyandoot kiosks can continue to produce areas of sustainable and verifiable development through pilot projects, these important metrics would become invaluable tools for those involved in the development of future projects.

Other Edu-Tech Development Projects

As with GLP's own funding from the U.S. Agency for International Development (USAID), other multi-national organizations have tried to bridge the digital divide with varying levels of success. In September of 2002, the United Nations Educational, Scientific and Cultural Organization (UNESCO) outlined its own strategy to "combat the digital divide" (UNESCO, 2002). Specifically, UNESCO realized that "enormous and growing inequalities between rich and poor nations in access to the new information technologies (ICTs)" were developing. This led them to establish a set of common principles, which UNESCO believed would be a strong model for the emerging knowledge-based economy (UNESCO, 2002). These primary guidelines for UNESCO's idea of an inclusive, powerful, and grassroots-based information society were spelled out as "Freedom of expression and its corollary, freedom of the press; free, compulsory and universal primary education; the recognition that education as well as cultural goods and

services cannot be treated as mere commodities; the pre-eminence of public policy, and; the promotion of public domain information and public service broadcasting (UNESCO, 2002). However, since education was ostensibly a major focus of this program, several other operating principles were developed for educational ICTs alone: that computer literacy should be recognized as a basic skill in educational systems; that free access to the Internet should be provided to all U.S. citizens in both schools and public libraries; and that in future projects, full advantage should be taken of the technologies improving the effectiveness of distance education, as well as other innumerable life-long learning opportunities offered by the application of ICTs to education and development (UNESCO, 2002).

However, as with some other international initiatives directed specifically at improving the access of students and teachers to ICTs, UNESCO's program seemed to have very broad goals without the requisite specific technologies in place such as relatively inexpensive personal computers (PCs) and equally accessible high-speed Internet bandwidth. However, we were able to find one way in which UNESCO was able to apply this strategy to a specific project, within the country of Lebanon in April 2004 (UNESCO, 2004). UNESCO Beirut is the official headquarters of the UNESCO program that utilizes some of the policy goals outlined in its strategy to "combat the digital divide". This program distributed 134 refurbished (older-model) PCs, gathered in cooperation with the Safadi Foundation, to 21 schools in a northern region of Lebanon. Teacher training was also a highlighted component of this program, influenced by programs that had utilized this tactic with some success. However, this program was still implemented with the top-down strategies envisioned within those original guidelines provided by UNESCO headquarters in Paris, France.

While successful in limited engagements, the UNESCO program and other similar international efforts may not provide a proper framework for education-oriented ICT development. Demand-driven, locally-generated projects such as those previously discussed, provide more relevant content produced dynamically by the community members, producing more sustainable results. The GLP bridges the gap between these locally-generated projects and international efforts, through facilitating content production by its community members.

The One Laptop Per Child Project

In contrast to the aforementioned locally-driven projects, the OLPC Foundation adopts a supply-side approach, wherein governments must make large purchases of laptop computers for distribution to their students. The OLPC Foundation posits that computers are valuable enabling tools to explore the world, and that individually-allocated laptops encourage this by providing a sense of ownership. This technocratic educational paradigm, with its established foundations in constructivist theory, sees laptops in the same light as other enabling technologies. Mr. Negroponte asks "I wonder if you would advocate one pencil per classroom, or a special room for all pencils, called a 'writing room'."[1]

The OLPC Foundation argues that current efforts in education, moving incrementally as funding allows through building schools, hiring teachers, and purchasing books and equipment cannot be done fast enough to make forward progress. This is instead causing developing countries to fall further behind by effectively standing still in the global development race.

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1 "Why is it important for each child to have a computer? What's wrong with community-access centers? // One does not think of community pencils—kids have their own. They are tools to think with, sufficiently inexpensive to be used for work and play, drawing, writing, and mathematics. A computer can be the same, but far more powerful. Furthermore, there are many reasons it is important for a child to own something—like a football, doll, or book—not the least of which being that these technologies will be well-maintained though love and care." - http://www.laptop.org/faq.en_US.html

Much like the diffusion of cell phones, the OLPC project is viewed as a leap-frogging project in education, funded partially by reallocating money from buying and distribution of books, which can be electronic on the OLPC laptop. In addition, OLPC project leaders maintain the mass-distribution of laptops will fundamentally challenge underlying theories of education, moving towards a more constructivist, "learning to learn" and "learning by playing" approach, as championed by Seymour Papert beginning in the 1960s. Interestingly enough, Papert is actively involved with the OLPC project.

Previous "One Laptop Per Child" Projects

> "I do not think of them only in classrooms, but part of an integrated and seamless experience for kids and their families." (Nicholas Negroponte, in The Wall Street Journal)

The OLPC laptop is a means to an end. It is a tool to enable if not completely transform education, not just improve ICT skills. There have been some successes in integrating individual laptops into education systems. Mr. Negroponte often draws on the state of Maine's 2002 mandate for one laptop per child. This move was heavily influenced by Seymour Papert, championing his own educational theory of constuctionism (which itself builds off of Piaget's constructivism). While most Maine teachers were reluctant at the outset, preferring that officials allocated money towards more tangible goods, they now report many benefits:

> Now, three and a half years later, guess what? They're reporting five things: drop of truancy to almost zero, attending parent teacher meetings which nobody did and now almost everyone does, drop in discipline problems, increase in student participation, teachers are now saying it's kind of fun to teach, the kids are engaged...
>
> So when you see that kind of thing, this is not something you have to test, the days of pilot projects are over. When people say "Well, we'd like to do three or four thousand in our country to see how it works, screw you, go to the back of the line and someone else will do it. Then when you figure out that this works then you can join as well."
>
> -- Nicholas Negroponte at the TED (Technology, Entertainment, Design) conference, February 2006, transcribed at OLPCTalks.com

More quantitative research has found that students with laptops collaborate more, are better critical thinkers, and create higher quality work, leading to measurable gains in grade point

average (GPA) (Gulek & Demirtas, 2005). This study shows dramatic improvements in these measures, but is confounded by a small sample size, teachers who volunteered to pilot the program, and non-random selection of the students receiving laptops (the article does not specify how students were chosen).

These above studies are in the United States, not a developing country. For the developing world context, Mr. Negroponte draws heavily on his experience in a rural Cambodian village, where he distributed conventional laptops to all the children. This project was closely managed, but reportedly a great success (though there are no papers available on the experiment):

> There's a village with forty-seven dollars per year, per year, income. No electricity, no water, no telephone, no television. We brought in some generators. You can see a satellite dish in the background. Get the Internet, spread it through, not only the school, but through the village with 802.11. The kids take the laptops home. Their first English word is "Google". And the parents love it. And why do the parents like it? Because, when the kid opens up the laptop it's the brightest light source in the house...
>
> -- May 2006, Nicholas Negroponte spoke at the World Congress on Information Technology (WCIT) about One Laptop Per Child during his keynote speech, transcribed at http://www.olpctalks.com/nicholas_negroponte/negroponte_wcit.html

Not all laptop/ICT projects for schools are as successful as these, and research linking computers to improved grades are mostly inconclusive and confounded by many other variables. Larry Cuban, a critic of blindly integrating computers to classrooms, notes that despite huge investments into computers and Internet in schools, there has been little impact on usage. Cuban argues strongly that the computer has not been successful as possible because teachers are not included in their deployment. With other teaching conditions held constant, such as class size, number of classes per day, and so on, adding computers is unproductive. Teacher technophobia is not the issue at the core of this problem, though. Cuban's research finds that eight out of ten teachers have computers at home, often using them to track grades and create lesson plans. However, using ICTs in classrooms tends to be more problematic than problem-solving,

particularly when they are pushed by external groups. Ultimately, the natural diffusion process, as well as finding reliable software and hardware as opposed to popular solutions, is co-opted and leads to poor results.

The OLPC model mirrors all too well many of Cuban's criticisms. The OLPC vision is supportive of student-centric, constructivist learning, where the student learns by self-exploration instead of lecture. While this is generally supported as an ideal pedagogical method, the extremes to which OLPC pushes it ignores some important points in educational and institutional constraints faced by teachers in developing countries. Lee Felenstein criticizes OLPC's technological bent on the constructivist approach:

> The educational theories behind this approach were developed by Alan Kay and Seymour Papert starting in the 1970's, and gave us both the LOGO language (Papert) and the concept of the laptop computer (Kay's Dynabook). While their work led to important advances in the shape and use of computers, it has not been generally validated as bringing about new paradigms of child learning. Children do not go out to play bringing along their laptops, and have not been generally observed to create LOGO programs spontaneously." - Lee Felenstein, The Fonly Institute

Regardless of the value of constructionism, it is not necessarily something that should be tied to the hardware or the software. A government should be able to adopt the OLPC laptop without causing an overhaul of its education system, and more importantly, the central goal of inspiring constructionist pedagogies through the "Trojan Horse" of the OLPC laptop should be explicit.

Of particular interest is a project undertaken in 1982 by the French government's *Le Centre Mondial pour l'Informatique et Ressource Humaine*, which provided Apple II computers and the LOGO programming language to schools near Dakar, Senegal. This project had similar goals to the OLPC Foundation, and indeed was led by Papert and Negroponte:

> The Center intended to use microcomputers to take computing to the people through educational workshops in both the developed and the developing world. Field projects were set up in France and Senegal... It was to be an international research center independent of all commercial, political, and national interests. Naturally, it failed. Nothing

> is that independent, especially an organization backed by a socialist government and staffed by highly individualistic industry visionaries from around the world. Besides, altruism has a credibility problem in an industry that thrives on intense commercial competition. By the end of the Center's first year, Papert had quit, so had American experts Nicholas Negroponte and Bob Lawler. It had become a battlefield, scarred by clashes of management style, personality, and political conviction. It never really recovered. The new French government has done the Center a favor in closing it down.
>
> -- Dray, J. and Memosky, J. (1983), 'Computers and a New World Order', Technology Review, No. 13, May/June

Is the OLPC project simply an attempt to try this again, with upgraded hardware (the custom-designed OLPC instead of Apple II computers) and software (using the programming languages of Scratch, a successor to LOGO, and Python, instead of LOGO)?[2]

OLPC Technology

While Mr. Negroponte constantly reminds us that "[i]t's an education project, not a laptop project," the reality lies somewhere in-between. While education is the goal, the OLPC project strongly believes that technology is the best, perhaps only, mechanism to close the educational and digital gaps between LDCs and developed countries. The laptop has been designed with much forethought into the environment it will be used. As such, the laptop's design is revolutionary in the ways in which it addresses the developing world challenges as well as educational needs.

The operating system and software for the OLPC laptop has focused on being adamantly open-source, and has rejected offers from Apple and Microsoft for free or reduced-priced versions of their operating systems. However, some interviews with Nicholas Negroponte

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2 Ethan Zuckerman comments directly on this on Public Radio International's Radio Open Source, February 21, 2007.

"What I am worried about, in some ways, is I'm not sure the schools in the nations buying in the project understand just what a revolution this is likely to be. And in some ways I think that my friends working on OLPC have been a little sneaky about this. This is in some ways a Trojan Horse. Governments are buying into this because this looks like a terrific way of creating a computer savvy workforce, fighting brain drain, essentially bursting into the 21st Century. But what it also is a backdoor into overhauling the entire education system of a lot of the countries that we are talking about." http://www.olpctalks.com?walter_bender/bender_radio_open_source.html, Audio file at http://stream.publicbroadcasting.net/ros/open_source_070221.mp3

insinuate that the OLPC laptop could eventually be a platform for commercially-developed operating systems (Stecklow, 2005)[3]. The software of the laptop deviates from traditional design to provide a very user-centric, instead of a file-centric, interface. The laptop's operating system is based on Linux, but has a user interface (UI) dissimilar to current Linux UIs such as KDE or Gnome, or even Windows and Macintosh interfaces. The interface, dubbed "Sugar," is tightly integrated with the mesh network, showing a neighborhood of other local users online, and a constellation of software available to the user. Sugar only allows for one active application window at a time to fully utilize the laptop's limited resources.

The hardware, while not high-powered, takes into account many of the challenges of the developing world. To be sufficient as a book replacement technology, the laptop must be rugged, able to be read outside in natural sunlight, at night, and without external power. In its black and white "book mode" the screen consumes power only when moving to a new page, and has an extremely high contrast ratio (far beyond commercially available laptops). The laptop as a whole has extremely low power consumption (a tenth or less of current laptop models), and comes with a pull-cord generator device. While not suitable as the laptop's only power source, one minute of generation can produce ten minutes of reading time. The OLPC laptop is tightly sealed and less modular than commercial laptops, giving it better protection against dust, moisture, and drops. While Internet access for the laptops is an issue of much debate even within the OLPC project staff and volunteers, the laptops are designed to automatically form a mesh peer-to-peer wireless network to enable file sharing, communication and perhaps accessing data such as a local copy of Wikipedia or other resources, stored on a server in each community.

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[3] Microsoft has released a version of Windows XP with reduced functionality, available to governments of developing nations for $3 per license, but only for computer given for free to schools or children.

The technological side of the laptop design has been exemplary of an open process, encouraging and incorporating the needs and constraints of many underdeveloped regions. The umbrella target constraint of $100 per unit over all the design decisions has been driving the cost down (McCullagh, 2005), however the current configuration (recently upgraded for superior performance) is estimated to cost $175 per unit. OLPC plans to achieve this low price through massive economies of scale. They are working with OEMs to combine all of the technological components with large orders. The current plan is to require a minimum order of one million laptops, paid in full and up-front per country.. The OLPC project would also require an initial overall minimum order of five million laptops (1 million minimum per country, only governments can buy the OLPC), and suggests an eventual volume approaching 100 million laptops. The laptop manufacturer, Quanta, has issued a press release indicating that soon after the release of the OLPC laptop, they will release a similar laptop for $200, purchasable by end-users in whatever quantity they wish. For other market price points, Intel's ClassMate retails for around $300, and Dell is working on systems designed specifically for the developing world market for under $500. With systems being offered to the open market by computer manufacturers in the $300 range, and the OEM planning to offer a system that costs just $25 more than the current price of the OLPC laptop, one wonders if the push for the massive scale for OLPC purchases is still necessary.[4]

OLPC Implementation

The techno-positivism revealed in the efforts to create a complete hardware and software solution, however, eclipses a real need to focus on the implementation side of the project.

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[4] Doug Mohney of The Inquirer points out that the entire PC market hovers around 200 million units annually, with between a third and a half being laptops; “With a high of around 100 million laptops and a "low" 66 million, OLPC expects to generate new demand for a low/no-margin product that would require around a 7 to 10 percent surge in unit production if they line up enough orders for a mere 5 to 10 million machines on a slow ramp.” (Mohney, 2005).

To be successful, the OLPC experiment cannot end at the distribution of the laptops to the countries. There are a myriad of further logistical problems, as well as implementation and adoption hurdles to overcome. From a purely logistical view, the laptops must be transported within the country to the students, probably using existing textbook distribution methods. The "bitfrost" security features on the laptop require some effort (and ideally Internet connections) to activate the laptops, but this hinders mass theft of the machines. Further technical issues are that while the laptop can be manually powered for short periods of time, it requires some access to electricity, as will the per-school servers which will provide resource storage (a virtual library) as well as back-up services and perhaps an Internet gateway for the school. Internet access, if provided via satellite, will require technical effort to set up. The mesh network may need to be extended in cases where a child lives too far from other members of the mesh to connect to them at home. Individually, none of these hurdles are insurmountable, but as a group, and happening across the country as the government attempts to deploy a million or more laptops simultaneously, poses some difficulty.

Basic distribution can be handled by whatever existing methods exist to distribute textbooks to the students, though it is not quite so simple. In response to concerns from countries, the OLPC laptop has a security system, dubbed bitfrost, that checks in regularly with a central server to make sure that it hasn't been reported as lost or stolen (if it cannot check in, or finds that it has been reported as stolen, the laptop shuts down). This must first be activated upon receipt by the student. Laptop maintenance and repair is supposed to be done primarily by the children themselves. This seems to only apply to the external hardware, such as the antennae, as the internal hardware is hardwired together, according to the bitfrost security specifications:

> We do not expect the machines will be an appealing target for part resale. Save for the custom display, all valuable parts of the XO laptops are soldered onto the motherboard.

Beyond these logistical issues, deeper problems of technology adoption remain. Teachers will often be reluctant or fearful of new technologies, especially if the children show a greater aptitude for it. This "end-run" around existing educational institutions may in fact be an underlying goal of the OLPC project's wide distribution; sovereign governments and their education ministries should drive their own domestic educational policies.

Regardless, teachers will need training and updated curricula on how to integrate the laptops best with education, to ensure that their children are able to learn skills which will be relevant to their lives. This is not an argument against the loftier goal of engendering limitless, lifelong learning in children, but merely to temper it with practical skills and the need to develop or enable entrepreneurship through institutional and policy change within a country.

The implementation process for the laptops requires countries to purchase a minimum amount of one million units (at a target price of $100 or less, currently at $175) for OLPC to meet their scale needs to provide this price. This $175,000,000 (minimum) price tag excludes shipping, local transport, setup costs, infrastructure changes, maintenance/loss, Internet connectivity, teacher training/curriculum integration, or local content and service creation. This is a massive scope for a project and presents a problem in effective diffusion of the laptops (distribution and adoption) to school communities.

Notice already that the sheer scale of this project has moved the focus away from its educational promise to the technical requirements. The education ministries of recipient countries, even acting in the best interests of the school system, will acquire large amount of a new technology and push it out to the school level. The OLPC project provides a well-designed device. However options for low-cost conduits (by reducing the cost of Internet through the

mesh network), the social levels of local content, and mediation and global networking are currently absent.

Successfully implementing the OLPC project requires fundamental changes throughout the educational hierarchy, creating digital "seed" content for the students, and revising curricula and training teachers to be more comfortable and adept with the new technology. OLPC has suggested some metrics in discussing the potential of this project; such as increased student collaboration, teacher self-reporting, increased engagement of students as well as parents, and reduced disciplinary problems. The conclusion section will go more in to depth on these metrics and how they can be used in conjunction with project implementation.

Policy Recommendations

Two dimensions must be addressed when looking at potential OLPC implementations. First and most importantly, we present a set of metrics that can be used to quantify project success without undercutting the constructivist educational theories of the project goals. Beyond having metrics, countries looking to implement an OLPC project will not only want to measure the overall project success, but also manage its implementation and diffusion in a locally sustainable method.

The Need for Metrics

The OLPC Foundation has so far been resistant to applying metrics to their projects, particularly in the form of standardized testing. The underlying constructivist theories, and the focus on "learning to learn" over other traditional educational methods may in fact cause a drop in standardized test scores. Nevertheless, there are many measurements that can be used to evaluate the success rate of the OLPC project which do not interfere with constructivist

methodologies. External institutional constraints may exist that will require students to excel on standardized tests to continue their education on the secondary and post-secondary levels. Entrance and exit exams for secondary and higher education will not change overnight, and may not be controlled by local governments (such as the SAT/GRE exams in the United States, or regional exams, such as the CARICOM community's Caribbean Examinations Council exams). Regardless of the desires of the OLPC Foundation in promoting self-learning paradigms through the usage of laptops, students will need to do well on these standardized tests to continue their education or find skilled employment.

OLPC project leaders often cite the Maine project as a prime example of the power of individual, student-owned laptops. The oft-cited Maine one-to-one laptop program used metrics revealing "evidence of learning" (Maine, 2006), using metrics such as attendance rates, reduced disciplinary reporting, and qualitative self-reporting by teachers and students through questionnaires.[5]

This approach provides a strong starting point for proxy measures that can indicate the success (or failure) of an OLPC project. However, other important metrics such as fundamental literacy and numeracy should improve or at least remain constant within any educational development model.

These metrics provide insight into the overall impact of the project, which is the most important aspect to measure. We can supplement these output metrics with the input metrics into the project - change in education spending per child, whether the laptops were successfully distributed, and basic usage rates. Luckily, the “bitfrost” security software, which reduces the potential for widespread theft of the laptops, has two components that can generate helpful

[5] The questionnaires are available online at: http://www.mcmel.org/MLLS/eval/instruments.html.

distribution and usage metrics. When the laptop is given to the student, their first step is to activate it, which is then authenticated against a country-wide list of laptops (this happens either via the Internet or USB keys if there is no network infrastructure in place). Furthermore, each country will set a timeframe (every two weeks by default) within which a laptop must 'check in' to the central list to verify that it has not been reported as lost or stolen. If it does not check in, or has been reported by the student as lost or stolen, the laptop becomes inoperable. By tracking laptops using this authentication method on a recurring basis, a country may then extract rough usage rates (for example, in a given country, 75% of computers check in monthly). The rate of laptops reported as stolen, ironically, also indicates the perceived value of the laptop.

Internet usage by students using OLPC laptops can potentially be tracked through the OLPC's unique implementation of the FireFox web browser (the unusual screen dimensions as compared with other commercial laptops may also provide an identification mechanism). Websites such as Wikipedia and Google could easily report OLPC laptop browser usage statistics to a range of actors. There are complicating factors involved in using this measurement that may invalidate it once the project gets off the ground (Internet access by all of the OLPC laptops at one school may operate via proxy by one server, for example).

Implementation and Acquisition Strategies

It is particularly important for countries to find ways to use the OLPC laptop to improve their level of educational development, taking into account specific local concerns. Governments are initially constrained by the scale requirements that the OLPC Foundation needs to reach their own minimum orders providing profitability to the equipment manufacturer. Ultimately, countries must address two important issues -- the first is how to use the laptop in the

most beneficial manner for the country; the second is how to acquire and distribute the laptop in a way that supports the planned usage.

Implementation

Governments must first determine the appropriate laptop distribution methods that will work best in their local context. This decision drives how they will choose to adopt (or reject) the OLPC laptop, and what partnerships or negotiations to make. We see three pillars of developing a local implementation plan to achieve the optimal usage for the laptop - pilot projects using the metrics discusses above, localization entailing local-language content, curricula, and teacher involvement and training, and industry demand creation.

Pilot Projects

Pilot projects are a time honored way to test a development project before committing to it, as well as exploring unintended consequences of the project. Considering the multiple factors that the OLPC laptop introduces (new hardware, networking style, security model, user interface, software...), it seems that pilot projects would effectively indicate the success potential of the laptop, provide the opportunity to mollify the kinks in its design and implementation models. The OLPC Foundation has been resistant to pilot projects, questioning their motives as being noncommittal and asking what metrics could be used to effectively judge the impact of the laptop. We think that there is a wealth of metrics available that do not rely on standardized test scores, as we discuss above.

Pilot projects will also reveal more information on the actual cost of implementation of the laptop. The equipment cost of the laptop itself, targeted at $100, remains closer to its existing competing solutions such as Intel's ClassMate PC and AMD's PIC system (neither of which requires mass purchases). Beyond the raw laptop cost, each school will have some form of server acting as a backup system and Internet access point when possible. Geographically

dispersed communities will require network devices to extend the range of the mesh network to students at remote homes. Schools and households will have increased electricity costs (mitigated somewhat by the pull-cord power system, but that is not sufficient to provide all of the laptop's power at normal functioning levels). Internet costs tend to be much higher in developing countries, so without further government intervention, this could cause a dramatic increase in school costs. Technical experts will be needed to work on the roll-out and activation of the laptops. Teachers will need extensive training, and curricula plans and textbooks will need to be modified to include the OLPC laptop.

Localization

The teacher training and curricula/textbook modification gets into the second pillar for the successful roll-out of the OLPC laptops. The often-cited One to One Laptop Program of Maine sees teacher involvement as key:

> The two most important factors are the quality of the teacher's practice, and the quality of the leadership of the learning with laptop initiative. MLTI has identified leadership as the single most important factor to the success of the implementation of a learning with laptop initiative. The vision and expectations, set by the principal and project leadership team, set the tone of the project and are critical for teachers to effectively begin to integrate the technology into their teaching and the students' learning.
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> Maine Learning with Laptop Studies, 2006

It continues, drawing on a study of five large educational technology projects by John Schacter in 1999 which emphasizes the primacy of teaching and learning, not technology, in educational technology projects. This is even more important in an international context, where language, national history, and culture are introduced as new variables.

Successful OLPC laptop implementations will involve teacher representatives in all phases of decision-making and planning, and train all teachers in effectively using the laptop in their classrooms as well as to simplify (or at least not further complicate) their job as teacher.

With training and incentives to both improve the education quality for their students and reduce their own overhead, they will be more likely to welcome the laptops into their classrooms.

This involves creating relevant content and services in the local language(s) which appeal to the students, teachers, administrators and parents. Examples include using the Moodle course management software, which provides online grade tracking, testing, and communication. Services for parents include not only information about their child's performance in school, but other practical services, such as agricultural information (global market prices, weather, satellite imagery, and so on).

The national curricula (in countries where curricula are determined at the national/ministry level) will need to be revised to include the laptops in the daily activities, but be robust enough to also include children who are without laptops (due to breakage, loss, theft, capture, and so on). Textbooks will need to be digitized, and other content (for example, certain Internet content) may need to be filtered or translated for the students to access. The peer-produced online encyclopedia, Wikipedia, is predominantly in English and other languages of developed OECD-member nations:

> "Most of the early growth was in English, but more recently there has been an increase in the number of articles in many other languages: most notably in German (more than 200,000 articles), Japanese (more than 120,000 articles), and French (about 100,000), but also in another five languages that have between 40,000 and 70,000 articles each, another eleven languages with 10,000 to 40,000 articles each, and thirty-five languages with between 1,000 and 10,000 articles each" (Benkler, 2006)

There are 466 entries in Quechua, a South American indigenous language from the Inca, and 11 pages in Akan, a Western Africa language, among others. As Dr. Warschauer points out, there are Western concepts built deeply into modern computing; the ASCII text standard being the most difficult with its failure to support extended characters in non-English languages, which

has "infected" the URL system for webpages, but the newer UTF-8 system is addressing this with support for non-English characters.

Naturally, these are challenges for any ICT project, not just OLPC-centric ones. Nevertheless, the sheer scale of OLPC implementation projects means there will be greater immediate demand for these services and content during the early, fragile stages of deployment.

Industry Demand Creation and Tech transfer

The primary suggestion of justifying the price of the OLPC laptop has been as an amortized textbook replacement cost. Obviously there are many ways that countries may have their textbook distribution implemented; it may be a purely governmental educational expense, children may pay some or all of the cost, it may be managed centrally or at the school level, and so on. If students are responsible for book purchasing, the OLPC laptop may or may not be as equitable as a textbook whose pages can be photocopied by poorer students. Many students may not be able to afford the up-front costs of a laptop (five years worth of textbook expenses) if it is not financed by the school, government, or other NGO or private sector organizations.

Even if the cost of the laptop is balanced out by eliminating printing and distribution of textbooks every year, the economic impact continues. There is less work for those previously employed in the textbook distribution, and the work that remains is much higher skilled, involving managing the security system of the laptops to disable any stolen units. The writers of the textbooks will probably be able to adapt their jobs to providing content for the OLPC, but may have difficulty charging for it. The textbook printers suffer the worst hit, losing a most likely lucrative and reliable contract to print and bind the textbooks every year.

There seems to be little or no job replacement for the lost printing. Brazil has come up with an innovative solution to this, by demanding that Brazilian computer manufacturers will build the OLPC servers that each school will have as a central node and possible connection to

the Internet. Ideally, the laptops themselves would also be built in countries with advanced capabilities, but for now Quanta computing has a lock on this.

This also suggests a need for tech transfer. While it is the stated goal for the OLPC laptops to be maintained primarily by older schoolchildren, further support for countries to localize not only the content of the laptop, but the production of the hardware and software itself would create demand for the very skill-sets that the children will be learning through using the laptops. This is easier with the software included, as it is all open source. The hardware is potentially more difficult, as some of the components are protected by patents and the process itself (presumably) requires massive scale to be profitable. However, with Quanta advertising that they will produce similar laptops at $200 for the market, perhaps this indicates that the real cost of the hardware is more approachable at lower scales than suggested (though Quanta no doubt will make some parts interchangeable between the OLPC laptop and its for-profit laptop to enjoy scale benefits). The Brazil model above is a good start, and more countries should investigate similar arrangements.

Acquisition Strategies

There are multiple actors in the OLPC project - the non-profit OLPC Foundation and volunteers, their for-profit manufacturers, development and funding agencies, and the LDC governments. The OLPC foundation and its suppliers have scale requirements forcing a certain level of inflexibility. While ideally they would be more realistic and up-front about implementation needs and costs, their goal is to distribute laptops widely to cause a leapfrog effect in education among LDCs. This puts the onus on development/lending agencies and the host countries to switch this supply-side push to a demand-driven pull. This runs the risk of going against the OLPC vision of the laptops as a universal good among schoolchildren, but

guarantees better and deeper adoption of the new technology - these are the forces that must be balanced in any OLPC roll-out.

As this target roll-out date nears, the OLPC Foundation is appearing to get slightly more flexible. Having failed to reach their goal of an initial five million unit order, they are scaling back the first production run to three million, and are now considering accepting orders in the hundreds of thousands of units, instead of millions. This is still a significant minimum order for all but the largest developing countries, but signals that the OLPC project is realizing that it must be responsive to its market.

The governments taking part in the OLPC project are better positioned to identify opinion leaders within their country, and are more familiar with conditions, culture, and institutions within their country.

Still, a way must be found by the governments to expand the diffusion process, approaching an individual model of diffusion. Each country will need to customize their strategy depending on local situations, laws, and informal institutions. Further, this first solution further only applies to countries large enough to purchase a million OLPC laptops themselves.

Banking

In this model, the government buys the laptops up-front as required, but does not blindly distribute them. Rather, the ministry would spread awareness and provide technical support. It would be up leaders within individual schools to submit some form of proposal outlining their needs and implementation strategies (and perhaps requiring some token form of payment/purchasing of the laptop). This would result in a slow, but reasonably successful diffusion of the OLPC laptops. A more active method would be for the ministries to extend their role as agents of change and identify leaders within schools, instead of waiting for schools to submit proposals. This requires a larger commitment of resources from the ministry, but could

result in better identification of authentically interested and capable school communities, reducing fraudulent requests for laptops, or schools merely seeking status symbols. The choice between these paths would depend on the ministry resources and social norms.

This allows the laptops to be tested out by schools through small pilot projects. Demonstrated successes in the early adopting schools furthers the diffusion in schools which may have been initially hesitant. Most importantly, banking balances the deployment strategies needed by the OLPC project with the need for localized diffusion at the school and community level.

Network Strategies

Network strategies may provide a solution. At a governmental/transnational level, Central American governments are working on a bulk purchase through the Inter-American Development Bank (IADB). This also enables knock-on benefits, especially among these governments sharing a common official language (Spanish) and several indigenous languages, they can easily share some best practices as well as educational software and content that is relevant to the region but not specific to any one country. This reduces each country's risk by potentially letting it pilot smaller projects, as the entire region could purchase the minimum order of one million units. This inter-governmental agreement is still at the planning stage, but provides an interesting model which includes the importance of localization, pilot projects and metrics:

> The agreement outlines the following strategic areas of common interest for the IDB and OLPC, and which constitute the framework for initiatives to be jointly developed: (a) regional and national policy dialogue, aimed at exploring the implications of adopting a new approach to the use of computers in education; (b) technical assistance, to be provided to countries participating in the exploration of such new approaches; (c) design and support for evaluation activities, in order to insure rigorous follow up and lessons learned from initiatives in this field; d) content development tailor-made to the 1 to 1 learning environment; e) design of effective strategies to integrate individual computer devices in the daily lives of children, both at home and in school; and f) design of effective approaches to supporting schools and teachers implementing 1 to 1 computing programs. (IADB press release, 2006)

This agreement was the conclusion of the 9th Hemispheric Meeting of the Education Network within the Regional Policy Dialogue, held November 8-10, 2006. Andrew Zucker of the Concord Consortia, a non-profit education technology research organization, focused on the lack of conclusive, empirical evidence that "one to one" laptop programs such as the OLPC project lead to improved test scores or increased economic competitiveness. Nicholas Negroponte responded somewhat acerbically to this:

> I will overlook Andrew Zucker's somewhat insulting remark […] that computers added to children equal magic. […] But the rest of your presentation was actually very inappropriate for this group [by focusing on the need for objective metrics.] Because in fact they do need some magic. They do need some miracles. And they do need to do things which isn't futzing around and moving deck chairs. And they can spend the next five years planning. But that's not what they should do. They have to take action. They have to take big action. To do a pilot project is ridiculous!"

(OLPCTalks transcription of the 9th Hemispheric Meeting of the Education Network within the Regional Policy Dialogue)

Regardless, the network of countries approach enables many of the centrally important aspects which will lead to successful OLPC projects. Even more powerfully, individual, globally diverse schools and communities could cooperate and pool resources to purchase an order of laptops to then be distributed among the participants. This has the significant benefit of guaranteeing dedicated local interest in the project, as setting up such a large network with significant financial interdependencies will be no small barrier. This creates transnational networks among communities at similar levels of development who could share best practices with ICTs as well as in other development programs, reducing their information inequality when interfacing with development agencies as well as their own governments. Many development situations will exhibit this exact problem, and finding a way to break through this barrier to adoption is central in technology projects. This is a major strength of diverse pilot projects. One

of the best techniques comes from the development organization Oxfam, which uses it to introduce communities which are in different stages of a development project.[6]

Wait and See (or Walk Away)

A valid option for many countries is to take a "wait-and-see" approach. The first round of implementing countries will serve as global pilot projects, showing some basic best (or worst) practices and seeding some international content that countries sharing languages can enjoy the brush-clearing work done by the leading edge countries.

The laptop manufacturer, Quanta, has indicated that it intends to sell a $200 laptop with many of the same features as the OLPC laptop. For countries in more demand-driven or microfinance-supported diffusions, this more expensive laptop may provide a lower total cost for a pilot, allowing a country to better manage risk. This is also the case for countries holding a pilot project with fewer than a million units.

Other market options also exist. Intel has a low-cost educational computer called the ClassMate, and Dell has recently announced that it is also interested in producing computers for emerging markets. Microsoft announced in early 2007 that it would offer a reduced version of their popular Windows XP system for $3/license to any government providing computers for free to their schools. This may be simply a tactic to combat the spread of Linux based operating systems in emerging markets. In fact, Microsoft has been working on a version of XP which would run on the OLPC laptop hardware.

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6 Oxfam supports exchange visits between a community that is interested in a particular initiative (be it a breed of goat or a new crop) and a community that has recently adopted it. Field workers regularly tell stories late into the night of what happened in other communities (the good and the ill) or instigate role plays, acting out what people most want their grandchildren to remember. Formal meeting employ case studies or a panel of speakers from different backgrounds analyzing a society's future or scenario-building or futures analysis presented by facilitators (in an accessible manner, one hopes).Yet remarkably few of these participatory mechanisms have been employed deliberately for the purpose of identifying cultural consequences of poverty-reduction activities explicitly" (Alkire p.196)

These changes in the market underline the curious fact that the price for the laptop, with a target of $100, has not yet even achieved that price point. Indeed, due to some upgrades which have dramatically improved the performance, it is currently closer to $170. This means one of three things - the original goal was too low, the OLPC laptop is acting as a price deflator, or there is something curious happening with production. If Quanta gains profit in selling OLPC-like devices for $200 within a year without massive purchase requirements, certainly the $30 price differential does not require production runs in the millions. It is possible that Quanta will take advantage of the existing production environment for the OLPC laptops and use many of the same parts and manufacturing processes, which reduces the overhead of their market offering. One would hope that the Quanta laptop looks distinctively different from the OLPC version so as to not endanger the OLPC vision of reducing theft by reducing the resale value of the OLPC laptops.

A final option for countries is to choose not to adopt the OLPC laptops, or attempt to get 100% diffusion of laptops for their students. There are many good reasons to look for different strategies to help a country increase its ICT diffusion rate - school computer labs and community cybercenters offer many benefits for overall low costs. They are a single point of effort and Internet connection, provide space for training classes, and enable peer support among the customers of a cybercenter. The provide opportunities for entrepreneurs to open and run them, and employment for skilled computer administrators.

Countries with existing ICT industries, such as India and Brazil, may have other motivations and options. India has chosen not to adopt the OLPC, whereas Brazil has, but as mentioned above, will build the school servers domestically. India rejected the OLPC laptop as being both "pedagogically suspect" and the Education Secretary Sudeep Banerjee commented on

the laptop, "We do not think that the idea of Prof Negroponte is mature enough to be taken seriously at this stage and no major country is presently following this. Even inside America, there is not much enthusiasm about this." Both India and Brazil have indigenous computer industries which have created systems targeted at lower income groups. Brazil's Computadora Popular has garnered less support from private industry than India's Simputer computer/PDA hybrid system. And while the Simputer has not yet made strong inroads into the education market, it has been popular among both urban and rural users. The relative success of the Simputer, and the Indian industry's general willingness to support domestic development both may help explain their lack of interest in the OLPC laptop - why buy millions when your domestic industry can expand their business by producing a system that is designed for the local situation.

Conclusion

Our analysis suggests that, as a technological endeavor, the One Laptop per Child project has effectively developed a relatively affordable laptop that includes a number of unique features and technologies that are particularly beneficial for developing countries. The laptop's unique design, durable exterior, and reliance on open-source technologies are a few of the many characteristics that make the OLPC laptop a compelling educational development tool for students in the developing world.

However, as an education-based development project that attempts to mitigate the digital divide between developing and developed countries, the OLPC project appears significantly flawed. First, the OLPC project questions the importance of longstanding education systems by espousing a constructivist student-centric approach towards learning. This is a dangerous assumption by OLPC project leaders because the constructivist theory of education where

students learn how to learn may not effectively prepare students in developing countries for national exams that require mastery in specific educational concepts and disciplines.

Secondly and more importantly, the OLPC project's top-down technology-push model counters locally-driven development solutions that have proven to be more effective. The OLPC project, in an attempt to capitalize from economies of scale, has required national governments to make large quantity orders of laptops rather than smaller orders for specific communities. Instead, local communities and governments should selectively apply some of the previously discussed alternative frameworks such as those utilized by the Global Learning Portal and the UNESCO digital divide project. These methods can be incorporated into a more localized strategy which can also employ specific acquisition, distribution, and usage techniques which will be more beneficial overall to a developing country.

Countries seeking to diffuse the laptops more naturally to communities with diverse needs may utilize micro-financing strategies to balance between egalitarian distribution and demand-driven technology adoption. Networking strategies can allow smaller nations or even communities to band together to take advantage of emerging economies of scale offered by both the OLPC project and its competitors. In addition, these groups will be better served by localized content and problem-solving generated by many teachers and policymakers alike working together within a community-based system like the GLP.

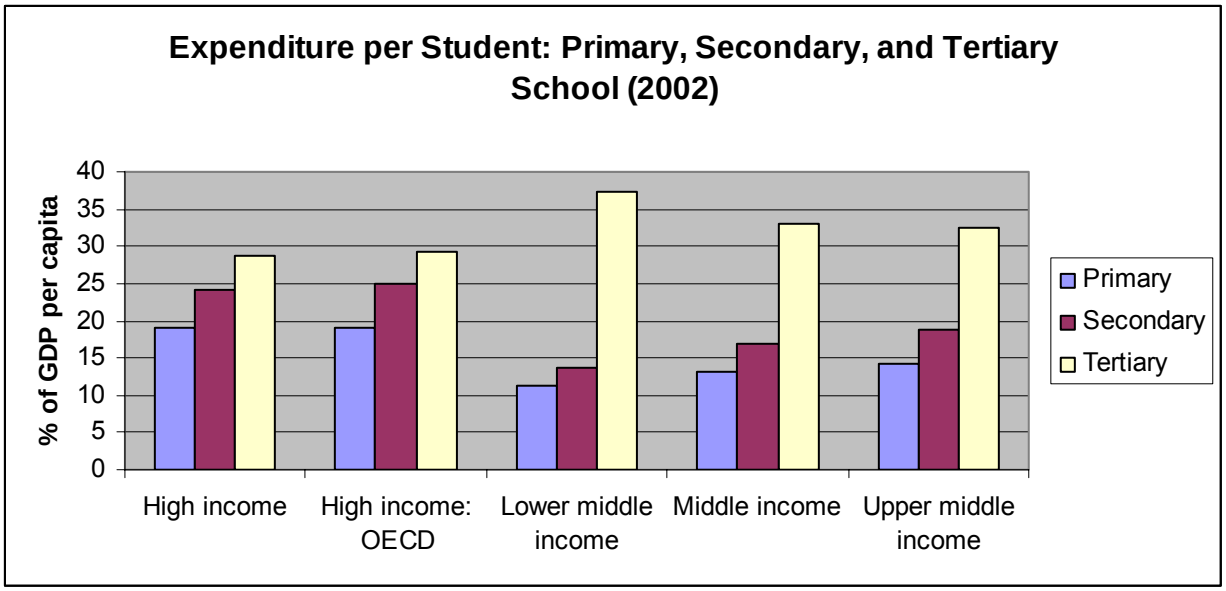
Developing countries are rightly skeptical in purchasing OLPC laptops to facilitate ICT and educational development. The total cost of the laptop, including delivery, set-up, and training, continues to increase, while the price of commercially-developed laptop computers with similar specifications continue to decrease. Additional uncertainties in implementation, networking, and financing, contribute to the risks involved in the OLPC project. Furthermore,

the OLPC Foundation's resistance to pilot projects casts an ominous shadow of doubt on its feasibility as an education project, considering fiscal constraints. The combination of factors that limit the control of both local communities and national governments question the large-scale purchase of OLPC laptops. Many developing countries will be better off waiting to see how the OLPC laptop technologies and costs develop vis-à-vis commercially-developed computers with similar specifications. Governments of developing countries should resist the temptation to adopt the OLPC project in its current state without either the development of proven metrics for success, or modifications to the project enabling demand-driven solutions addressing locally prevalent issues. Ultimately, a combination of both localized supply-push and demand-pull strategies must be implemented for any ICT-based education development plan to produce measurable and sustainable positive results.

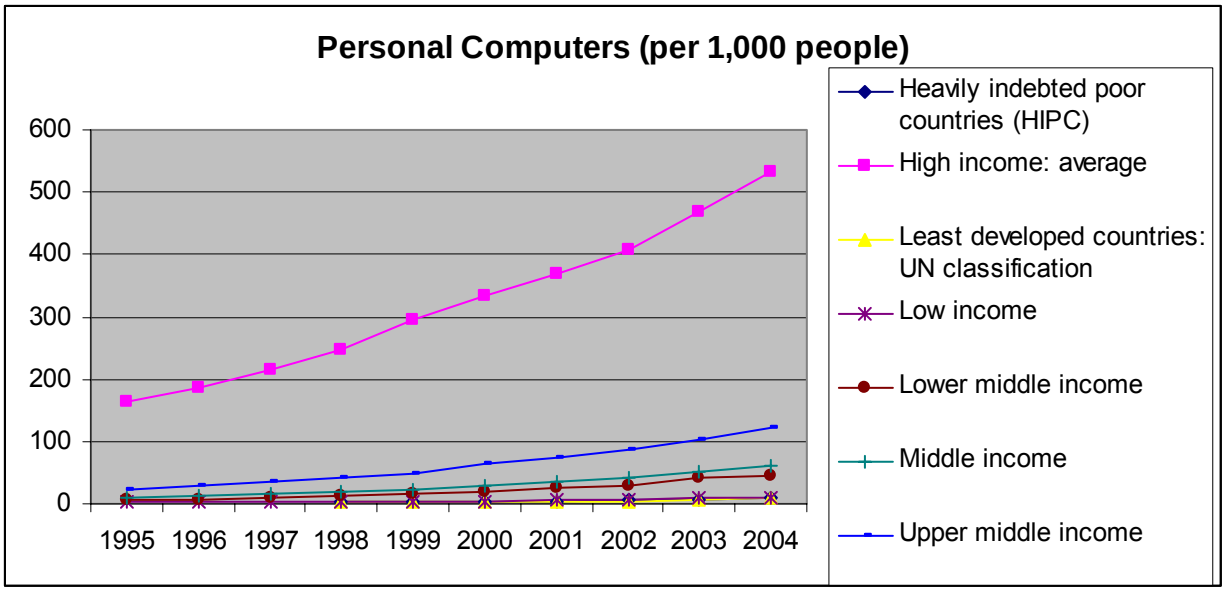
Appendix A: Charts

Ability to Use ICTs

The chart illustrating the expenditure per student shows that countries typically allocate the same amount of funds towards education at various levels on a relative basis. However, since there are wide disparities in GDP at these income levels, high income countries spend more towards education in absolute terms.

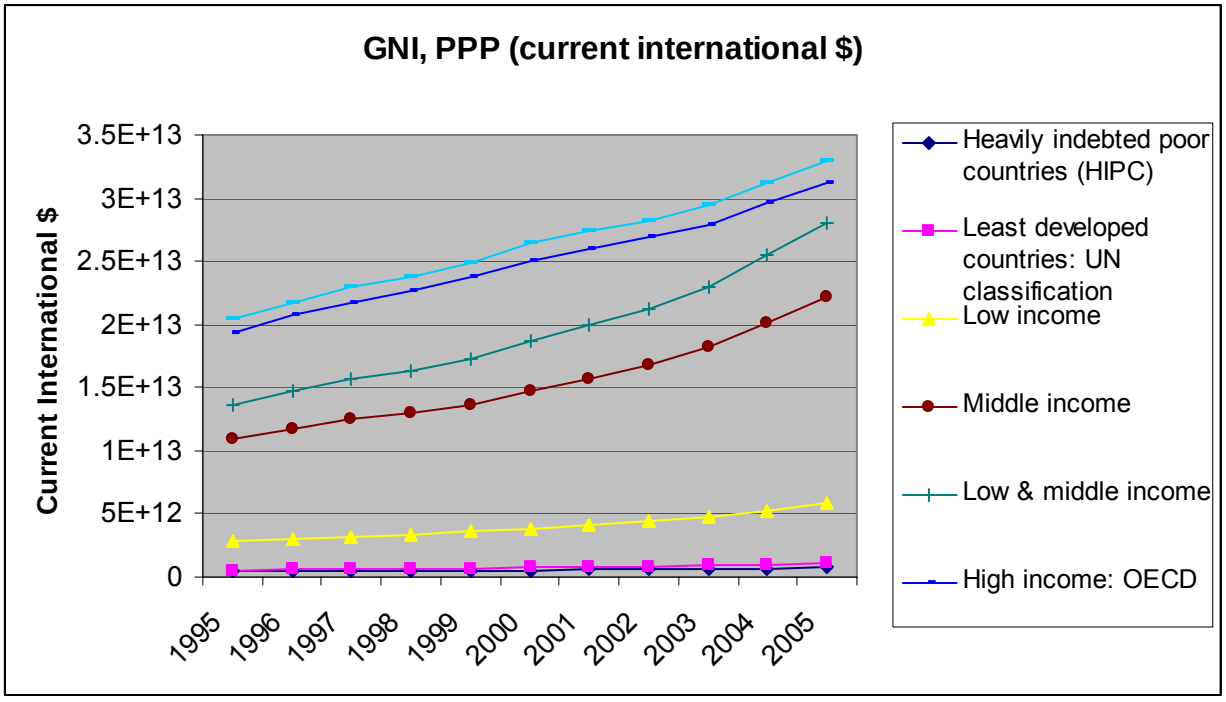


Disparity in ICT Use:



Source: World Bank Development Indicators

Economic Divide between Developing and Developed Nations



Source: World Bank Development Indicators

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