Technology in the classroom in conditions of infrastructural and capacity constraints: Lessons from Uganda

Abstract

For at least the past decade, political leaders and policymakers have stressed how important it is for Africa to harness technology, leapfrog development, and take part in the global knowledge economy. In numerous initiatives aimed at realizing these goals, education is a primary target, viewed as a mechanism through which ICT can empower societies to develop technologically literate workforces. Unfortunately, there is a considerable gap between policy rhetoric and effective project implementation. This paper's argument is centered on and informed by ICT-in-education projects that are increasing in number, yet still often lack necessary pre-project assessments, enumerated goals for outcomes, or an understanding of what technology can and cannot do. The paper introduces a case study of an ICT-in-education project in rural Uganda that offers important lessons to inform similar projects in the future, as well as government-led policy initiatives.

Introduction

The level of interest and investment in projects intended to bring the benefits of new technologies to the developing world—and to Africa in particular—has skyrocketed in recent years. This trend reflects the high and ever-increasing expectations placed on the ability of information and communications technology (ICT) to improve quality of life, empower populations, and assist in economic development.

Education is seen as a primary mechanism through which ICT can empower individuals, communities, and societies to develop technologically literate workforces able to participate in the information society and economy of the present and future. As such, it has been a key target of ICT-for-development initiatives. *Infodev*, a partnership of international development agencies, reports that most African countries had, by 2007, created national ICT policies, and that "of the 48 countries that either have a national ICT policy or are in the process of developing one, 39 of them have education sector ICT policies…or are in the process of developing them" (Farrell & Isaacs 2008:6).

While this is undoubtedly a positive proclamation, two additional points made in the same report are relevant to the arguments and methodology put forth in this paper: first, that the numerous small-scale ICT-for-education projects already underway within these countries served to inform national policy formation (p.17), and second, that there remains a disconnect between the formulation of these policies and the translation of them into reality (p.1, 7).

Given these two points, further analysis of case studies is warranted, on the basis that if governments learned from pilot projects in which they had little-to-no involvement and were subsequently challenged by the translation of vision (as enumerated in policy) to realized implementation, then they will once again need to look to case studies—to successful pilot projects—for insight. Most national policies were formulated in the early 2000s and the fieldwork informing them was carried out even earlier. It is worthwhile therefore, for governments to take a look at what has been successful in the ensuing years.

This paper will address considerations necessary for the introduction of ICT into primary and secondary schools worldwide, but with a focus on the developing world. It will be informed by a discussion of ICT-for-education, as illustrated by the examination of a successful Ugandan ICT-in-education project notable for its employment of creative strategies to ensure sustainability.

These best practices will be examined in order to see which may be applicable in terms of policy formulation and implementation at the national level.

The paper proceeds as follows: After a background and overview of ICT-for-education projects in the developing world the challenges particular to such projects will be discussed. The methodology and a discussion of theory development are subsequently presented. Following that is an overview of the current education situation in Uganda, followed by the case study. The paper concludes with a discussion of findings from the case and of relevant policy implications.

Background/Overview

Education is believed to play an essential role in the development of a knowledge-based society. The rationale is that education is a powerful tool that contributes seminally to economic growth through the development of the skilled workforce necessary to increased productivity. It is equally vital to social development, as it empowers people to improve their health, environment, and governance.

Despite the soundness of theory, a sizeable number of recent ICT-focused developing world education initiatives have failed to produce ecosystems of technology adoption or uptake in the classroom; in addition, follow-up and measurement of outcomes from these projects too often remains left undone. Thus, questions remain as to how to best pursue successful and sustainable ICT-for-education projects. Understanding how and when to use technology appropriately to improve the educational experience and ultimately develop a workforce literate in, and prepared to contribute to, the knowledge economy remains an unaddressed challenge.

Given the rapid rate at which ICT projects can be designed and implemented, there is a tendency to see ICT as a short-term silver bullet that will be adopted instantly on a wide scale, bringing immediate solution to past and present hindrances to political, social, and economic growth. Few governments, or project implementers for that matter, realize the level and duration of macro-scale commitment necessary for ICT to be adopted sufficiently to enable change. A failure to conceive of ICT-in-education projects as long-term infrastructural and human capital investments more often than not leads to an under-commitment of funds and overly high expectations for quick results. There is also an often-held misconception that ICT is an end in itself, or that simply distributing computers will create a need for them, a comprehension of their technology, and a technologically literate populace. Further, societies simply do not change as

quickly as do the technologies introduced into them, or even at the rate these technologies might allow or enable. All of these factors can lead to unrealistic expectations, creating a gap between aspirations and outcomes.

Despite the promise that today's new technologies hold, the unplanned introduction of ICT without a realistic understanding of what technology can and cannot do—and which capabilities it may enhance—can intensify existing inequalities in society and lead to disappointments. Projects that do not succeed will represent unfulfilled aspirations for the participants, as well as a squandering of scarce resources for developing country governments. The stakes are high.

One of the challenges facing many well-intentioned ICT-for-education projects is that such projects traditionally have failed to anticipate the importance of such considerations as teacher training, educational outcomes, infrastructural requirements, and the like; in other words, many fail to take a holistic approach to the adoption of the technology. And yet, it is becoming widely recognized that in order to promote uptake, adoption, and a culture of use—to achieve sustainable outcomes—a focus that includes the entire ecosystem of a project is necessary. Further challenges include performing a truthful assessment of the conditions into which ICT is introduced, and enumerating realistic goals that use of ICT is anticipated to achieve.

Misunderstanding ICT as a Panacea

Adelman has identified the dominant paradigm in development economics as troubling and counterproductive: "the (inherently misguided) search for a single-cause, and hence a single remedy, theory of development," a tendency stemming from the "keep it simple stupid" paradigm found in economics (2001: 104). This trend has been mirrored in the policy realm: one-size-fits-all prescriptions and interventions have been carried out repeatedly by development or aid organizations targeting the developing world. The prescriptions have changed over the decades, but the accompanying mindset has not (Adelman 2001; Akpan 2000; Evans 2005; Rodrick 2006).

One of the dangers of the top-down, one-size-fits-all prescriptive policy approach is that it fails to allow or account for societal, historical, political, or any other existing differences, or for change. It looks to theory for an answer as to what will cause growth—the simpler the better—and then attempts to apply that theory to a complicated reality, with life-altering consequences for countless human beings. When the proposed solution fails to deliver, the developing

country's shortcomings are blamed, and the theorists regroup to come up with the next solution. Over time, the single-solution "answers" proposed to bring about growth have included: increased capital, entrepreneurship, foreign investment, international trade, human capital, and more—or less—government (Adelman 2001; Evans 2005). Technology is currently being touted as the new "answer."

Not surprisingly, as with most panacean initiatives, once there is an answer, little is done by way of examining what the question was. ICT cannot be a solution if the source of the problem has not been thoughtfully and honestly articulated. For example, if there is no universal education in a country, there is a reason, and it has nothing to do with whether there are computers in the classroom. There may be no classrooms. There may be no teachers. The prevailing social, economic, political, or even infrastructural conditions may not allow parents to send their children to school. None of these issues will be addressed or solved by handing out computers. Technology that will lead to meaningful development cannot be an answer in search of a question. It must be the other way around. This is by no means exclusive to Africa—it is relevant all over the globe.

One of the shortcomings of the leapfrogging argument so often alluded to when describing the potential for ICT vis-à-vis development is that it tends to focus solely on the technology and misses the human element of meaningful ICT use. Merely providing technology does not automatically create a need for it, nor does it foster a culture of use or attempt to comprehend the underlying issues and challenges most efficiently addressed with the aid of technology. It has become an axiom among those who study and deploy ICT that technology is "neutral." This view ignores the fact that technology is always and everywhere introduced into a society that is far from neutral; the individual characteristics of each society greatly affect fundamental issues such as whether and how technology will be adopted and used, and who will benefit from it.

The very notion of "bridging the digital divide" is simplistic and misleading. It offers up an attractive visual image of being able to provide a bridge to a technologically disempowered "have not," so that he or she may cross over (and progress) to join the enabled, empowered "haves" on the other side. However, it has been argued that there are multiple "divides" (Keniston 2004), as well as gradations of technological access and use (Warschauer 2002). Seeing the issue as black and white, as an either/or dichotomy, oversimplifies the concept as well as the proposed solutions, often making them unrealistic. It also tends to privilege the technology

itself as the bridge, rather than recognizing that complicated human beings face multifaceted realities that will, to a great extent, determine what technology is perceived as useful.

It is quite tempting to confound the goals of assisting development with the goals of providing technology; this is further complicated by the fact that most of those who study, or are involved in, these areas have good intentions and want to see technology assist development. Still, technology must be seen as an enabling tool, and for it to be effective in its purpose of enhancing people's capabilities to meet their needs and desires, it must also be appropriate to their circumstances. It may not always be that complicated technology is the most appropriate solution for addressing a given issue. This notion is far more complex, and offers less instant gratification, than jumping on a bandwagon with a sound-bite solution such as seeing laptops for children as the way to solve all developing countries' education and technology issues. Yet when simple solutions do not remedy complex problems, disappointment is the result.

Developing a populace and workforce able to access, incorporate, and create information is a worthwhile goal, but one that will take an honest, circumspect evaluation of whether and how technology can enable, empower, and enhance existing methods of teaching and learning, and a rejection of the too-simplistic notion that technology alone is the answer that will change everything. If technology is adopted, this will require a long-term investment on the part of governments and all participants and shareholders in ICT-for-development projects, as well as an understanding of what such an investment will require. Simple provision of—and access to—technology may be necessary, but it is far from sufficient.

ICT for Education: What do we think we know (that we didn't know before)?

Schools are being called upon to build the human capital essential for participation in a technologically advanced society and in the global economy. Information technology is being introduced into schools around the globe, yet the goals for doing so often are not clearly articulated. As a result, project success is not easy to determine and outcomes are difficult to measure.

One often-cited goal for the introduction of ICT into schools is that of making the learning process more efficient (Cuban 2001:13). It is arguable whether this is indeed possible. Technology may make many peripheral processes and capabilities associated with learning more efficient, but the learning process itself is not sped up through technology. To wit: even with all

existing technology at its disposal, the world has not yet discovered shortcuts for teaching children how to read, write, or figure math problems. Technology does not make learning more efficient, but it can enhance the experience.

This possibility for enhancement points to an alternate goal for ICT in education, one that is possibly more feasible: Technology can transform teaching and learning into an engaging and active process connected to real life, and can prepare students with the skills necessary to enter the workplace of the 21st century (Cuban 2001:14-15).

However, even this goal has a number of hidden assumptions that bear discussion. First, we should not take for granted that there is a relevant workplace for ICT-literate workers to enter and contribute to upon their graduation—particularly in the developing world (Mercer 2005). Second, "transform" is a strong word. Cuban finds in a study of ICT-equipped schools in Silicon Valley, California, that the overwhelming majority of teachers implemented technology only partially and incrementally into their lesson plans, largely maintaining the status quo in terms of their teaching styles (2001). If this is the case where state-of-the-art technology and comprehensive training and support were provided, and where teachers may be considered reasonably comfortable with and adept at using technology because it is integrated into many aspects of their everyday life, what can we expect of teachers who have never seen or used a computer before, or who have not received sufficient training or support?

Once again, it is important to examine underlying assumptions and expectations about technology use. There seems to be a belief inherent among development and aid organizations, as well as among many scholars and practitioners, that Africans, if provided computers and the Internet, will use them only for obtaining information that will spur them to economic growth and socio-political development (Mercer, 2005). But it is unrealistic to expect user patterns of new adopters of technology to differ significantly from user patterns already witnessed around the world (Mercer 2005). How can we expect that Africans will only use the Internet for information-seeking in order to improve their livelihoods, skills, and incomes, when the majority of people around the world use the Internet largely for entertainment and communication?

Providing schools with computers—or giving laptops to students—without addressing underlying educational issues or attempting to anticipate how their presence would change the learning environment is a fruitless endeavor; it has been tried in the developed world with disappointing results (Hu 2007). Computers and technology alone do not further the education

process. It may be true that even young children can teach themselves how to use a computer, but it would be a rare child indeed who taught himself or herself how to read, write, and do math problems with that computer, if there were games to be played on it instead. Indeed, most programs that attempt to teach children how to read, or to learn a language, are packaged in the form of games. Children like to have fun—schools do not exist to teach them how to do so. It is generally agreed that schools exist to teach children such things as skills, social norms, and ways of learning that most likely would not come to them if left entirely to their own devices.

Technology does not teach children other intangibles also learned in school, such as how to interact and get along with other children their age, respect for the authority of the teacher, and respect for various other rules and concepts such as attendance, timeliness, waiting in line, sharing, and working in teams. Education has come to be recognized as a universal human right, and schools—at least at the primary level—are universally the place where children go to be taught and learn from teachers who make use of lesson plans and curricula. Though there are certainly exceptions to the rule and numerous cases where universal primary education is not yet a reality, agreement is general worldwide that it is a common good (even a human right) that should exist.

Perhaps a realistic expectation for computers-in-schools programs in the developing world is that they may come to resemble similar programs in the developed world, in terms of teacher adoption and use of technology. Cuban reports that a decade after the introduction of computers and the Internet into California schools, no advances have been made in terms of efficiency of learning or teaching that is attributable to their presence (2001:178). However, the argument that computers have become ubiquitous tools in an information society is still valid, and schools can provide this training, so equipping children with the skills to use relevant technology tools is an appropriate goal. What is important is to not set expectations that are based on unrealistic visions of what technology can accomplish.

One further consideration worth mentioning is that ICT is a long-term investment. In addition to teacher training and support (from the government, administrators and parents), there are other important considerations that must be part of the investment equation for the developing world—and for Africa in particular. ICT is not a one-time investment. It is an infrastructural and human capital investment that requires upkeep and reinvestment on a much faster pace than traditional infrastructural capital investments. Countries across the African continent have an unfortunate

legacy of not reinvesting in infrastructure (Tomlinson, 2007). This mindset will need to change regarding both ICT investments in general and ICT for education projects in particular, on a number of fronts. First, the human capital needs to be considered: training and support must be offered on an initial and ongoing basis. Second, the equipment will need to be maintained, and the hardware and software updated when it becomes outdated or obsolete.

Another factor often overlooked is the long-term power costs involved with setting up ICTs. In Africa, electricity, where it is available, is often expensive. This means that the least costly methods for operating computers should be taken into consideration; computers should use as little power as possible to operate (bringing into question the wisdom of using old donated power-hungry refurbished PCs), and alternate sources of electricity than that available from a grid should be investigated. Solar power or other renewable sources of energy should be considered. All of these budgeting issues must be kept in mind by implementers of both local, small-scale projects and larger government initiatives.

Methodology and Theory-Building

This paper employs a qualitative, case study methodology, which is particularly relevant for researchers examining strategies in emerging economies. In addition, the case study is the most appropriate method for studying the "many variables-small N" type of subject presented herein (Lijphart 1971). The case study is best employed when there are a limited number of cases for analysis, as it allows the researcher to examine the study intensively. An additional strength of the case study methodology is the contribution it can make to theory building, and to best practices identification. We adopt Gerring's definition of a case study as "an intensive study of a single unit for the purpose of understanding a larger class of similar units" (2004:342).

One distinct theory building area to which we hope this paper will contribute is to the enumeration of a process theory of the "top-down-meeting-bottom-up" approach to ICT and development related efforts. Drawing from the literature on International Business, we can witness a changing paradigm regarding interaction between developed and developing world actors. (The disciplinary origin of this literature is not meant to reflect a business-oriented perspective in the case at hand or for such projects in general).

In 2004, London and Hart identified a problem: corporations from the developed world tended to conduct business in the developing world according to the Western norms to which

they were accustomed. However, given the high failure rate of numerous endeavors that they investigated, combined with the absence of efficient, formal markets and the rule of law to uphold property rights often seen in the developing world, they concluded that a new strategy for Western firms doing business with the world's poor was needed. In the same year, C.K. Prahalad published his widely cited book: *The Fortune at the Bottom of the Pyramid*, which encouraged Western corporations to consider the profit potential of doing business with the poorest of the poor around the globe, and cited numerous examples of original, successful approaches to doing so.

However, Iqbal Quadir, founder of GrameenPhone in Bangladesh, challenges the top-down strategy that has been generally been employed with BOP initiatives: simply treating the poor as consumers does nothing to increase their incomes or therefore their purchasing capacity, nor does it stimulate much-needed entrepreneurship (Quadir & Morse, 2003). Thus, there is also a growing comprehension that reaching this group and realizing successful ventures will require new strategies. Hosman and Fife (2008) have identified two paradigm-shifting strategies to promote sustainable outcomes in projects that involve developed- and developing-world participants: the first is to focus on the wants, needs, and characteristics of the local communities and involve them as stakeholders from the outset of such projects, and the second is to form partnerships to carry out the projects (p.52).

Discovering the true needs and demands of the poor will require their input and involvement. Determining whether these needs can best be met through technology and then establishing how to do so may best be done by those with pre-existing technological expertise. The challenge is to establish a feedback loop between the top and bottom, in order to understand local communities' needs and develop appropriate technology-based projects. Scholarly study on the topic of bottom-up meeting top-down initiatives is nearly non-existent.

There is not (yet) a theoretical framework that focuses specifically on public-private or international partnerships (Stewart and Gray, 2006). Even so, some types of partnerships have been identified as promising: Public-Private Partnerships are currently held in extremely high esteem by governments, NGOs, development organizations, and firms alike. Another form of partnership—involving universities and university-based researchers—not only holds promise for establishing back-and-forth communication between locals and "experts," it also bodes well for academic analysis, since by definition, those involved are university-based.

The rather unique partnership highlighted in the case study below involves three parties: the St. Julie School in Buseesa, Uganda, a San Francisco based non-profit technology solutions provider (Inveneo), and a local technology expert, based in the Kibaale region of Uganda. In fact, before the case below took place, a partnership already existed between the local technology expert and Inveneo, because in order to promote local capacity building and sustainability, Inveneo recruits, trains, and certifies local ICT professionals. In turn, after hands-on guidance with their first project, these entrepreneurs perform the installation, maintenance, and support for ongoing and future endeavors. At the stage of the case detailed below, the St. Julie School entered into a partnership with Inveneo and the local technologist. This partnership, as well as the computer lab project, is described in further detail in the case study and discussion sections. As stated above, it is the intention of this article to contribute to the theory-building process on partnerships for development, and in particular, how effective feedback loops as well as local capacities can be developed to promote successful, sustainable partnered projects.

The research findings presented herein are based on a combination of secondary literature review and document content analysis, as well as interviews with key project participants. The interviewees included Sister Anita, the project leader at the St. Julie Model Primary School, which is the school under focus in the case study, and with Mark Summer, co-founder and CEO of Inveneo, the NGO partner in the project and provider of local technology training in the region. He was involved directly with the project from the time that Sister Anita first contacted him in the spring of 2007. The interviews informing the paper took place between October and December, 2007.

The case was chosen because of the success factors evident at this stage of project deployment (including the enumeration of goals for technology use, the training of teachers, and of technology use evident in the classroom) and the challenges faced (such as lack of electricity and harsh environmental conditions) that likely will be common to similar projects undertaken in the future. The paper makes use of micro-level findings in order to inform at the macro-level, by using the insight gained through in-depth case study analysis of the challenges and successes experienced at one school, to inform and make policy recommendations aimed at the state level. Still, there are inherent difficulties extrapolating from a single case study. What has been successful in one geographical location may be completely inappropriate for another. Any attempt at policy prescription must be preceded and informed by a sincere effort to understand

the particular situation at that point in time, and of how it got there, on both a recent and historical time scale. We are mindful of this limitation.

Primary and Secondary Education in Uganda

Uganda's National Information and Communication Technology Policy was established in July 2002. (The web site on which this document may be located electronically belongs to an international agency—the International Labor Organization; oddly enough, it cannot be found on any local or official Ugandan government website.) Within this document, ICT is explicitly identified as having "the potential to leap-frog Uganda to benefit from the globalized economy" (Government 2002).

Although there is no specific Ugandan ICT-for-education policy as of yet, the national ICT policy does mention education. It is mainly addressed in section 3.4: human resource issues. The fieldwork and surveys performed to inform this policy document were carried out in 1998. It is time to take another look at cases that have proven successful during the intervening decade to inform the creation of the nascent ICT for education policy currently "in progress," (Farrell and Isaacs 2008).

The government of Uganda mandated universal primary education (UPE) in 1996. In a single year, primary school enrollment surged from approximately 3.1 million pupils to 5.2 million, an increase of about 68 percent (Uganda Bureau of Statistics 2008). The state did not legislate an increase in the number of teachers and schools to accommodate this massive swell in student enrollment. In fact, it was only after the UPE was promulgated that thought was given to creating a regulatory framework for carrying out the mission (McGee 2000:88).

Some of the regulations put into place subsequent to the UPE's introduction include: restricting beneficiaries to four children per family, at least two of which must be girls; making Parent Teacher Associations (PTAs) and the fees associated with them illegal; and instituting automatic promotion from year to year of all pupils, regardless of achievement (Dauda 2004; McGee 2000). Goals for the project were announced mainly in terms of easily quantifiable targets: 55 pupils per teacher, 55 pupils per classroom, one book per pupil—none of which have come close to being met, but all of which fail to take into consideration any meaningful measure of the quality of education.

Unfortunately, this focus on easily-measured but non-quality-related metrics is all too commonly mirrored within development organizations, typifying the focus on easy answers originating from the "keep it simple stupid" argument noted above. In fact, Deininger (2001), from the World Bank, bases his analysis of the program on school attendance, disregarding any notion of quality as demonstrated by retention rates, relevance of curriculum, completion rates, literacy levels, achievement, the experiences of teachers, and the like. He pronounces the program "a success" (p.292) and "remarkably effective" (p.303). In fact, he ultimately dismisses the topic of the importance of the quality of educational inputs, asserting that early discussions of the topic were not generally satisfactory (p.293-4).

Meanwhile, micro-level studies undertaken on the ground in Uganda reveal a different picture. Dauda (2004) reports that the outlawing of PTAs halted the development of an institutional organization that had sprung up in the 1980s and 1990s to make primary education possible by promoting accountability and communication between teachers and parents—in the absence of governmental funding. In fact, in a reversal of policy, the Ugandan government eventually partially restored the legality of PTAs under the UPE (p.32).

The government is still making incremental attempts to remedy the situation created over a decade ago by its lack of foresight and planning regarding UPE's overnight implementation, though these efforts often consist of little more than stopgap measures. To address severe overcrowding in the capital city, for example, some secondary schools have mandated a double shift program, in which Level One students will study in the morning, while those in Level Two will study in the afternoon (New Vision 2008a). Tellingly, once again, the human resource issue has not been addressed. Teachers, whose workload has effectively doubled as a result of this measure, are offered no increase in remuneration as a result of the new policy (New Vision 2008a).

Ugandan primary and secondary schools face a number of infrastructural and basic supplies deficiencies. These include shortages of trained teachers, classrooms, water, latrines, and textbooks. Teachers are paid next-to-nothing, and sporadically at that (Dauda 2004:30). Other schools have resorted to using shade trees as classrooms and/or staffrooms (New Vision 2008b).

Some parents have become so disillusioned with the public schools (or lack thereof) in their areas that they have instituted private, community-run schools in a grassroots attempt to address public school shortcomings (Arbeiter and Hartley 2002; Dauda 2004). These community schools

are not without their own challenges. Boseley reports on one such school wherein all of the textbooks are borrowed from other schools, and they have, at most, one for each subject in each year (2007).

Though the Uganda Bureau of Statistics reports that the student-to-teacher ratio continues to improve, it also reports that primary school enrollment has continued to fall during the present decade (UBOS 2008), and the recent announcement to allow an increase in the maximum class size (Boseley 2007) belies official reports of progress in this area. A few secondary schools in Uganda have initiated ICT projects, but the Government points out that "only a very small percentage of Secondary Schools are offering ICT Training, and in almost all cases the facilities are awfully inadequate for reasonable hands-on experience" (Government 2002).

Another on-the-ground research endeavor—one in which local educators were trained to carry out structured analytic research on the quality of primary education within their own region in Western Uganda—revealed surprising results (Heneveld 2007). The educators had assumed that they needed more classrooms, books, and housing for the teachers. After systematic assessment, they discovered, to their surprise, that their particular region was not so overcrowded, and that there were sufficient textbooks (but these were sitting in storage).

This project was carried out across four different regions in Africa; studies found that the teaching style remained rather uniform across regions: the teachers talk, while students are passive but pay attention. Further, the most effective educational outcomes were realized when teachers prepared lesson plans, emphasized reading and writing, and evaluated students regularly (Heneveld 2007:654). Even so, each region produced its own unique findings as well; this cautions against universal truths being proclaimed and strengthens the argument for the importance of involving local researchers' insights in the implementation of national reforms.

This overview is not presented in order to detract from the positive aspects of increasing children's enrollment in school and providing them with educational opportunities. Rather, it is to highlight the government's failure to consider the necessity of planning for project implementation, or to provide the basic requisites—like teachers, teacher training, and infrastructure—necessary to ensure that students receive a quality education. At this time, ICT's "potential to leap-frog Uganda to benefit from the globalized economy" seems disconnected from the government's lack of assessment of what constitutes a quality educational experience and requirements that such be realized.

Case Study

In 1995, the Sisters of Notre Dame—an international congregation of Catholic women—established The St. Julie Model Primary School in rural Buseesa, Uganda, to board and educate children in grades three through seven. A secondary school was started in 2003, and the primary school has since added grades one and two. The primary school is co-ed, while the secondary school is only for girls. The sisters who run the school hail from the United States, Germany, and Uganda. In total, there are approximately 150-180 students attending the school; they live in dormitories, while the sisters—the school's teachers— live in an adjacent convent. The school has six classrooms, one of which now functions as a computer lab. The school and convent both make use of solar power to meet their energy needs.

The children attending these schools are mainly from the Kibaale district, which is often called "the forgotten district" or "lost district" because of its severe lack of roads, infrastructure, electricity, and its endemic poverty. Even so, fees to attend this school are much lower than for many private schools in Uganda, thanks to cost-defraying donations from the United States. The school is working on becoming self-sustaining, so that when sisters from the US and Germany return home or move on to other missions, Ugandan sisters will be able to continue their work.

The idea to put a computer lab in the school was the result of an October, 2005 visit to Buseesa by two California-based provincial superiors. The superiors discussed the idea with the sisters in Uganda, and in June, 2006, secured a grant from a foundation, also based in California, to fund the project. Sister Anita, who is originally from the United States, took the lead in pursuing this project, and as such, may be considered the project coordinator.

As the school was already solar-powered and the sisters were already utilizing solar-chargeable laptops, the initial thought was to opt for laptop computers for the lab. However, there are drawbacks to the use of laptops. First, they are far more costly than traditional PCs, both for the initial outlay and for repairs (generally the whole computer needs to be repaired if one part breaks, which is a likely occurrence with numerous young children using them on a regular basis). Next, they would each require an expensive inverter to convert DC to AC power, and finally, they are not energy-efficient, and would in fact require quite a bit of power to run.

In the Spring of 2007, through word-of-mouth, (in fact, from someone at the internet service provider that previously provided internet service to the mission, but has since gone out of

business, leaving the sisters with no connectivity,) Sister Anita learned of Inveneo, a non-profit company based in San Francisco that provides innovative ICT solutions to those in rural and remote locations in the developing world. She emailed them, and a dialog began.

In order to most appropriately meet the ICT needs of their clients, the people who work at Inveneo first determine existing infrastructural conditions and eventual goals. Inveneo then assesses whether their products are a good match for these circumstances and expectations. When creating ICT devices, Inveneo considers external environmental conditions, energy supply (or lack thereof), and long-term energy costs. In this particular case, the technology users will be multiple classes of children rotating in and out of the computer lab throughout the school day; the environment is one of considerable dust, heat, and humidity; and the energy supply is limited.

The solution proposed was to outfit the computer lab with twenty computers that operate on a 12-Volt battery system recharged by the school's existing solar power setup. (Twelve volts is an extremely low amount of energy to power computers.) The software and operating systems are open source—free—for both the servers and desktops. The computer lab has been operational for approximately four months.

One unique aspect of Inveneo's focus on project sustainability is the recruitment, training, and certification of local ICT professionals to perform the installation and maintenance of, as well as support for, the projects. This keeps costs down, promotes sustainability, and benefits the local economy by building local expertise and abilities. This focus on the "local" is most important with regards to maintenance and support. It is easy to forget that technology deployments rarely run perfectly upon installation; the St. Julie school computer lab is no exception. The software has required reinstallation three times, for various reasons. The solar panels have been dislodged and blown off the roof twice during storms. There are ongoing network problems and individual computer issues. These realities underscore the importance of having local, trained technical support for ICT projects. In fact, this point can be taken further—there is also benefit to having competition among local ICT technicians. Inveneo has trained multiple local technology experts in the Kibaale region, and the St. Julie school found that the second local partner to which they were introduced was more interested in and amenable to working with a school and meeting its particular needs and concerns.

In terms of teacher training, the school has hired a young man from the local village who has computer skills and training. He assists two of the sisters in the teaching of students during the

week, and trains the other teachers on the weekends. Approximately 70 percent of the teachers/staff are Ugandan and do not have prior experience with computers, so training is important. Even so, not all of the teachers are attending the ICT training thus far, illustrating the fact that not all teachers are, in fact, eager to embrace technology and adapt their lesson plans and teaching styles.

The goals for having a computer lab and making use of ICTs at the St. Julie mission are pragmatic and realistic. Uganda instituted a national testing program in Computer Studies in 2004. It consists of both theory and practical use of computers (including use of word processing, databases, spreadsheets, and the Internet). Students must sit for a certain number of exams at the end of their studies, both after the primary level and four years later when it is necessary to obtain the Uganda Certificate of Education. Computer Studies is now included in the list of elective exams with which students can meet the required total number of exam subjects. The school's goal is that their students will be able to sit for the Computer Studies exam by 2010, and as a result, that these students will also have developed the credentials and skills to use technology to help them get a job, which can provide funds that will enable them to further their education.

At present, the computers are being used to teach students how to type and to use word processing; those studying accounting have set up computer balance sheets. There is also a dictionary program on the computers that the students can use to learn new words (in English) and to improve their grammar. In the future, the school hopes to acquire read-aloud story books, math-practice software, and eventually, an Internet connection. Still, they are mindful of the fact that the computers are there to meet the goal of supporting the national testing curriculum.

Regarding student interest in the computers, Sister Anita reports:

> The students are so excited. They love any moment they spend in the lab and any free second I have, they want me to take them in there. They would love to listen to more music and, of course, they miss not having the Internet. Since we do not have a telephone network and a satellite connection is very expensive, we live without that. In fact, it would be a mammoth job of controlling that, for sure. So we have what we need and what we can manage.

Discussion

It may be too soon to comment on the outcome of the technology initiative at the St. Julie Mission School. Even so, there are identifiable characteristics of the school that bode well for the success of the project.

The technology that was installed is a complement to the existing infrastructure and pedagogy at the school. It may be considered an enhancement to the teaching and learning process.

The goals for adding a computer lab are clear, realistic, measurable, and in line with the introduction of Uganda's Computer Studies exam, as well as with the capabilities and interests of a sufficient number of the teachers. Teacher training is provided, but not required. Those who are not currently interested are not forced to take part against their will. The project also benefited from a project champion willing to investigate alternate possibilities for the technology, deployment, and maintenance, as well as to look after training and lead the first computer courses.

The technology may be deemed appropriate for local circumstances, as it took into consideration environmental conditions, energy capabilities, characteristics of the potential users, and long-term costs. The project may be considered sustainable, as funds are expected to continue to accrue through donations. Some may take issue with whether this type of funding is sustainable; the school also has plans in place to become sustainable from school fees. However, at this time, fees are being kept low to ensure that local enrollment is possible.

Appropriate local partners were identified for project deployment and service and maintenance were built in to the agreement. The local economy is supported through the employment of both the technicians and the computer instructor.

Re-shifting the focus to the bigger picture, we can identify several characteristics of this project that may inform the Ugandan government's efforts at ICT deployment on a national level. Still, there are difficulties inherent in extrapolating from a single case study. What has been successful in one location may be completely inappropriate for another. History has demonstrated that development is a multifaceted, complex process rooted in the socio-cultural, political, economic, and historic reality. Any attempt at policy prescription must be preceded and informed by a sincere effort to understand the particular situation at that point in time—and of how it got there, on both a recent and historical time scale. We are mindful of this limitation.

The first best-practice characteristic we can identify is an understanding of technology as an enabling tool and a complement to existing teaching and infrastructure, not as a silver bullet or an end in itself. The second is a realistic assessment of the existing situation. If there are insufficient schools, classrooms, and teachers, the provision of these must precede technology initiatives (or at best, be combined with them). It is beyond the scope of this paper to make recommendations as to how the recruitment of teachers and building of schools will best be achieved, but this reality does need to be addressed.

The next characteristic concerns the size of the endeavor: modest efforts in line with local realities and appropriate to local conditions are more likely to be adopted and may prove more successful and sustainable. This may be a case where the government should continue to focus on promoting cases and pilot projects rather than legislating an overnight change to be implemented in all schools across the country regardless of readiness or appropriateness—as was the case with the "overnight" promulgation of universal primary education legislation. Smaller projects are more easily adapted to changing conditions. Even successful, scalable projects often begin as pilots, the successes of which may inspire the confidence to "think bigger."

A further characteristic is the identification of the technology appropriate to the project. Oftentimes, simpler is better. In this case, some of the newest available technologies were utilized, but this had much to do with the local environment and power situation. In the end, the choice of technology must be determined by the project's characteristics.

Training is important. The St. Julie School is actively offering technology training to teachers, and yet not pushing it too hard. There are a sufficient number of teachers who are interested in using the technology and, as such, are taking the training courses. The school is in the (financial) position to be able to offer training. These are all key human resource issues that the state must factor in to any technology initiative. Just as there is no shortcut for teaching children how to read and write, there is no dependable accelerated technique for making adults who have never used technology comfortable with it—each will adjust differently.

Another characteristic is the setting of realistic, achievable goals. The goals set forth for the technology at St. Julie's school are in line with Uganda's recent offering of an exam in Computer Studies. Further, they are concrete, enumerated, and feasible for the school to reach. A goal of "harnessing technology to leapfrog into the information society" is vague and unrealistic; it is

therefore non-measurable and likely unattainable. It is better to clearly specify achievable goals and avoid the aspirations gap.

A project champion is important as well; this has been well-documented in studies of ICT-for-development project implementation at every level and size, from pilot programs to nation-wide initiatives. The St. Julie school benefited from the presence of Sister Anita; similar project champions need to be identified, empowered, and supported in any government-led ICT-in-education projects, ranging from head teachers in individual schools to the national minister of education.

Project sustainability is of great consequence. The St. Julie school uses solar power, so the ongoing expense of grid electricity was not a factor in its case, but it may be for numerous schools across the country. Energy costs and upkeep and maintenance of technology need to be taken into consideration. Additionally, support for and maintenance of the technology was part of the contract/agreement with the local technicians at the St. Julie school. Such an agreement should be the case for schools targeted for ICT deployments; employing local technicians will help the economy and make support and maintenance efforts more efficient. Ongoing funding for project continuation is another consideration. The St. Julie school can expect to continue receiving US funds and having teachers. By contrast, public schools will need continued public funding to meet this need.

The establishment of feedback loops to promote a top-down-meets-bottom-up method for project implementation is imperative as well. In this case, the NGO Inveneo establishes such a dialog, first by working with clients (bottom-up) who approach them, and second by asking the clients what their needs, goals, and present circumstances are. It then offers its expertise (top-down) to provide solutions, while at the same time training local staff in the skills necessary to provide support/maintenance on the current project and carry out future deployments on their own. If recent history may be considered indicative, the Ugandan government will likely make use of public-private partnerships to carry out ICT-for-education initiatives. Establishing similar feedback loops will be essential to avoid an overly top-down mentality and to determine local needs, desires, interests, and capabilities.

The technology in the case presented is promising in terms of adoption and the meeting of goals because all of the other pieces were in place and the technology is a complement to them. The school has the proper infrastructure: a classroom that can be used for computers, a project

champion, and ongoing support. It did not set unrealistically high expectations for technological solutions.

Specific policy implications may be taken from the case level in order to inform at the national level. First, the implementation of Uganda's Computer Studies exit exam is in fact a top-down policy, issued centrally (with no corresponding human capacity or infrastructural provisions for being able to effectuate its realization—a pattern identified above). Yet, the St. Julie school's adoption of computer technology with the goal of enabling their students to sit for this exam in fact represents a bottom-up effort to creatively make use of a top-down act of policy to realize educational goals. Creative efforts—particularly those with bottom-up approaches—to bring about improvements to the educational system may be seen both as a valuable method for addressing shortcomings on the part of the national government, and as a stepping stone for building local capacities.

Another policy that the government should be encouraged to continue is that of allowing Parent-Teacher Associations (PTAs) to develop. These organizations build increased accountability between civic groups and local institutions. This vital stepping stone in the building of civil society groups that hold local and national levels of government accountable is crucial to socio-political development in any nation. Further, the local level of government may, in fact, be a more appropriate level for carrying out educational policy. It may be that national governments are not the most appropriate actors to implement educational initiatives; their involvement may be most effective when it is indirect, where power and control are devolved to the local levels in order to determine what solutions are most appropriate. Accordingly, if local competencies are encouraged to develop—as in the local research-capacity building initiative described above—solutions proposed may be more fitting and relevant, with those responsible more likely to see themselves as stakeholders contributing to the process of educational reform.

Conclusion

Africa has witnessed its share of revolutions, transformations, and grand plans over the years; all were intended to be the answer to its problems of slow growth and underdevelopment. Unfortunately, the hyperbole currently surrounding information and communication technologies trumpets it as the new solution to these problems without an examination of their underlying causes; by doing so, it sets this latest-and-greatest panacea up for failure as well. But that is not

the only possible outcome, and the case presented offers up the possibility for success. ICTs do indeed hold promise and potential, but it must be remembered that, though they enable human beings to meet their needs and desires more efficiently, they are not silver bullets or ends in themselves. They will not transform society and the economy overnight, simply by their presence. A realistic assessment of existing circumstances, an understanding of how technology can empower and enable human capabilities, and an enumeration of goals for technology-oriented projects are critical steps that must be taken for success in ICT-in-education initiatives.

This paper presented a case study of an ICT-in-education project in rural Uganda and enumerated policy-relevant lessons that may be taken from it. Though the project described is a promising one, the overall picture—once that instance is extrapolated and translated into policy implications—becomes complex and full of challenges.

African governments have a historical pattern of neglecting ongoing investment in infrastructure that must be overcome; long-term human capacity building must be recognized as paramount for the adoption of ICT—supplying technology alone will not create a need for its use nor will it solve underlying problems. A realistic assessment of ways in which technology can complement and amplify current capabilities must be made before further scarce resources are invested in the ever-increasing number of ICT-related projects implemented in the name of development. The case detailed above described a local-level initiative to bring the benefits of ICT to students, while at the same time establishing the realistic goal that those students become equipped with the skills to sit for a computer studies exam within two years. This program was an example of a local-level initiative meeting an opportunity offered by a top-down government initiative that provided for no human resource or infrastructural support. Local, creative initiatives should be allowed—and encouraged—to continue to inform future national policy and promote the cultivation of local-level competencies, in order to assist those entities and institutions that advance socioeconomic development to do so. If such entities are enabled to handle educational issues in the future, perhaps national governments can devolve power and responsibility to the levels and bodies most appropriate to the task—but currently lacking the capabilities—in Uganda and elsewhere.

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