Implementing and Monitoring ICT in Education in the Developing World

Jennifer Helms
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Abstract

Information and communication technology (ICT) has become the foundation of a modern economy. Word processing, spreadsheets, and email are essential tools for operating in the job market. Due to its critical role in society, there is a drive for ICT to be applied to the education sector in various ways. There are efforts to ensure that students know how to use ICT tools and there are efforts to enhance the learning experience of students in schools by using ICT as an aid. This paper explores the education sector in the developing world and why ICT may be a solution for improving student learning. Given the financial investment ICT programs entail in comparison to other development initiatives, it also examines the critical factors for successfully implementing a program that works to integrate ICT in education. I spent ten weeks working with the American India Foundation to develop metrics to track the resources, activities, outputs and outcomes of their Digital Equalizer program that will ultimately be incorporated into an online management information system (MIS). This experience is provided as a case study, including background on the education landscape in India, challenges AIF faces in program implementation because of inadequate foundational critical success factors, and tools and suggestions for better program monitoring.

The Education Landscape in the Developing World

Each developing country obviously faces a unique set of challenges in the education sector however across all countries there is a need to improve quality and access. With education a core foundation for economic growth, developing countries have immense challenges to overcome in this sector. As a result the United Nations millennium development goals made their second goal to achieve universal primary education. This target, however, is unlikely to be met by 2015 despite improvements made in the sector. By 2008 about 69 million school age children were not going to school compared to 106 million as of 1999. In addition, dropout rates, while improved, remain an issue. For example there is still a 30% dropout rate from primary school in sub-Saharan Africa (1).

Access, however, is not the only issue. Quality is a significant issue in developing countries as well. Resources are often seen as the solution to quality problems. The US spends about $6,800 per year per primary student on public education in contrast to only $156 per student per year in Iran, $64 per student in India, $30 per student in Laos, and only $19 per student in Rwanda (2). While resource based solutions are not cure alls, there does appear to be a minimum amount of resources needed for student achievement (3).

Quality and access are such issues in developing countries that in a recent study of cohorts of school-leaving age children, there was the following finding:

> "In Ghana, South Africa, and Brazil, only 5%, 7%, and 8% of a cohort, respectively, reach literacy. The remaining more than 90% of the population are illiterate: because they never enrolled in school; because they dropped out of school at the primary or early secondary level; or because even after completing lower secondary education, their grasp of basic cognitive skills was so low that they have to be viewed as fundamentally illiterate" (3).

Why ICT in Education?

Firstly, what is ICT in education? According to GeSCI, a NGO that was born out of a UN task force, it refers to "an umbrella term that includes any communication device or application, encompassing:

radio, television, cellular phones, computer and network hardware and software, satellite systems, etc. as well as the various services and applications associated with them, such as videoconferencing and distance learning in education (4)." Given the education landscape in the developing world, why promote ICT in education? ICT is largely seen as a solution to quality problems in education. A core argument in favor of promoting the use of ICT in education stems from the belief that because ICT is so essential in the world today, if students are not introduced to these tools then they will not be able to compete in the job market.

Another key issue is that those students with the least access to technology are often those that are the most impoverished and living in rural areas. Without promoting ICT in education for all, a further division between the classes will result. From a global perspective we have been seeing an increase in the division between the rich and poor. By 1999, the richest 200 people had the combined wealth of $1,135 billion and the poorest half billion people in all developing countries was only about 10% of that amount (5). As technology becomes more and more of a foundation of economic growth, a further division between the developed and developing world will result. The home PC is now accessible to over a billion people worldwide; but there are over five billion people that do not have such access (6).

An additional key driver is to use ICT as an aid to create better classroom experiences. ICT tools can be used to help explain difficult to understand concepts and to achieve greater student engagement in the learning process. The argument is that ICT can support more student-centered teaching approaches to instruction instead of the lecture in front of the classroom style so often used (7).

Finally ICT can be used as a tool to allow for continuing professional development for teachers. By accessing platforms online, they can gain access to new information to incorporate into lesson plans. Without ICT, teachers too often can become ingrained in using the same lesson plans, year after year, despite significant changes in society's knowledge. The internet can also allow for teachers to connect to larger communities of teachers and expert groups. Tools such as UNICEF's *Teachers Talking about Learning* have been designed to allow for international collaboration between teachers (7).

Controversy Surrounding ICT in Education

Despite the general excitement for ICT in education, there is controversy surrounding it, particularly regarding whether it really has the impact on student learning it attempts to achieve and if it is really the most effective use of resources in the developing world.

Does it really have an impact on student learning?

A review of the existing literature published by The International Bank for Reconstruction and Development and The World Bank found that in general the impact of ICT on student achievement is still open to debate, stating "A review of the research on impacts of ICT on student achievement yields few conclusive statements, pro or contra, about the use of ICT in education. For every study that cites significant positive impact, another study finds little or no such positive impact". (8)

Skepticism comes to the spotlight when reading Anurag Behar's, co-CEO of the Azim Premji Foundation a NGO in India, declaration that the four years his organization invested in producing India's largest library of digital learning resources was a failure. In the end, they felt that it added no actual value to student learning (9).

Is it the most effective use of resources in the developing world?

Visiting the Shantidevi Devi Charitable Trust, I was amazed at the beautiful computer lab existing amidst an urban slum. I was even more amazed observing that technology in contrast to what the students there did not have, particularly running water or a clean and safe place to play (their dirt playfield was flooded and I watched as a family of pigs strolled by after bathing). Deworming pills, for instance, cost 50 cents per child per year and can increase student attendance by 25% due to decreased illness (10). When text books are exceedingly inexpensive in comparison to technology tools, is technology the answer? When students do not even have access to clean drinking water let alone water to wash their hands in schools, should money be spent on ICT tools? My analysis of the situation leads me to respond with a probably, but only if done in the most effective and efficient manner as possible. Investors should demand true results from ICT in education programs that they support knowing what other good could be accomplished with their investment. While it may be difficult to directly tie learning outcomes to ICT in education programs, the resources, activities, outputs, and outcomes should be reported on as thoroughly as possible.

Different Approaches across Sectors

There are many different NGOs and private sector companies working with governments around the world to incorporate ICT in education and trying innovative approaches. A few spotlights include:

GeSCI

Founded by the United Nations ICT task force, GeSCI does not do direct implementation but provides strategic advice to Ministries of Education. They also have a large focus on international research in the field. In addition, GeSCI has created tools to assist governments such as a total cost of ownership calculator for technology investments. GeSCI was brought into India with a specific memorandum of understanding with the government to align key stakeholders and they have fulfilled that agreement. The government of India has, however, requested their continued involvement but GeSCI does not have the capacity with their current focus in Africa, where they work in 20 different countries, though they may work with individual states on a case by case basis (11) (12).

T4 Technology Tools for Teaching and Training

This is a program of the EDC, a global nonprofit organization, which began in 2002. It has three main program areas. Their major flagship program is an interactive radio program. Programs are broadcast through radio stations via a regular time table. There are teacher guides which help the teachers learn how to implement the activities. They also make educational videos which are provided via satellite in

Karnataka. Their final program is group teaching and multimedia software. A limiting factor in India is access to computers and so the program is designed such that 20-25 students can be utilizing the program with one computer. They have also worked on teacher professional development with trainings for 5 days, 8 hours a day, in 3 rounds for a total of 120 hours of training. The teachers come to the organization for the training since it would be too difficult to go to each individual school (13).

World Links

In 1997 the World Bank initiated the World Links program. It became an independent nonprofit in 1999. It is based in Washington DC and operates in over 30 countries in the developing world to train teachers on technology and integrate ICT in education. World Links has a cascade system of training teachers who then train other teachers who in turn train students. World Links has also introduced a Telecenter model for computer labs to allow them to be revenue generators and therefore be sustainable in the long term. These Telecenters are a combination of computer lab and internet café in which the lab is opened up to the community and public during non school hours. (14) (15).

Educomp

Educomp Solutions Limited was founded in 1994 and is a publicly traded company. Educomp has 27 offices worldwide, 20 of which are in India. Educomp offers a large array of e-education products such as Smart Class, which provides teachers with interactive digital lessons for explaining difficult concepts such as 3D animation to show how DNA replication works. At the end of the lesson, a quiz is displayed for students that they take immediately with personal devices so that the teacher can obtain instant feedback and review concepts students did not understand. Through Educomp's Edureach program, Educomp has partnered with 14 state governments in India to set up and run computer education programs in over 14,500 schools (16). Educomp is an example of a private sector firm that has managed to reap large financial rewards for promoting ICT in education, according to the Wall Street Journal, Educomp's net profit for the April-June quarter rose to 366.4 million rupees ($8.28 million) (17).

Intel® Teach Program

Has trained over 9 million teachers across 60 countries worldwide as part of their Corporate Social Responsibility initiatives. Their training introduces teachers to tools as well as helps them work on how to integrate technology into the classroom. In addition Intel has produced CD and online based courses in 24 languages as well as a website offering free tools and resources for teachers (18). By investing in ICT in education, Intel not only is providing a social good but is helping promote their business by creating the next generation of consumers for their products.

One Laptop per Child Association

Is a nonprofit organization that has developed a low-cost, high durability laptop for children in the developing world. The laptop is designed to withstand developing world conditions; it was built to be both waterproof and rugged as well as have a high battery life of 10-12 hours. Each laptop is designed to have Wi-Fi capability and is equipped with radio antennae that allow for 2-3 times better Wi-Fi range than traditional laptops. They have even built in security features so that if the laptop is stolen it stops working within 24 hours (19). Since this innovation, other low-cost commercial net books are now also being produced by companies including Intel, Hewlett-Packard and others. This has posed difficulties for One Laptop per Child, but means that there are now more options on the market for developing countries.

The Critical Components for Implementing ICT in Education

I have identified five critical components for implementing ICT in education that build on each other. Each of these components is identified at a high level in figure 1, however the critical components within each category are discussed below along with solutions to their implementation that are particularly innovative and/or provide significant cost savings.

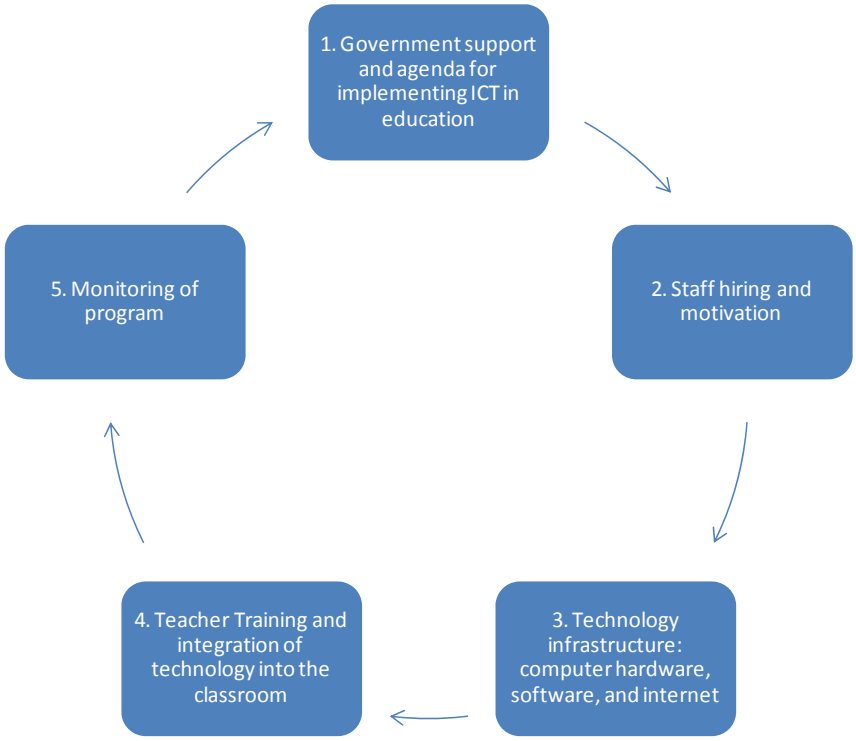


Figure 1

Government Support and Agenda for Incorporating ICT in Education

To implement an ICT in education program, there must first be government support for ICT in education. It has been found that this support needs to come from the Ministry of Education to be most successful and the responsibility of the initiative be undertaken by an internal team within the Ministry or an external NGO partner. Often ICT in education initiatives are undertaken by the IT arms of the Ministry of Education or other ministries such as for communication. The result is that there is inadequate staff support and knowledge of education to support the initiative. The role of the Ministry of Education or external partner is mainly to provide "leadership, advice and expertise in the areas of policy, strategic planning, coordination and project management" but not actually implement the program. Implementation is done by either NGOs or private sector companies (4). However, without a strong foundation of government support in place, as I found in my work with AIF, NGOs will struggle to implement programs and will have a difficult time effectively using donor dollars.

I asked Mary Hooker of GeSCI what she saw as the role of the NGO in implementing ICT in education, and her response was that their role is to respond to the government agenda (11). Of course it can also be the role of NGOs to work to shape that agenda such as IT for Change has done in India. When the new policy in India came out that seemed to largely cater to private sector interests, IT for Change fought for a revision which is yet to be released (20). The government's role is then to monitor their

partner NGOs and private sector companies. As mentioned regarding donors, it is of the utmost importance that these government units demand thorough data regarding these programs and hold these NGOs accountable.

Staff Hiring and Motivation

When implementing an ICT in education program, staff will be going to schools to be involved with each of the critical components, though the capacity of their involvement will vary depending on the model of the program. It is therefore essential to successful program implementation that the right people for the job are hired and incentives are put in place to motivate performance. Hiring is difficult throughout the nonprofit sector given the lower wages that are offered for work responsibilities comparable to private sector jobs.

Hiring is, however, particularly difficult in developing countries. In India for instance there is an issue of people being educated but still unemployable. Even in the field of engineering, "India produces about 650,000 engineers. But Pratik Kumar, executive vice president for human resources at the information-technology and outsourcing giant Wipro, says his company considers fewer than a quarter of them employable" (21). ICT in education programs need to find people that are not only great teachers for performing the trainings but also have technical skills and are great with kids. Given this difficult bill to fill combined with this human resources landscape, it is imperative that organizations invest resources in talent search and retention to find people that will be truly motivated by the mission and will deliver results.

Another difficulty for nonprofits in particular is that they have been found to often be undermanaged. A reason for this that The Bridgespan Group has found in their work with nonprofits is that visionary leadership is reinforced but nonprofit leaders are generally not recognized for their managerial skills. They then identified what successful leaders accomplish; they have clarified their organization's strategy, developed metrics to assess progress in reaching identified goals, and created a team of balanced leaders. Key to staff motivation here is the second concept, developing metrics that can keep everyone in the organization focused and help instill a results oriented culture amongst all staff (22). Developing monitoring systems and metrics will be discussed in more detail later in this paper.

Technology Infrastructure

The largest financial component for implementing ICT in education is the technology infrastructure. This is largely where the focus has been for ICT programs instead of the other key components of implementation (8).

Hardware

Hardware can be a significant financial investment for the government or a donor. When choosing the hardware to use, however, there are options for significant expense savings. When choosing non-portable PC options, server based computing (SBC) provides an option that is both cost effective and easier to administer. SBC involves users having what is known as a thin client which delivers user's input to a server which does all of the processing and data storage. The thin client then delivers the screen image and the sound from the server to the user. Easier administration is a considerable benefit of this system since just the server has to be maintained with the appropriate software. For this reason, SBC solutions have actually been found to increase the quality of the user experience because centralized administration allows for all terminals to automatically be kept up to date (23). Another cost-effective solution for schools is to invest in used or refurbished computers

Software

The need for proprietary software to implement ICT in education results in recurring expenses for resource strapped schools because software need not only be acquired but regularly updated. Open source provides an alternative option to schools, allowing ICT costs to be reduced significantly. Due to open source options, software can actually be the least expensive and easiest to obtain part of the technology toolkit needed. What is open source? For open source certification by the Open Source Initiative "the software must be distributed under a license that guarantees the right to read, redistribute, modify, and use the software freely" (24).

Resources like SchoolForge.net have developed with the mission of providing a platform for open source software related to education, from network security to educational material that can be used in classes. In addition open source software has been created with similar functionality to key programs used for everyday business in the Microsoft Office suite. While switching to open source software may seem a significant transition for schools, it presents an incredible opportunity for access to free or inexpensive tools for implementing ICT in education and should be seriously considered.

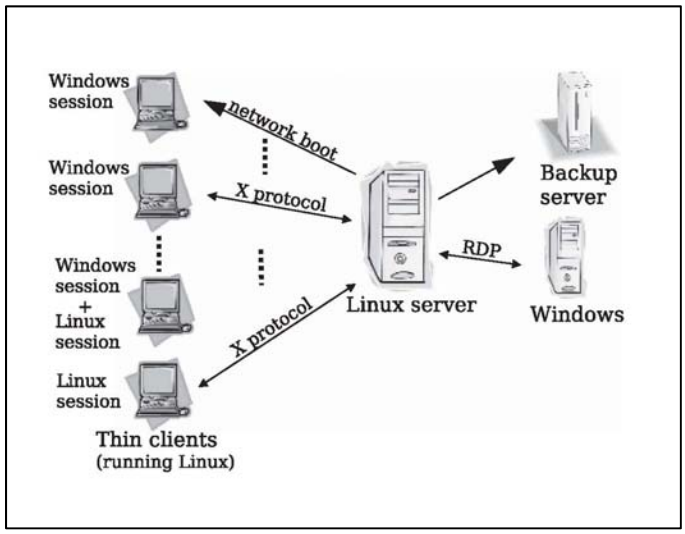


Figure 2: Source 21

Figure 1 depicts a SBC solution utilizing an open source Linux operating system. In addition, a Windows server is utilized that allows the user to also access commercial software (23).

Internet

Importance for Education and Development

Internet is widely believed to be a vital component for development. During last September's United Nations summit on the Millennium Development Goals a *Declaration for Broadband Internet for All* was issued. This report had backing from high profile development leaders including Muhammad Yunus and Jeffrey Sachs (10). In education, the internet can provide a way for teachers to access professional development tools as discussed below as well as allow students access to information and educational

resources. In schools that invest in high speed internet there has been found an "increase in satisfaction, use, and integration into the curriculum" (14).

Access

Access to the internet varies dramatically in the developing world. As of 2006, 62% of schools were online in Chile whereas only 7% of schools across 8 countries in sub-Saharan Africa have access to the internet. The internet is incredibly expensive for these schools to install, however there are examples of ministries of education pursuing partnerships with telecommunications companies to bridge the funding gab. In Chile a deal was arranged with the Compania de Telecomunicaciones de Chile to provide free internet in 6,500 schools for ten years as well as a host of other web-based services (14). As with Intel, such a solution is good business for the telecommunications firms as they will be creating more users for their services in the future.

WORLD INTERNET USAGE AND POPULATION STATISTICS
March 31, 2011

World Regions	Population (2011 Est.)	Internet Users Dec. 31, 2000	Internet Users Latest Data	Penetration (% Population)	Growth 2000-2011	Users % of Table
Africa	1,037,524,058	4,514,400	118,609,620	11.4 %	2,527.4 %	5.7 %
Asia	3,879,740,877	114,304,000	922,329,554	23.8 %	706.9 %	44.0 %
Europe	816,426,346	105,096,093	476,213,935	58.3 %	353.1 %	22.7 %
Middle East	216,258,843	3,284,800	68,553,666	31.7 %	1,987.0 %	3.3 %
North America	347,394,870	108,096,800	272,066,000	78.3 %	151.7 %	13.0 %
Latin America / Carib.	597,283,165	18,068,919	215,939,400	36.2 %	1,037.4 %	10.3 %
Oceania / Australia	35,426,995	7,620,480	21,293,830	60.1 %	179.4 %	1.0 %
WORLD TOTAL	6,930,055,154	360,985,492	2,095,006,005	30.2 %	480.4 %	100.0 %

Figure 3. Source: http://www.internetworldstats.com/stats.htm

How the Internet Is Used

It is not enough to just have internet access in the schools. Internet use needs to be monitored thoroughly as students will quickly go to exploring social network sites as opposed to educational sites. InfoDev provides an open platform for discussion on ICT in education in the developing world. A teacher in Kenya shared an experiment he did in which he had software that allowed him to control his student's PCs from one location. He found that students immediately went to social websites or other entertainment sites when unmonitored. It was only by blocking these sites that students began to browse Google and educational sites (25). In fact broadband internet access in schools has been found in some studies to be associated with lower test scores (10). Considering how the internet may be being used, this is no surprise and exemplifies the importance not just of having internet available, but that the use of the internet by students must be monitored and supervised to ensure that it has educational impact. Monitoring software is available for free through open source platforms online, such as Teacher Control Panel through sourceforge.net which allows a teacher to monitor, lock and operate student computers.

Power

In the developing world, power is an essential consideration in deploying the technology for ICT in education programs, particularly considering that many programs focus on rural areas in an attempt to reach underserved populations. Interrupted power supplies can cause computers to shut down and work to be lost, discouraging users. In an impact assessment of participants of the World Links program

29.8% of respondents found problems with electricity to be a major barrier (26). Additional investment is needed in batteries and uninterrupted power supplies.

Maintenance

Getting the technology equipment is not the end of the story. Computers need to be maintained. It is estimated that 70% of the total cost of IT systems during their lifetime is spent on maintenance. Using a server based solution as discussed above can lower this cost (23). Beyond this issue of expense is the issue of usage, if there are technical difficulties, computers will not be used. In implementing ICT programs all over the globe, World Links found that "A myriad of problems ranging from electrical spikes, to viruses, dust, heat, and normal wear-and-tear can bring activity in a developing country computer lab to a screeching halt". They have also found innovative solutions such as the "Kids on the Block" initiative in Namibia in which students are trained to refurbish, install, and maintain the school computer labs (14). With the mission of ICT programs so often to bridge the digital divide, to empower the students to do this work seems like the ideal solution. At AIF, I found that different states were managing this in different ways including outsourcing this work to the private sector firm Educomp, discussed above.

Teacher Training and Integration of Technology into the Classroom

Without sufficient teacher training, the most elaborate technology investments go to waste. Far too often technology investments are made that just sit collecting dust. Providing technological skills training is a starting place but it is not enough. GeSCI has created a detailed framework for teacher ICT competency which " defines principles and models for ICT integration along a continuum of emerging (basic use), technology literacy (applying), knowledge deepening (infusing) and knowledge creation (transforming) stages" (27). The framework starts with the basic need for teachers to be aware of how ICT fits into the government educational agenda and then moves toward teachers actually helping students develop ICT skills and creating understanding of how ICT can be used as a tool in their teaching. ICT tools need to be shown to be relevant and helpful to teachers for them to be used.

> "Educational technology is not, and never will be, transformative on its own – it requires teachers who can integrate technology into the curriculum and use it to improve student learning." (28)

However there are significant challenges in implementing teacher training. In Africa, it is believed that one of the greatest challenges in the education system is the need for competent and qualified teachers (29). In such a human capital stretched environment, training teachers on ICT skills becomes difficult. World Links has found in their experience that at least 80 hours of teacher training are needed before teachers can then move to integrating technology into the classroom. Their program in fact is a 200 hour program over a 2-3 year period. Teacher training is often a low priority and schools that are working with a fixed technology budget will prioritize technology investments over this vital component (28).

There are a few different models for teacher training but research as to the benefits of one model over another is sparse. Some studies show that the most successful programs are the face-to-face models that occur in the schools (29). A benefit of this model is that teachers are trained on the equipment that they will actually be using on a daily basis. However, my experience with AIF was that in the schools, trainings were interrupted, cut short, and did not have the teacher's full attention. Another model utilized is to have a centralized training in which teachers come to the training facility to be trained. Benefits of this model include an opportunity for teachers to network with teachers from other areas,

the ability to use higher-caliber trainers, and it allows for teachers to be focused on the task at hand without the distractions of other responsibilities in the schools. A challenge in providing this type of training is for teachers to be away from the school for days at a time. A final model is a web-based training model in which ICT itself is the medium for providing the ICT training. Online resources also allow for teachers to collaborate with other teachers and continue professional development. For example World Links connects teachers in developing and developed countries for collaborative learning via the internet (5).

While lessons on how to integrate technology into the classroom should be part of the teacher training, ongoing support for teachers is also needed. In general, ICTs are integrated into the classroom in two ways "to support existing 'traditional' pedagogical practices (teacher-centric, lecture-based, rote learning) as well as to enable more learner-centric, 'constructivist' learning models" (8). Too often, however, ICT is treated as a discrete subject. "There is an almost universal emphasis on teaching basic skills for software use and information gathering, whereas research indicates that integrating ICT into subject learning is far more effective for students" (29).

Monitoring

Performance monitoring of an ICT program, or any program, involves "Continuous tracking of data, typically by an organization's own staff through an internal data system, for the primary purposes of accountability, learning and improvement". Why is monitoring and evaluation important, why does it need to move beyond these basics? By measuring performance in order to learn and improve, organizations find that they can do more towards their mission with less money, can adapt their programs more readily as circumstances change, and can make better resource allocation decisions (30). Despite the importance of monitoring, monitoring and evaluation indicators have often focused on the easiest to collect data, indicators surrounding ICT hardware and software (8). So, even with all of the claims of what ICT in education can accomplish in terms of student impact, there is little data to support these claims.

Before looking at what to monitor and measure, however, it is important that the organization determine what the goals are for their program, what are they trying to achieve? This is an essential step in the process; however it is often a very difficult step for organizations (30). Next, to successfully monitor an ICT program, metrics need to be developed that are tied to the essential components of the program:

1. Resources/inputs: To understand how ICT affects subsequent activities, outputs and outcomes it is essential for the resources to be tracked, even if increases in this area are not directly a result of the program but instead a result of changes in government policy. However, with ICT programs, organizations need to remember that it is not just technological resources that affect the program but human resources as well. For example, while training teachers might be an activity of the program, teacher's background is an input that will directly impact the success of any initiative.

2. Activities: These are the actions of the ICT program that are undertaken to achieve the desired outcomes. For instance a core activity of ICT programs is often teacher training so metrics could include the number of trainings and hours spent training.

3. Outputs: Outputs and outcomes can often be confused and so let's start with a definition: "Outputs are the measurable, tangible, and direct products or results of program activities"

(31). Metrics to monitor the outputs of training can involve the number of teachers trained and the number of ICT related activities that are integrated into the classroom.

4. Outcomes: "Outcomes are the changes that occur or the difference that is made for individuals, groups, families, organizations, systems, or communities during or after the program" (31). Outcomes are then divided into short-term, intermediate, and long-term outcomes based on how far in the future you hope to see the results of your program. Outcomes are the most difficult to measure piece for an ICT in education program. InfoDev identified some key outcome areas for ICT programs which I discuss highlights of below:
    - **Student learning:** Often national or international assessments of student learning are used, however these are not targeted assessments and so an alternative is to use a customized assessment.
    - **Student attitudes:** ICT can improve student motivation and this data is often collected through a self-report.
    - **Student ICT skills:** Assessment of students increase in technological skills is a short-term outcome of any ICT program. Standards have been created for what students should be able to accomplish. InfoDev has a separate category for what it calls "21st century skills" however these seem to also fall under ICT skills assessments which should include internet use and application of ICT skills.
    - **Teacher outcomes:** Teacher learning is an important outcome. Programs often include trainings which focus on teacher ICT skills and pedagogical skills related to integrating ICT into the curriculum. These learning outcomes can be assessed either directly or indirectly (32).

When determining metrics, it is important to also investigate some other questions beyond just tying the metrics to the theory of change of the program.

- What decisions will these metrics influence, either within the organization or at the government level? It is important that metrics will actually be useful and can influence decision making for the company.
- Are the metrics actually measurable? This can be particularly challenging when linking metrics to outcomes of the program.
- What is realistic for the organization? It might not be possible to collect everything that might be hoped for given resource and time constraints, it is important to start small with the monitoring process to ensure success.
- Are there metrics that need to be included for purposes of reporting to the government?
- Are we prepared to give staff the time and resources to share data and a venue for discussion and learning (30)?

Ideally monitoring systems would be in place from the start of any initiative however there is a significant investment in resources needed.

> "In many African countries, where over 90 percent of Ministry of Education budgets are spent on teachers' salaries, governments and donors frequently see such external monitoring and evaluation as being less important than the actual delivery of education on the ground." (32)

Because of the significant investment with already resource strapped budgets, it is important to get involvement of all stakeholders in this process, including teachers and government officials. The system should therefore be set up such that everyone can see what the technology benefits are to them. InfoDev suggests that 5-10% of the budget for a program should be allocated toward monitoring and evaluation (32).

Case Study: The American India Foundation's Digital Equalizer Program

The Indian landscape

India's share of the technology and business process off-shoring market grew from $1 billion in 1990 to almost $60 billion in 2009, this industry as a whole was estimated at $100 billion in 2009 (10). With such a strong focus on technology in the economy it makes sense that a focus on technologies in schools would also exist. Despite India's lead in IT outsourcing, however, the conditions in K-12 schools leave much to be desired. With 1.12 million schools spread across 35 states, India has the largest school system in the world (33). Shyam Sunder, faculty member of the Yale School of Management was quoted in the Economic Times in 2009 as stating that, "India has one of the lowest ratios of teachers. In the US, it's 3,200 teachers per million people, in the Caribbean it's 1,500, in the Arab countries it's 800 and in India it's 456 teachers per million people" (34).

Currently India does not have a central policy in place for ICT in education initiatives. Most educational decisions happen at a state level. India has 28 states and 7 union territories with an incredible amount of diversity. India has three major political parties but numerous regional and smaller national parties. In addition to Hindi and English, India has 16 official languages (35). Such diversity and lack of centralized ICT agenda in place from the government means that each state is approaching ICT in education initiatives in different ways. The multiple languages mean that it is difficult to create tools that can be used broadly across the country.

The Digital Equalizer (DE) Program: A Uniform Theory of Change

The American India Foundation is mainly focused on teacher training and monitoring. The DE program operates in Delhi, Andhra Pradesh, Karnataka, Punjab and Tamil Nadu. They have additional programming in Orissa but it is sufficiently different that it is not addressed in this paper. They have three key models to their program: full-service in which AIF invests in the infrastructure, large-scale which is the majority of their program in which the government invests in the infrastructure, and a hybrid model in which AIF and the government are jointly making the investment. Their approach to training is robust; covering the three areas of training that are considered necessary for teacher preparation for ICT based education: information technology literacy, child-centric interactive teaching, and integration of ICT-based instruction in child-centric interactive teaching (36).

They utilize Instructor Led Training Manuals created by EZ Vidya to train teachers in the schools, spending 84 training hours spread over 2 years to complete the training in each school. The modules are as follows:

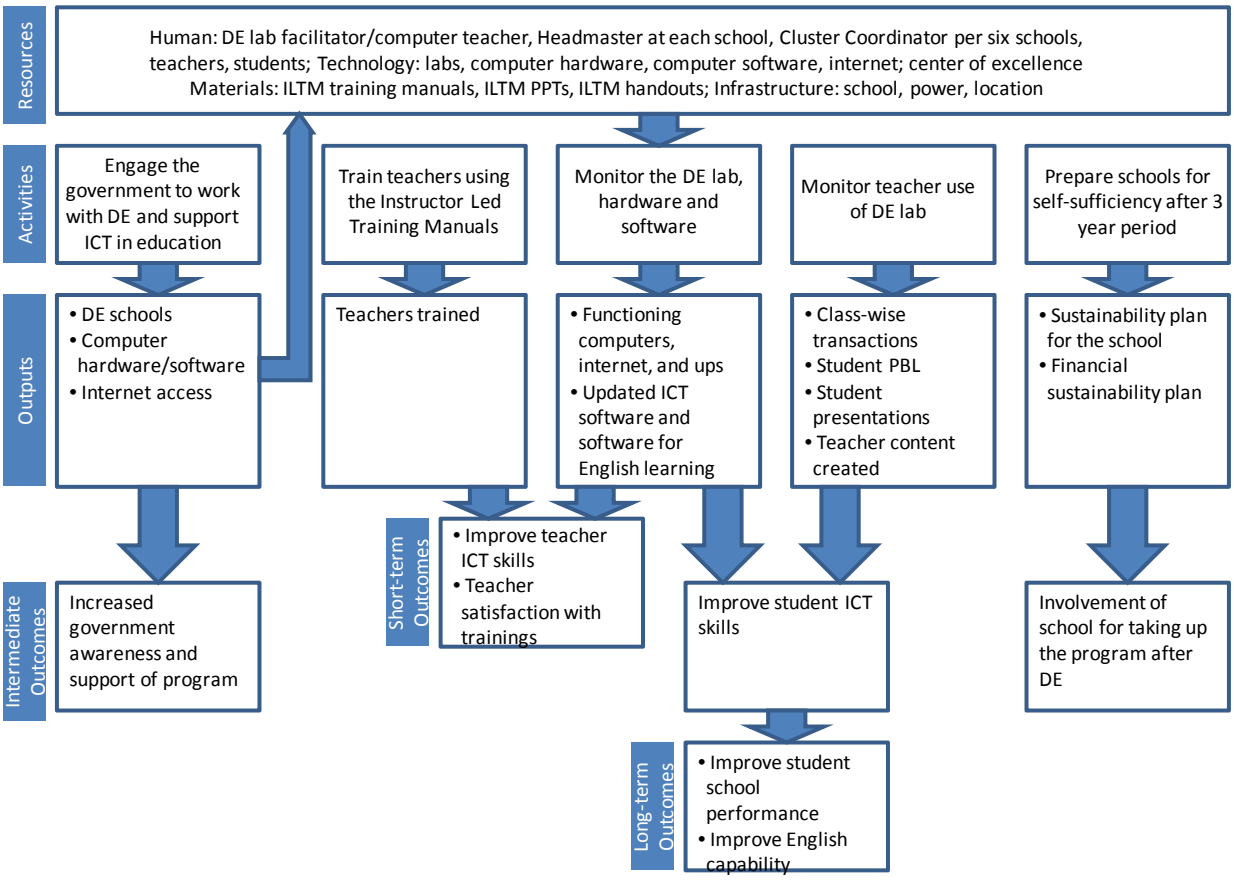
- Module 1 – setting the stage: this focuses on the importance of the training program and exploring the learning process for students
- Module 2 – introduction of AIF and benefit of DE
- Module 3 – building blocks of DE, the different technological and pedagogical topics needed to cover as the basis for Project Based Learning

- Module 4 – Implementation of Project Based Learning (PBL)

In addition to training the teachers, the DE program monitors the use of the lab to ensure its employment and the creation of teacher content and student projects. AIF exits the school three years after beginning the training, once the school has been prepared for sustainability of the program after AIF's departure. Preparing schools for sustainability, however, is a current weak spot of the program and something they want to further invest in. They are piloting a "lite" version of their program in Punjab in which they continue to visit schools on a fortnightly basis during years four and five.

Each state implements the program in a different way, largely in response to their unique environment. For instance in Punjab, they have the closest relationship with the government and each computer lab is staffed with a government teacher. In contrast, in Andhra Pradesh, the computer lab has a volunteer facilitator with responsibility over it. Despite these differences the core resources, activities, outputs and outcomes of the program are captured in the following theory of change for the program that was created as the starting point for determining metrics for the organization to use for monitoring:

Theory of Change for the Digital Equalizer Program



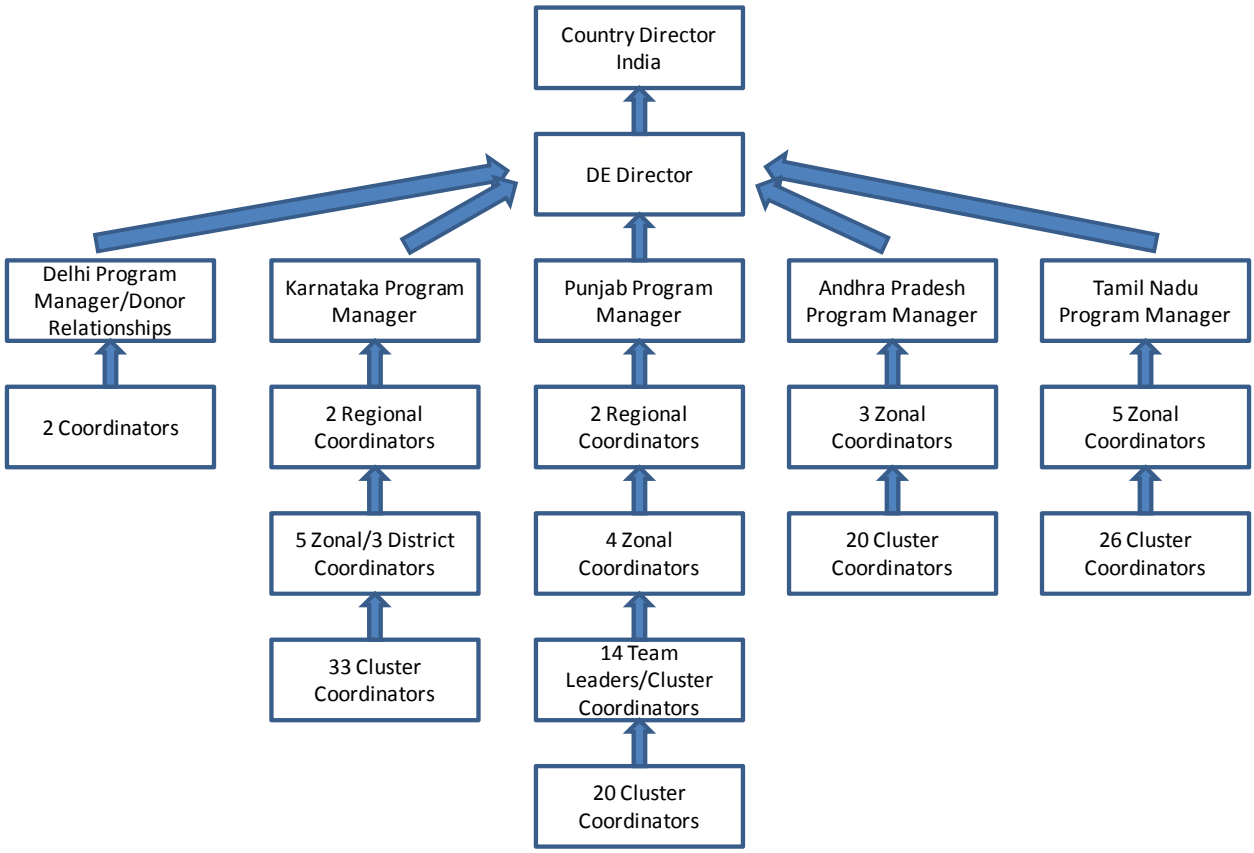
Background of Data Collection and Monitoring

Across all states, Cluster Coordinators are the ones primarily responsible for data collection because they are primarily in the field. Each school has a Cluster Coordinator that spends one day per week with them. Current reporting is done via Word and Excel. They send the reports to their superiors, the Zonal Coordinators, to consolidate who then send on to the Regional Coordinators to again consolidate. It is

estimated that 2-3 days per superior per month are spent on this consolidation effort. Any increase in effort expended to collect additional metrics, if combined with a MIS that will eliminate this need for entering and reentering the same information, should not result in increased effort for AIF staff on net.

While many different data points are being collected there was not much value found in the reports requiring the need for additional metrics and reporting to allow managers to monitor the performance of their program. For instance, while AIF was tracking the number of schools with internet in a way that led me to believe about 76% of their schools had internet, in truth schools with one computer with access, not even in a DE computer lab, were being qualified as having internet. As another example, AIF management was receiving reports with the number of teachers trained instead of the percentage of teachers trained, even though their program goals was for a certain percentage of teachers to be trained in the schools. By simply changing the format of how that data is reported into a percentage basis, staff will have the ability to compare their performance to their organizational goals, something they cannot do as easily with a report of the number of teachers trained. AIF had an excellent system in place for upper management to visit schools as well and check in with the headmasters in the schools about this program. Qualitative feedback was being generated from these meetings as well as regular meetings with staff for updates.

DE Staff



Key Monitoring Tools and Metrics Developed

Adapting a model for measurement outlined by the Bridgespan Group, a nonprofit consultancy, after identifying the key resources, activities, outputs and outcomes of the organization in a theory of change model it was time to tie metrics to measure each (30). Metrics collected that do not have a purpose will unlikely be collected so an additional worksheet was created that suggested metrics and the management decision that they would influence. An interesting challenge was that I was looking to develop a uniform system however each state had variations to their program and to the language used for their work as discussed above. To support the collection of these metrics, a few additional monitoring tools were created for the organization.

The first tool developed was a simple training evaluation that would be completed by the teachers in training at the midpoint and endpoint of the first two years of the program. While ideally this evaluation would be completed online, given the limited internet access in schools it will have to initially be completed via a paper form that will be entered into a MIS. This evaluation was developed to provide qualitative feedback for managers as well as get data points on:

- How well teachers feel supported in the training
- How well teachers feel the material is explained
- How well teachers feel the training actually applies to their teaching
- How they feel their confidence with computers has improved as a result of the training

This data will allow AIF both to better monitor the performance of their staff and to gather information for evaluating the overall impact of their program on the teachers they train.

A second set of tools developed were assessments for teachers of the competency they develop in Word, Excel, and PowerPoint as a result of the training. A pre-training assessment allows AIF to exclude teachers that might already have advanced skills in these programs so that they can focus more on the teachers that need help. A post-training assessment allows AIF to gauge how much teachers are learning about these basic programs. These assessments or a variation thereof can also be used with students, however given the huge number of students involved in the program; it was recommended for AIF to only perform such an assessment with a sample of students.

Key Challenges Identified in Program Implementation

Unfortunately the program faces some major hurdles that no level of monitoring will be able to overcome without significant changes to their program as well. The program has dedicated staff working hard for their mission but without sufficient government support, they are fighting an uphill battle. Key challenges fall into the following categories:

Infrastructure

Lack of Internet access: As mentioned about 76% of schools have some form of internet access. However, it is estimated that only about 25% of labs have adequate internet access for their program. With internet a foundational ICT for students and teachers to be exposed to, AIF is not able to fully implement their program.

Shortage of Hardware: In my observations of program, 2-4 students share a computer which results in only 1 student per computer actually getting practice. Even in Punjab which has significant government support the student to computer ratio averages 33 students per computer with a range from 9 students

per computer to as many as 76 students per computer. While an ideal figure of 5 students per computer (37)may be too difficult to achieve, the variation is staggering.

Teacher Participation

Difficulty in implementing trainings: By training teachers school by school instead of in a centralized setting, AIF faces major barriers. Teachers do not always attend trainings due to other commitments at school, sick leave, and time off. In addition, trainings get cut short due to other demands at school and given teachers busy schedules teachers do not have time to practice what they learn in the trainings. Finally the trainings pose an additional staff performance challenge. The trainings become a large focus of their work in the schools, taking away from their focus on monitoring the integration of ICT into the classroom and from the students.

Difficulty in implementing PBL: Interviewing teachers and staff it was clear that a significant challenge is that teachers claim that they do not have time to create projects, a foundational aspect of the program.

Student Time

Training time insufficient: The Indian school day is divided into 45 minute class periods. However with the DE program students are only at the computer for 30-35 minutes during one period since they have to go to their classroom first. Students visit the lab 2-4 times per week resulting in very little exposure time to the technology.

Suboptimal usage of computer lab: I observed full labs in some periods, again with 2-4 students sharing a computer while the same lab sat completely empty other periods.

Sustainability

Discontinued program: While the organization does not have good data on how their program is sustained after they exit the program, in Karnataka it was estimated that in their last batch of schools only 20%-30% of programs continued.

Insufficient lab support: While Punjab state has government teachers in the labs, other states have only a volunteer. Without someone to really take ownership of the lab and the program, it is not possible for the program to sustain.

Assessment of Challenges Identified

Where do these challenges come from for AIF? Looking at the critical success factors identified at the beginning of the paper it becomes quite clear. The first success factor identified is government support and agenda for incorporating ICT in education, which is largely the root cause of these challenges. As mentioned, India does not have a policy in place for implementing an ICT in education program at the national level. Without this AIF is working with individual states to work in schools and having to work incredibly hard to do so.

One way the program might improve for AIF would be by performing centralized trainings to overcome the training challenges they face but they would need government support to do so. Centralized trainings alone, however, would just provide the starting place for teacher training with skills being further developed, emphasizing integration into the classroom, via in school trainings. In addition increased dedication from teachers would require stronger incentives for their involvement from the government. Teachers are underpaid, overworked, and under resourced. With no change in their other demands, it is an unproductive battle to try to engage teachers in adopting new practices which take such a significant investment of time and energy.

The insufficient infrastructure requires either a larger investment in more computers, creative cost-savings measures as discussed above, or for there to be a focus on a smaller number of schools which have more technology concentrated in their locations. To solve infrastructure and training issues will require AIF to gain more government support which means AIF needs to have a clear focus on what their goals and needs are of their program as well of an understanding of how they can deliver better results given the increased support. This necessitates setting up better monitoring processes for their current program but also to be able to take a hard look at the goals of their program.

Conclusions

There are incredible challenges facing the education sector in developing countries and ICT is one of many solutions to improve the educational landscape. ICT is a resource intensive solution but there are innovative and cost-effective approaches that are being utilized and need to be further explored by Ministries of Education, NGOs and private sector companies working in this space. Donors and governments should demand these innovative and cost-effect solutions and to focus their efforts on working with NGOs and private sector programs that are successful in each of the critical components for implementing ICT in education identified in this paper. First and foremost, however, the government in these countries needs to create an agenda for integrating ICT in education, otherwise the most well-intentioned initiatives will face a challenging, uphill battle as they fight to implement program in an environment in which teachers do not have the time or resources to invest in their program. To ensure that staff, infrastructure, training and ICT integration into the classroom are being implemented effectively, donors and governments should demand monitoring practices that require NGOs and private sector partners to deliver on agreed upon goals for their programs.

Areas for Further Research

- While there is popular belief that broadband internet is a key tool for development, there is limited data on the impact of internet access. How does internet access increase student learning outcomes when monitored and supervised appropriately?
- What is the opportunity cost of using limited electricity supplies in developing countries for ICT in education initiatives?
- What are the benefits of different teacher training models over others? Which models have the greatest impact in the developing world?
- How does the inclusion of typing skills education increase the effectiveness of ICT in education programs?
- What are the barriers to using open source software in the developing world? What will it take to implement open source usage across more programs?

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