

2013

ICT

IN
EDUCATION
STUDY



ACKNOWLEDGEMENTS

This one-year collaborative action research study 2012-2013 was conducted by a team of multidisciplinary experts from the Columbia University Teachers College, the Earth Institute at Columbia University, Kampala University, and University of Nairobi working together to understand the effects, opportunities and challenges of integrating Information and Communication Technologies (ICT) into secondary education settings in rural sub-Saharan Africa for the purposes of improved quality teaching and learning.

The ICT in Education Study was designed, commissioned and managed by Connect To Learn, based at the Earth Institute at Columbia University and Millennium Promise, and was led in collaboration with University partners.

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Connect To Learn aims to support student learning levels with access to 21st century tools and resources and related teacher professional development. ICT integration strategies recommended are to help school administrators and teachers move from being technology-enabled to becoming confident and mature in their ICT usage and practices for increasingly improved quality education among their students.

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The use of ICT in classrooms can clearly have positive effects on education with appropriate and sufficient support. Connect To Learn is only at the beginning of rolling out its practical solutions globally. For continuing success, it is imperative to expand existing partnerships and form new ones, work with educators, national education ministries and partners to ensure adequate teacher training and learning materials, and ensure adequate ICT and data resources.

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FOREWORD

Mobile broadband has fundamentally changed the way we live our lives. The potential to revolutionize the field of education is just beginning. In fact, our latest figures (November 2013) show that mobile broadband subscriptions will surpass two billion in 2013, and mobile subscriptions will exceed 9.3 billion by 2019.

This means that today a teacher or student with a mobile device has instant access to millions of articles, books, essays, academic research, instructions and lectures on every imaginable subject.

The Networked Society has created an unprecedented platform to increase the availability of education for all. It can break down the barriers that used to exist between knowledge and traditional schools and libraries that were the gatekeepers of this knowledge. It can simplify access to content and experts, overcoming traditional constraints of time, location and collaboration. And it can enable lifelong learning as children globally will need to develop their knowledge, skills and competence throughout their lives in an effort to improve income and grow as human beings.

In November 2011, Ericsson gathered ICT leaders, world-renowned professors, top politicians and inspirational global leaders to discuss: How can ICT shape the future of learning. The event was NEST, the Networked Society Forum, the location was Hong Kong and among many other prominent speakers Jeffrey Sachs made a compelling case to the audience about

the importance of ICT in transforming education, as well as the importance of evaluating the impact of ICT. We decided to take that challenge, and the result is this research report which is aimed to shed light on one simple question:

How do you measure success of ICT interventions in education?

The Earth Institute has been our scientific advisory partner in Connect To Learn, and we relied on their guidance and leadership in looking at these questions. This report presents the findings of the study answering the question of what works in ICT in education. The study also presents a model and logic framework by which on-going and future interventions in schools can be captured, which serves to provide a framework for understanding the effectiveness of ICT investments.

I hope this report will provide valuable insights to those looking to understand how mobile broadband can bring access to education, while capturing an opportunity to improve the quality of resources for teachers and students around the world. The mobile industry clearly has a major role to play in ensuring quality education for all, and I encourage you all to engage with us on Connect To Learn or local education initiatives with support of these insights.

Hans Vestberg
President and CEO
Ericsson



Education is at the very core of economic development and a key to ending poverty. In the world economy today, every nation's success depends on the education of its people. ICT will increasingly be at the center of the education process. ICT offers new and creative ways to combine classroom experience, home learning, global outreach, and connectivity of students and teachers to the burgeoning world of online learning. Classrooms everywhere, from primary schools to higher education, will be dramatically transformed in exciting and enriching ways.

Connect To Learn is pioneering ICT in rural classrooms and charting a course for scalable solutions. With this study we have learned that, while not challenge-free, the opportunities are great. Effectively integrating technology into teaching practices in resource-poor settings requires bringing many key elements together to enable ICT to fulfill its great potential for improving student learning outcomes. Reliable connectivity, a consistent energy supply, and teacher training are among the key elements for getting started. Designing new curricula that combine online and classroom learning is another high priority. Through broad-based investment and dynamic partnerships with the telecommunications leaders of the world, there is a huge and thrilling opportunity at hand.

As Director of the Earth Institute at Columbia University I am pleased to present this report, which offers very useful insights on paths forward for ICT in primary and secondary education in low-income settings.

We believe that new ICT public-private partnerships can help close the student achievement gap with key investments, policies and programs that can be scaled from local to national levels. This research study was designed and led by the Connect To Learn team at the Earth Institute and conducted in collaboration with distinguished faculty researchers from Columbia University's Teachers College, the University of Nairobi and Kampala University, as well as secondary schools and partners from the Millennium Villages Project sites in Kenya and Uganda.

I deeply thank our research partners for their outstanding commitment to this important work, and I heartily thank and commend our partners at Ericsson for their foresight in promoting ICT for education and for funding this study. It is a great pleasure and honor for us at the Earth Institute and the Millennium Villages Project to work together with Ericsson in Connect To Learn. We believe that this effort will help to spur practical solutions in classrooms around the world, and help to catalyze a new generation of global e-citizens to address the world's greatest sustainable development challenges together.

Professor Jeffrey Sachs
Director of the Earth Institute at Columbia University
Special Advisor to the UN Secretary General



BACKGROUND

During a workshop visit to the remote Ntungu Secondary School in Ruhiira, Uganda in July 2013, the Education Sector leader from the Ruhiira Millennium Villages Project (MVP) office set aside a few minutes to introduce the research team to Connect To Learn's female scholarship recipients – girls who, without the financial support of a scholarship, would be unable to attend secondary school, ending their schooling after a basic primary education around the age of 12. As the girls eagerly introduced themselves and briefly shared their hopes and experiences, the Education Coordinator took a moment to ask the girls a series of questions illustrating for the researchers the world these girls knew. He asked “How many of you have ever been on a paved road?” “How many of you have ever watched a television?” “How many of you have ever been to Mbarara (the nearest town 40km away from where the researchers had travelled that very morning)?” For each of these kinds of questions, no more than two or three girls in a room of 100 raised their hands in affirmation.

Without access to the internet and the world of information and resources available online, these girls would have scarcely a chance to know the vast world of possibilities beyond the remote, mountainous communities where they live.

A world where all girls and boys have access to secondary schooling and all teachers and students are connected to quality learning resources through internet access is the vision on which Connect To Learn was founded.

Connect To Learn launched its mission as a set of practical solutions to contribute to efforts aimed at ending extreme poverty globally. One of its goals aims to identify how the quality of education could be bolstered by the use of ICT for teaching and learning even in the most remote, resource-poor parts of the world. When Connect To Learn was founded in the Fall of 2010, the public secondary schools in the MVP communities it partnered with had few if any learning resources. If schools had computers, they were using decades-old desktops with outdated, barely functional software. Some of the teachers lacked formal teacher training, and even those who had been trained received little if any ongoing professional development.

As of the end of 2013, Connect To Learn has raised funds to support 745 students with multiyear secondary school scholarships – the vast majority of them girls – across 12 MVP sites in 10 countries in sub-Saharan Africa and, with the inputs of our technology industry partners, has installed computers and broadband connectivity in most of their schools. In addition to the MVP schools Ericsson and partners have brought ICT computers and connectivity to an additional 22 schools around the globe covering a total student population of over 35,000 students.

The ICT in Education Study was conducted with funding support from Ericsson. The aim of the study was to gain a better understanding on how computers and cloud computing solutions installed in the CTL scholars' schools could foster creativity, motivation, and innovation among teachers and improve learning among students. After a flurry of initial excitement

when the packaged computers arrived, one could have heard a pin drop on the rough cement floor when, during the initial computer installation meeting in a Ruhiira school, the MVP Education Coordinator, Lawrence Ssenkubuge, told teachers and school administrators that the new shiny computers alone would not change anything, but rather it was their own vision and ideas for how the computers could be used to enhance teaching and learning at the school that would make an impact.

Designed by the Connect To Learn team and professors from Columbia University Teachers College, Kampala University and the University of Nairobi, the ICT in Education Study was implemented collaboratively with locally based secondary school educators in Kenya and Uganda. The goal was for university faculty from colleges of education to work hand in hand with Connect To Learn's secondary school staff on a swift and robust path for developing school culture and teaching skills to effectively integrate technology into classrooms. This was necessarily done while identifying, adapting for, and tackling the infrastructural and environment hurdles unique to the sites as they were encountered and documented.

Two years after initial conversations for the study began, the four secondary schools who took part in the study have forged profound changes, with nearly half of

the teachers now using ICT resources to develop their teaching notes, research lesson topics and activities, find new learning resources to share with students, prepare slideshow presentations, and prepare examinations and student records. Teachers who were skeptical at first of using these unfamiliar tools are now enthusiastically exploring new resources and teaching methods to employ in their classrooms.

It is the goal of this research that the findings and recommendations included within this report be used as a springboard for future interventions. First, to sustain and build on this progress to see these changes in teaching practice translate into quantifiable improvements in student learning outcomes not only at the East African research sites, but across Connect To Learn's global sites. Second, to lend impetus to the expansion of the initiative with new partnerships with telecommunications industry leaders, local and national governments, teacher training colleges and universities, like-minded organizations, schools and teachers. Raising the demand for quality education enhanced by the use of ICT in communities where such resources never existed until now is something that can benefit all stakeholders involved. This report presents a way forward to ensuring that those young people around the world who start off with very little will have an opportunity to achieve their dreams through ICT-integrated education.



EXECUTIVE SUMMARY

CHAPTER

01

WITH APPROPRIATE INFRASTRUCTURE SUPPORTS AND TEACHER PROFESSIONAL DEVELOPMENT, COMPUTERS AND INTERNET ACCESS IN SCHOOLS CAN PROVIDE IMPORTANT TOOLS AND RESOURCES TO HELP IMPROVE TEACHING PRACTICES AND STUDENT LEARNING OUTCOMES. THIS STUDY HAS WORKED TO DEEPEN UNDERSTANDING OF KEY FACILITATORS, SUCCESSES, CHALLENGES, AND POTENTIAL SOLUTIONS TO TEACHERS' ADOPTION AND INTEGRATION OF ICT IN CLASSROOMS.

A one-year study was conducted to deepen the understanding of how Information and Communication Technology (ICT) can best be implemented in secondary schools in resource-poor settings around the world. Secondary schools in sub-Saharan Africa, namely in Uganda and Kenya, were intensively studied during the year-long engagement. The study was designed to equip Connect To Learn leadership and its chief technology partner, Ericsson, with insights on how to create the best implementation strategy to fulfill Connect To Learn's mission to drive improvements to the quality of education for girls and boys in the developing world through the integration of technology in the classroom.

The study has worked to deepen understanding of the key facilitators, successes, challenges, and potential solutions to teachers' adoption and integration of ICT in their classroom practices. The principal investigators of the study, all senior educators, have achieved this by actively working to address some of the most apparent gaps and obstacles in four schools across two existing program implementation sites as they arose over the course of the 12-month project through the following means:

■ **Systematic implementation of ongoing Teacher Professional Development (TPD)** in the integration of basic ICT skills into teaching preparation and classroom practice, which was tailored around the expressed needs of teachers

■ **Design and implementation of school practices that encourage open access to computers** for teachers' use in lesson preparation and execution

■ **Adaptation of critical elements of infrastructure**, principally the provision of working computers, software updates, projectors and flash disks at each school to enable and facilitate use of the computers in both ICT lab facilities and classrooms throughout schools

■ **Collection and sharing of relevant online teaching and learning resources** and collaborative learning tools for access by teachers across Connect To Learn school sites through the Connect To Learn Online Resource Library

■ Identification of key next steps for the successful, sustainable integration of ICT at project schools

METHODOLOGY

The methodology was built upon a collaborative approach, with teachers and school principals actively participating in the documentation of their evolving ICT skills and teaching practice over the course of the year. At the four project schools, two each in Sauri, Kenya and Ruhira, Uganda, teachers and school principals played important roles helping to shape the content of the professional development they received. Data collection methods included

teacher surveys and interviews at the beginning and end of the project, regular observations of teaching practice in classrooms, and observation of teacher participation during monthly workshops. Over the course of the year, each school participated in seven workshops.

Observations during the implementation of these strategies over the past year have revealed more nuanced factors such as optimal school characteristics, challenges and both short term and more robust potential long-term solutions. It has been made remarkably clear, for instance, that the process of building the confidence and skill of a school's teaching staff to innovate their entrenched teaching styles through the integration of ICT is a slow one that requires time and persistent effort. While much progress has been made over the past year, sustainability of this progress will require continued and consistent support for teachers throughout each school.

KEY FINDINGS

1. Physical Infrastructure
2. ICT Infrastructure
3. Teacher ICT and Pedagogical Skills and Knowledge
4. Open Source Teaching and Learning Resources
5. Student ICT Participation and Knowledge
6. Public-Private Partnership Implementation

Research findings show that over the course of the year, there were significant increases

both in teachers' reported skill and comfort with using ICT for educational purposes, as well as in their observed use of ICT in the classroom. For example, where only 21% of teachers considered themselves to be "advanced" users of ICT at the beginning of the project, by the end, 45% of teachers were reporting themselves to be advanced users. There was also an 18% increase in reported use of ICT in the classroom over the course of the project.

RECOMMENDATIONS

Recommendations are grouped according to the six key intervention areas

PHYSICAL INFRASTRUCTURE

■ Develop school policies for open access to computers and projectors by teachers and students

■ Equip all classrooms for computer and projector use with appropriate electrical outlets and security

ICT INFRASTRUCTURE

■ Provide computers and projectors in phases that align with teachers' increasing integration of ICT

■ Provide wifi networks at the schools such that every classroom is connected

■ Provide adequate airtime to schools to meet educational needs

■ Hire school-based ICT teachers to act as project facilitators

■ Use computer logins to understand computer usage patterns

TEACHER ICT AND PEDAGOGICAL SKILLS AND KNOWLEDGE

■ Engage teachers in ongoing, practical professional development facilitated through partnerships with local universities and/or NGOs

■ Provide capacity-building to teacher trainers from local universities and/or NGOs

■ Observe classrooms regularly to encourage and support increasing use of learner-centered methods and integration of ICT

OPEN SOURCE TEACHING AND LEARNING RESOURCES

■ Lead teachers through the exercise of locating relevant online resources and uploading to the Connect To Learn Online Resource Library

■ Expand the availability of quality online resources for secondary teachers in collaboration with African faculties of education

STUDENT ICT PARTICIPATION AND KNOWLEDGE

■ Encourage teachers to assign online research or information presentation assignments that utilize LibreOffice software to their students

■ Encourage both students and teachers to use the computers for education-related purposes only in order to conserve airtime

PUBLIC-PRIVATE PARTNERSHIP IMPLEMENTATION

■ Hire local facilitators in each site to provide ongoing professional development and support to administrators and teachers

■ Forge partnerships with in-country Faculties of Education and Telecommunications Industry leaders to institutionalize the integration of ICT at the tertiary level

■ Deepen partnerships within the telecommunications industry to provide infrastructural and program support to the schools

The recommendations outlined here and explained in detail in the report offer a path forward that, if followed by a coalition of public and private stakeholders, will translate into quantifiable improvements in student learning outcomes, giving students from resource-poor parts of the world the opportunities they deserve for achieving their dreams.

RESEARCH SUMMARY

The ICT in Education Study report is organized as follows:

First, it presents a review of the project schools and activities undertaken over the course of the one-year study.

Next, the report provides a review of key findings based on data and research team experiences during the year-long series of workshops, broken down into the six key intervention areas – Physical Infrastructure, ICT Infrastructure, Teacher ICT and Pedagogical Skills and Knowledge, Open Source Teaching and Learning Resources, Student ICT Participation and Knowledge, and Public-Private Partnership Implementation. Based on these findings, a set of common school characteristics are presented for each intervention area.

Finally, the report concludes with a series of recommendations for a scalable ICT in Education Intervention Model across sites, which is accompanied by a logic framework that offers a phased roadmap for implementation of the proposed model.





REVIEW OF PROJECT SCHOOLS AND ACTIVITIES

CHAPTER

02

FOUR SCHOOLS IN RURAL KENYA AND UGANDA WERE STUDIED DURING THIS ONE-YEAR ENGAGEMENT. GENERAL CHARACTERISTICS FOR SCHOOLS IN THESE RURAL AREAS INCLUDE LACK OF ROBUST 3G CONNECTIVITY, RELIABLE ELECTRICITY AND LOW ICT EXPERIENCE AND COMPETENCE AMONG TEACHERS.

Before delving into the key findings and initial outcomes of the work done over the past year, it is important to understand the school contexts in which the project was implemented, as well as the kinds of activities that were undertaken. This snapshot will help enable fuller understanding of the work necessary to achieve sustainable change in such contexts. The school environments are described below including a set of common characteristics seen in many secondary schools in resource-poor settings. This is followed by the activities that were undertaken over the course of the project.

Four schools were intensively studied during the year-long engagement, two in the Millennium Villages Project site in rural Kenya and two in the Millennium Villages Project (MVP) site in rural Uganda. It should be noted that in both of these MVP sites, Ericsson has been a partner since 2007. As part of that partnership, Ericsson has made significant investment in establishing basic mobile communications for all of the MVP sites across Africa. When the connectivity is described as poor or lacking below, it is in part due to the fact that initial telecom investments were made prior to the launch of Connect To Learn, and so the coverage is not optimized for the locations of the schools, which are typically just outside the MVP village areas.

TWO SCHOOLS IN SAURI, KENYA

The Sauri cluster of Millennium Villages Project (MVP) villages lies in western Kenya (Yala Division, Siaya District, Nyanza Province)

Uranga Secondary School

Located in the Nyanza province of western Kenya, the school has a small population of roughly 200 students, with a teaching staff of 13. The classroom block includes an administration office and one classroom for each form level, totaling four classrooms. There is also an ICT lab and a science lab; both are electrified with outlets. In addition to the 25 Connect To Learn netbook computers, the school has two desktop computers. However, the classroom block still lacks electricity. Uranga has weak connectivity, with teachers keen to acquire improved connectivity as their comfort with and interest in ICT grows. The Principal, Mr. Stephen Ogolla, notes that the internet “has been so weak and at times not even there, making it difficult to perform activities that are to be done online.” Both the Principal and Deputy Principal demonstrated keen interest in developing their own ICT skills and encouraged use of ICT among the teaching staff, which they did increasingly over the course of the project.

It was noted by the Principal that at the beginning of the project, “ICT was viewed with a lot of suspicion” or as “a waste of time” by teachers. By the end of the study, however, the Principal said “A lot of positive changes have taken place,” and that the use of ICT has “helped in boosting the performance in the school.” He also noted that teachers find it easier “organizing and reorganizing their work when material is in soft copy.”

Ulumbi Secondary School

Located in the Yala division of western Kenya, the school has a population of about 480 students, with a teaching staff of 23. The school has three stories and more than a dozen classrooms, including an ICT lab with 25 desktop computers in addition to 25 Connect To Learn netbook computers. While the ICT lab and the administration offices have electricity, the classrooms do not have outlets to plug in projectors or computers. The internet connectivity is somewhat stable at Ulumbi, but it is not strong enough to provide a sufficient signal for effectiveness when more than a few users are accessing it at any given time. Both the Principal and Deputy Principal were supportive of the project, and increasingly so as the project continued, though they were not directly involved. These key school administrators’ early disinterest in learning and utilizing ICT may have contributed to the overall lack of teachers’ access to computers indicated during the pre-intervention survey, when 88% of teachers at Ulumbi noted that few teachers had access to the computers.

According to one teacher at Ulumbi, teachers early on in the project “did not see the importance of knowing and using the ICT in their teaching practices.” By the end of the project however, the same teacher noted that “teachers’ attitudes have really improved” and that some “have gone ahead to look for interactive learning materials and have been embedding them in their teaching since the project has even seen the school acquiring a new projector.”

TWO SCHOOLS IN RUHIRA, UGANDA

The Ruhira cluster of MVP villages lies in southwestern Uganda and is 40km from the nearest city, Mbarara

Ntungu Secondary School

Located in the remote Isingiro District in Western Uganda, Ntungu has a student population of over 300 and a teaching staff of 22, many of whom are part-time. The school has seven classrooms, including the ICT lab and a library. All classrooms have power, but only the ICT lab has outlets. Ntungu is similar to Uranga in that the connectivity is weak. During the various workshops the leaders attempted to use several carriers; of these, none but MTN succeeded, and connection was quite spotty and unreliable. Midway through the project, the Uganda Communications Commission installed 15 desktop computers in the ICT labs.

Ntungu has a mathematics teacher who is in charge of the ICT lab and who demonstrated significant enthusiasm for the job. He was asked to take on leadership responsibilities as a co-facilitator for the ICT in Education Study project, working closely with his equivalent at Kisyoro and with guidance from the MVP Education Coordinator and research team. Though his skills exceed those of his peers, there is still much room for improvement in order for him to be an optimally effective ICT coach at the school. The abilities of the Headmistress to assist in execution of the project objectives seemed limited, probably due to the employment arrangement (part-time) with most of her staff; this was reflected in the inconsistent workshop attendance at Ntungu and the reported comments among teach-

ers that they wished for compensation for their participation in the workshops.

Kisyoro Secondary School

Also located in the remote Isingiro District of Western Uganda, Kisyoro has a student population of about 700 students with a teaching staff of 26. The Headmistress of Kisyoro, though very new to using ICT, is a notably strong leader who has shown great enthusiasm for encouraging use of ICT among her staff. Workshops have been well attended, and she has hired a security guard to stay at the ICT lab until 10 pm during the school week to encourage increased use of the computers. The Headmistress has also made a point to address any expectation among the teachers that they should be compensated for the training, reminding them that they are receiving training for a valuable skill that many would have to pay significant fees to receive. She emphasized this with her own experience, stating “In my pursuit to gain ICT knowledge I once paid UGX 30,000 (US\$ 12) for a one hour lesson but the lesson ended even before I had learnt how to move a mouse”. When asked about the impact of the program at her school, she noted “before the ICT project, hardly any teacher knew anything to do with ICT so very few, if any, would move the cursor on the computer and one or two were interested in the computers which we had at school. As we started the program, some picked interest and by the time the project ended, some full time teachers had got interest. They are now in position to draw lesson plans, schemes of work and lesson notes using computers. Most of the teachers can teach using computers with the help of a projector while deal-

ing with large classes. Teachers are able to use computers when making reports, especially making marks.”

The connectivity at Kisyoro is relatively stable, though its capacity only allows for a few computers to access it at any given time, with pages taking several minutes to load. The school had six electrified classrooms including the ICT lab; however the ICT lab is the only classroom with outlets to access electricity. As in Ntungu, the Uganda Communications Commission installed 15 desktop computers in the ICT labs midway through the project.

The ICT teacher, a PTA-funded teacher without a government contract, was tapped for the role of Project Facilitator. His station at the school enabled him to support teachers often and respond quickly to requests of the research team. He noted that at the beginning “teachers didn’t take ICT to be useful until this project proved it to be useful.” He also observed that, since then “there has been an increase in the use of ICT equipment in teaching.”

COMMON SCHOOL CHARACTERISTICS

The Connect To Learn program has been active in an additional 31 schools across sub-Saharan Africa, Latin America and the Middle East. Combining the findings of this deep study of four schools with the experiences of engaging in the other 31 schools, it is clear that the following characteristics are commonly in evidence in schools in rural, resource-poor settings:

Secondary schools lack robust 3G connectivity: Schools are often not prioritized in network rollout plans by Mobile Network Operators. This may be due to the lack of clear business models where schools are not seen as a vital part of commercial considerations when planning mobile network coverage. A consequence is that rural schools are often poorly served by mobile broadband networks.

Secondary schools often lack reliable electricity. In many cases, even where there is electricity available from the grid, the service can be poor and unreliable. This makes it difficult to plan and implement ICT based programs which depend on reliable sources of power.

Teachers generally lack basic ICT competence and unless the schools management is supportive then it is difficult to implement teacher professional development programs that are essential to drive ICT usage within schools.

Schools often lack access to even basic learning resources, let alone the kind of quality, dynamic content available through ICT. Installation of ICT resources can make a huge difference in resource-poor settings, but need dedicated, ongoing support to optimize the resources.

PROJECT ACTIVITIES

Teacher Surveys

A total of 43 baseline (pre-intervention) surveys were collected early in the project between October-November 2012. A total of 49 surveys were collected during the post-intervention survey conducted in late July 2013. Note that there was some flux among

the teaching staff over the course of the project, with some teachers transferred from the project schools, and new ones joining the schools who were invited to join the training workshops. The pre-intervention survey informed the development of the workshop series. The post-intervention survey was nearly identical in order to allow for comparison; however, it

included some additional questions asking teachers to reflect on a) what they had learned, b) what they found to be most effective from the workshops, c) what they found to be some of the most significant barriers, and d) what they believe to be most critical to improving ICT integration at their schools going forward.

Table 1: Teacher Surveys

	Sauri, Kenya		Ruhira, Uganda	
	Uranga	Ulumbi	Kisyo	Ntungu
Pre-Surveys (43)	8	18	9	8
Post-Surveys (49)	12	13	17	6

Teacher Interviews

The teacher interview component of the research was designed to elaborate upon the informa-

tion gathered from the surveys in order to further understand teachers' specific needs, interests, and challenges with regard to ICT

learning. The round of interviews conducted at the beginning of the project helped inform the development of the workshop series.

Table 2: Teacher Interviews

	Sauri, Kenya		Ruhira, Uganda	
	Uranga	Ulumbi	Kisyo	Ntungu
Pre-Interviews	8	8	4	6

Classroom Observations

The classroom observation tool has been the core research tool used to observe the evolution of teaching practice over time, both in terms of integration of ICT and use of learner-centered pedagogy. Studies of ICT in education

generally rely on reports of attitudes, not classroom practice; observations help remedy that lacuna. Observations have been conducted monthly at all of the schools, and they have included both open-ended and Likert scale questions to enable both qualitative and quantitative analysis. The

numbers of observations conducted at each school is included in the table below. The information collected during regular observations also informed the design of on-going professional development workshops.

Table 3: Classroom Observations

	Sauri, Kenya		Ruhira, Uganda	
	Uranga	Ulumbi	Kisyo	Ntungu
Phase 1 (Oct-Feb)	11	11	3	0
Phase 2 (Mar-Sep)	3	6	12	7

Teacher Professional Development Workshops

In both Sauri and Ruhira, seven workshops were carried out over the course of the project. The goal

was originally to conduct eight workshops at each school, but unavoidable situational challenges such as the national election and lengthy teachers' strikes in

Kenya, as well as delays in funding disbursement, reduced this number very slightly.

Table 4: Teacher Professional Development Workshops

	Sauri, Kenya	Ruhira, Uganda
Phase 1	4	2
Phase 2	3	5

During the workshops, teachers were asked to share examples of how they had been using the ICT to enhance their teaching, examples of which are shared in the findings section. The practical nature of the workshops also allowed the research team

to observe teachers' developing skills as they applied their learning to create lesson plans using Libre Office Writer and presentations using Libre Office Impress, integrating resources found online through their own research, such as diagrams, images, simulations

and YouTube videos. These activities provided the research team with observational data, shared in the findings section, to assess the overall learning of the teachers over the course of the project.



KEY FINDINGS

CHAPTER

03

KEY FINDINGS CALL OUT THE SIX PRIMARY INTERVENTION AREAS DETERMINED TO BE CRITICAL IN EFFECTIVELY INTRODUCING AND INTEGRATING ICT RESOURCES IN THE SCHOOLS WHERE CONNECT TO LEARN WORKS.

These key findings are organized into the following essential intervention areas. Each section concludes with a set of common characteristics used to inform the recommendations that follow in the next chapter.

- Physical Infrastructure
- ICT Infrastructure
- Teacher ICT and Pedagogy
- Open Source Teaching and Learning Resources
- Student ICT Participation and Knowledge
- Public Private Partnership Implementation

After a review of findings in each of these sub-sections, a set of common characteristics is provided as a tool for planning a complete ICT intervention in similar secondary school contexts. The recommendations in the next section of this report stem from these common characteristics.

PHYSICAL INFRASTRUCTURE

This section outlines some of the factors relating to power infrastructure, security, and school cultures and practices that influence teacher and student access to the computers for use in classrooms.

Power

The lack of electrical infrastructure poses various challenges at

the four schools that are common among schools in rural African contexts. The table below outlines

the power infrastructure situation at each of the four schools.

Table 5: School Power Infrastructure

	Grid Connection	Alternative Power Sources	Electrified Classrooms	Average Days without Power in a 5-day School Week, Pre-Survey	Average Days without Power in a 5-day School Week, Post-Survey
Uranga	Yes	None	ICT and Science labs have electricity; 4 other core subject classrooms do not	2.4 days	2.46 days
Ulumbi	Yes	Generator	More than 12 classrooms are electrified, but only ICT lab and admin offices have outlets	2.85 days	2 days
Kisyyoro	Yes	Generator, Solar	ICT lab and one of the two classroom blocks is wired for electricity, but only the ICT lab has outlets	0.55 days	1.76 days
Ntungu	Yes	Generator, Solar	All 7 classrooms are wired for electricity, but lack outlets	2.65 days	0.83 days

With regard to power, though grid power is generally unstable, all the schools except Uranga have backup as noted in Table 5, enabling them to plan with relative confidence for ICT-related activities in those classrooms that are electrified with outlets. However, unreliable electricity remains a challenge at schools with no backup like Uranga, as the team experienced during professional development workshops. The bigger issue is lack of electricity across the school campus. As a prerequisite for ICT installations by Ericsson for Connect To Learn,

schools were required to have an electrified ICT lab; all four schools in this study did. As a result, the ICT labs were – until recently – where all the computers were always kept. The need for security requires the room to be locked when not in use; heavy class demand for the space among faculty and the ICT his/herself further reduces access.

Ulumbi is the most well equipped school with regard to electrified classrooms. The entire school is electrified with overhead lights, but only the ICT lab and administrative

offices have outlets. The research team never observed the classroom lights in use, likely because the natural light rendered them unnecessary.

At Uranga, Kisyyoro and Ntungu, many of the classrooms have no electricity, and some of those that are wired for electricity and have overhead lights still lack outlets to plug in computers and/or projectors. For the teachers in those classrooms, it becomes difficult for them to integrate their growing ICT skills with their students during class time.

Security & Access to Computers

Concern among school leaders over the security of the laptops was found to be a considerable detriment to the widespread use of the computers. During visits to schools by the research team members early in the project, it was apparent at all four schools that the computers were being brought out for the workshop but were otherwise stored away on most days due to security concerns and protection from dust.

These precautions were taken in addition to the computers being specially designed to withstand dust and humid conditions and also being equipped with encryption software as a theft deterrent. The task of moving the computers from storage was quite time-consuming, requiring 20-30 minutes of setup time by the ICT teachers.

Based on pre-intervention survey data, a majority of teachers (63%) began with the perception that the computers were only available for “a few teachers”. The point was clearly made to the school leaders and teachers in every workshop that the computers were meant to be used as much as possible for teaching and learning purposes and should be kept readily available for use by teachers and students. By the time of the post-intervention survey, the majority (61%) had shifted to claiming that “most teachers” have access to the computers. One of the advantages of the ICT cloud management system supplied by Ericsson is that reports of online usage can be generated from remote locations. With a stable internet connection, this system can provide valuable information on usage patterns of the installed base of computers even to the point of indicating which schools were not actually

using their computers and connecting them to internet. Over the course of the project and with the assistance of the Project Facilitators and ICT teachers at the schools, solutions were developed to address the issue of accessibility. Tools were created to enable teachers to “sign-out” and “sign-in” computers and/or the projector for their use. All four schools have now implemented this practice for borrowing computers at the school. Teachers have been encouraged during workshops to take note of their computers’ ID numbers so that they can continue to build their collection of work on one computer. Several teachers at Ulumbi and Uranga in particular have informed members of the research team that they use the computer ID numbers to request specific computers they have been using to create their notes and presentations and collect downloaded materials.

As teachers began to increase their use of the computers over the course of the project, another concern that school leadership raised was the increasing cost of airtime data and the need to limit access to certain high-bandwidth or non-education-related sites, particularly since some teachers were using the school’s data plan to access social media sites in their spare time and many teachers were looking to YouTube and other educational websites to stream or download large video files.

Some of the solutions now being implemented to mitigate this issue include:

- Advising teachers of the importance of responsible use of the internet and managing their behavior on the internet when using the school’s data package
- Demonstrating during workshops how to change default

download settings so as to optimize the available bandwidth e.g. setting YouTube videos to default to lower quality settings in order to use less bandwidth.

Knowledge-building and training, along with the introduction of similar measures should be integrated into initial ICT implementation training and support manuals in all sites.

A request that was reiterated many times over the course of the project, and increasingly toward the end of the project period as teachers’ levels of interest grew along with their skills, was for teachers to be able to take computers home with them for practice and classroom preparation. With family and other responsibilities, staying after school to use the computers is not an option for many of the teachers. At Kisyyoro, the Headmistress has begun permitting teachers who live near the school to borrow the computers for use at home. At the other schools, this matter has been discussed with the principals and the teachers have been advised to consult their Principals on this issue and to develop measures of accountability.



Common School Characteristics – Physical Infrastructure

■ Schools lack reliable grid electricity. Unreliable electricity makes it difficult to organize ICT-integrated lessons.

■ Schools often have alternative power sources, and those that do not struggle as a result.

■ Schools lack electrical outlets in classrooms, which inhibit use of ICT in those classrooms.

■ School leadership concern over computer security can be detrimental to teacher and student access. Early in the project, it was clear that at some of the schools, the computers had been stored and not turned on in quite a while.

ICT INFRASTRUCTURE

As a result of the installations made by Ericsson for Connect To Learn at the four schools, each school has 25 functional netbook computers and a number of desktop computers ranging from 2-25 as noted in the school descriptions above. This number works as a starting point for teachers considering that the sizes of the ICT-novice teaching staff are between 13-26 at each school; however, the number is minimal to meet

the needs of a classroom of students, where the typical class size is between 40-60 students. As integration and usage of ICT increases, more computers will be needed to meet the demand.

Connectivity remains a significant challenge at all four schools, most notably at Uranga and Ntungu. At all four schools, when more than four or five teachers or students want to use the internet at a given time, such as in a class setting, the speed slows immensely. On average, the time it took to load a page during a workshop at any of the four schools ranged from two to ten minutes. Poor connectivity is mainly a result of the schools not being prioritized when original network rollout projects were implemented by local Mobile Network Operators.

Another challenge is that the connectivity radius does not span the entire school. When members of the research team checked for connectivity in classrooms using their smart phones, it was found that, at best, the connectivity could be accessed in classrooms immediately bordering the ICT labs.

During the pre-intervention survey early in the project, the most common response to the question of perceived barriers to

ICT integration was that teachers lack experience using ICT (33%, Table 6). By the end, the number of teachers naming lack of experience as the biggest barrier shrunk to 18% (Table 6), demonstrating the need for teacher training at the beginning of the project and the effectiveness of the training that was undertaken. By the time of the post-intervention survey, teachers reported a lack of reliable access to internet as the largest barrier (51%, Table 6). The table below outlines teachers' responses to the question of barriers to ICT integration in the pre- and post-intervention surveys. It is telling to note from the data in Table 6 that, prior to the workshop series, only 19% of the participants stated that reliable access to internet was lacking. At the time of the post-intervention survey, a majority (51%) indicated that access to internet is a problem. This shows that, early in the project, teachers were not aware that the internet was weak or unreliable, which further shows that the teachers were not attempting to use the internet prior to the intervention. By the end however, the teachers were regularly using the computers for internet research, and therefore became aware of its unreliability.

Table 6: Most significant barriers to Integration of ICT

	Pre (43 respondents)		Post (49 respondents)	
	# Respondents	Percentage	# Respondents	Percentage
Lack of steady, reliable access to electricity	7	16%	9	18%
Lack of reliable access to internet	8	19%	25	51%
Non-functioning computer hardware	3	7%	5	10%
Non-functioning computer software	1	2%	6	12%
Teachers lack experience using computers	16	37%	2	4%
Teachers lack time to prepare lessons using computers	5	12%	1	2%
Teachers lack access to quality content that aligns with the curriculum	3	7%	4	8%

Reliable/consistent computers, software, supporting equipment, and connectivity to the internet are key for schools to adopt and integrate the use of ICT in their teaching and learning practices. Based on usage patterns late in the project, an ideal monthly data package per school would include roughly 1 GB per computer per month. At a school with 25 computers, this would be 25 GB per month. In Kenya, the Project Facilitator was able to purchase airtime for 1000 KSH per 1.5 GB, or approximately 12 USD per 1.5 GB.

At this rate, a monthly cost for adequate airtime at a school with 25 computers and which is actively integrating ICT would be approximately 300 USD. This is a considerable expense for a school in this kind of resource-poor community, and so telecom partnerships are necessary for the success of this kind of program.

Another finding relating to ICT Infrastructure is the need for additional equipment such as projectors, flash drives and printers/copiers (Table 7). During the first half

of the project, the only school that had a projector was Uranga. This severely limited teachers' opportunities to integrate ICT into their whole class teaching practices. Even at Uranga, the reality that only one classroom apart from the computer laboratory had electricity made the use of the projector quite limited. When asked what kinds of additional ICT resources would encourage the integration of ICT in the pre-intervention surveys, the most common responses were as follows:

Table 7: Additional ICT Resources – Pre-intervention Survey

	Uranga (8 respondents)	Ulumbi (16 respondents)	Kisyyoro (7 respondents)	Ntungu (8 respondents)	TOTAL (39 respondents)
Projectors	0	13	5	3	21
Relevant online/digital resources	1	2	1	2	6
Scanner	1	2	0	0	3
Printer	2	1	0	0	3
Camera	1	1	0	0	2

*Note that at the time of the pre-intervention survey, Uranga already had a projector.

Given the clear need for projectors noted by teachers, it was decided by the research team to use a portion of the project budget to purchase projectors for the three schools that did not have projectors. Once the projectors were received by the schools, teachers immediately began making use of the computers. Within the first month of the projectors

arriving in the Ruhiira schools, five teachers at Kisyyoro and four at Ntungu began using them in their classrooms. Further professional development with the projector and with identifying relevant resources should increase this number.

By the time of the post-intervention survey, when asked the same

question about need for additional ICT resources, the most common responses were as shown in Table 8 below. Note that at Ulumbi, this survey was conducted the day before their projector arrived (later than had been expected due to logistical delays at the Sauri MVP site). Therefore, this need has since been addressed at Ulumbi.

Table 8: Additional ICT Resources – Post-intervention Survey

	Uranga (12 respondents)	Ulumbi (12 respondents)	Kisyyoro (12 respondents)	Ntungu (4 respondents)	TOTAL (40 respondents)
Projectors	0	11	5	1	17
Printer/Copier	8	1	4	0	13
Additional router / modem / improved connectivity	3	2	0	1	6
Relevant online/digital resources	0	1	3	1	5
Flash drives	1	1	1	1	4
Additional laptops	0	2	1	1	4
Scanner	0	2	1	0	3



This survey suggests that many teachers, and particularly those at Uranga and Kisyoro, would benefit from having a photocopier/printer available. Teachers across the schools reported efforts to digitize their course notes and assessment materials, but without access to a printer they could not make use of those materials.

Early in the project it was noted by the research team in Uganda that the ICT teachers, or teachers appointed to oversee the ICT lab, were not government contracted teachers but rather part-time teachers funded by the school PTAs. As such, it was possible to contract these teachers as the local project facilitators, a strategy that was found to be quite effective

as the teachers are enthusiastic about taking on leadership and well placed to support their peers on a regular basis. Though not ICT experts, they were positioned to offer limited technical support, as well as to collect monitoring and evaluation data and act as liaisons between the schools and the research team.

Common School Characteristics – ICT Infrastructure

Schools lack an adequate number of computers to enable frequent access by all teachers and students. With student populations in the hundreds, teaching staff between 13-26, and average class sized between 40-60, larger numbers of computers are required to meet the needs of all students and teachers.

Teachers require ancillary supporting equipment in order for computers to be adopted and usage to be optimized toward their greatest needs. Without projectors, printers or scanners, teachers lack incentive to use the computers outside of the ICT lab, and even in the ICT lab it is difficult to facilitate a shared learning experience.

Schools have connectivity, but it is often weak and unreliable. When the connectivity works, few users can access at the same time, and the radius of access does not reach the entire school.

Schools lack the local technical support necessary to facilitate integration of ICT.

Schools often have PTA-funded staff to teach ICT classes. Such instructors could facilitate ongoing teacher training program.

Teacher ICT and Pedagogical Knowledge and Skills

The initial visits by the research teams to the schools and the pre-intervention survey, interviews and classroom observations helped the team assess the necessary starting point for the workshop series based on teachers' existing skills and experience. Though many of the teachers had received basic training by Ericsson during the initial installation, with the teachers in the Ruhiiira schools having received additional, condensed training at a later point, a lack of consistent follow up made it so that most of the teachers recalled little of what they had learned previously. During the first workshops, it was

apparent that the vast majority of teachers had difficulty performing the most basic tasks of locating applications, opening files and typing. The main topics covered in the workshop series therefore were designed to start at the very beginning, and included the following, in order of implementation.

- Turning on the computer and introduction to the Linux interface
- Creating and using email (gmail)
- Creating learner-centered lesson plans using Libre Office Writer
- Using the internet and introduction to the Connect To Learn ORL
- Creating class presentations using Libre Office Impress, integrating online resources
- Demonstrations of learner-centered lessons integrating online resources
- Introduction to online collaborative learning platforms

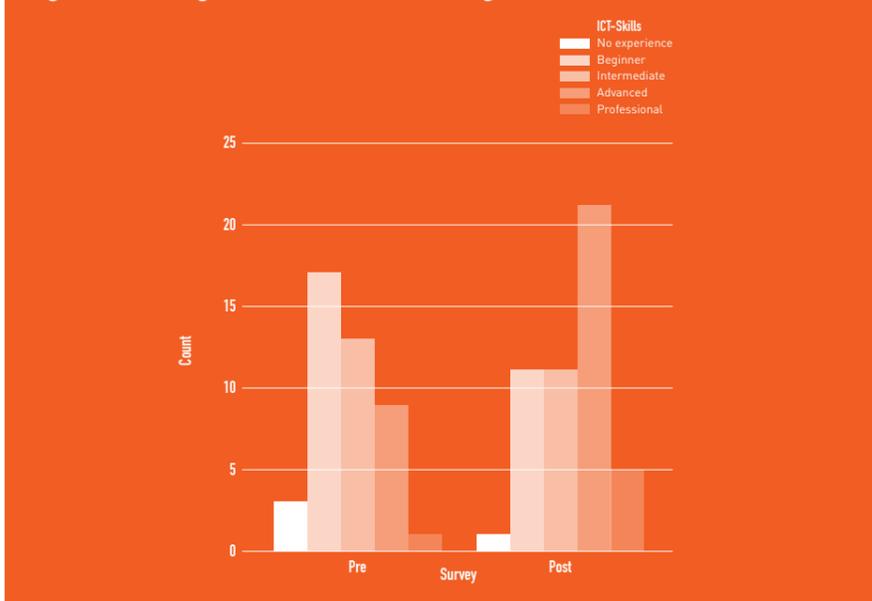
Each workshop typically lasted between 4-5 hours.

Over the course of this project, the teachers at all four schools made significant progress in their understanding of and enthusiasm for ICT. Most teachers were demonstrably keen to learn more about ICT for educational purposes early in the project, though it was reported later by school leadership that some teachers had been skeptical at the beginning before they understood how ICT could benefit their teaching. Teacher responses to the pre-intervention survey indicated that 37% of teachers described themselves as an ICT “beginner,” while 26% identified as “advanced” or “professional.” By the time of the post-intervention survey, those numbers had shifted to 22% identifying as “beginner,” and 55% identifying as “advanced” or “professional.” Overall perceived knowledge of ICT improved significantly ($F = 9.783, p < 0.05$) (Fig 1.). In addition, observations made by the research team during workshops documented the immense change that had occurred: teachers who at first could barely type were, by the end of the year, creating word documents and slideshow presentations and downloading learning materials researched on the internet.

Workshop attendance remained consistent throughout the course of the study at all four schools, demonstrating the commitment of the teachers and school leaders involved. The only school where less than a majority of teachers attended on average was Ntungu.

In addition to the reported increase in ICT skill level reported by teachers as explained above and outlined below in Table 9, data collected from the pre- and post-intervention surveys show that teachers from all four schools

Figure 1 : Showing Teachers Perceived knowledge of ICT Pre and Post Intervention



also report an increase in the actual use of ICT for educational purposes in either their lesson preparation or delivery (or both), from 21% to 39% as outlined in Table 10 below. While the 29 percentage point increase in teachers reporting an “advanced” or “professional” ICT skill level demonstrates the effectiveness of the workshop series and indicates the teachers’ beliefs that they have improve significantly, it must be noted that, based on classroom observation data, these teachers still have work to do to be fluent in their ICT skills and comfortable with learner-centered teaching methods. As shown in Table 11, use of ICT in teaching increased over the course of the project, yet this does not seem to have any significant effect on their perceived comfort with ICT ($F=0.03, p > 0.1$). Still, less than half of teachers are integrating ICT in their lesson delivery, and those who are still rely largely on lecture methods. Classroom culture in these schools was characterized largely by quiet, obedient students sitting in rows facing a teacher in the front who lectures on the topic, perhaps asking occasional

factual questions. Students were rarely asked to work with each other on in-class assignments, to assess themselves, or to present to their peers, though there were a few notable exceptions. Though research team members observed an increase in learner-centered methods being employed by teachers over the course of the project, there was not a noticeable correlation between increased use of learner-centered methods and increased use of ICT: some teachers were using more learner-centered methods, but were not necessarily integrating ICT, while others were using ICT to prepare and/or execute lessons, but were not necessarily departing from the lecture-based method. This supports the recommendation that teacher training be designed to teach both ICT and learner-centered pedagogy in an integrated manner.

Though the teachers have not achieved ICT fluency, their learning to date has equipped teachers with enough knowledge of the potentials of ICT to engage their students in ICT-enabled learning. One teacher of history, during a workshop at Ntungu, made the profound observation that, “though I am still beginning with computers, if I know what is possible, I can ask the students to find things using the internet and then share with the class so that

we all learn.” This point has been emphasized during recent workshops so that the teachers know that they do not need to wait to feel like experts to integrate ICT, but can rather direct their students to use ICT tools to collect and curate relevant information to share with their peers as part of the learning process.

An outline of the teachers’ change in self-reported skill and comfort with using ICT is given in Table 9

below. Table 10 and Figure 2 both demonstrate the increased use of ICT for educational purposes between the beginning and end of the project. The second data set (Table 10) comes from the teachers’ self reported data from the pre- and post-intervention surveys, while the third data set (Table 11) comes from classroom observations conducted over the course of the project period.

Table 9: Teacher Skill and Comfort with using ICT

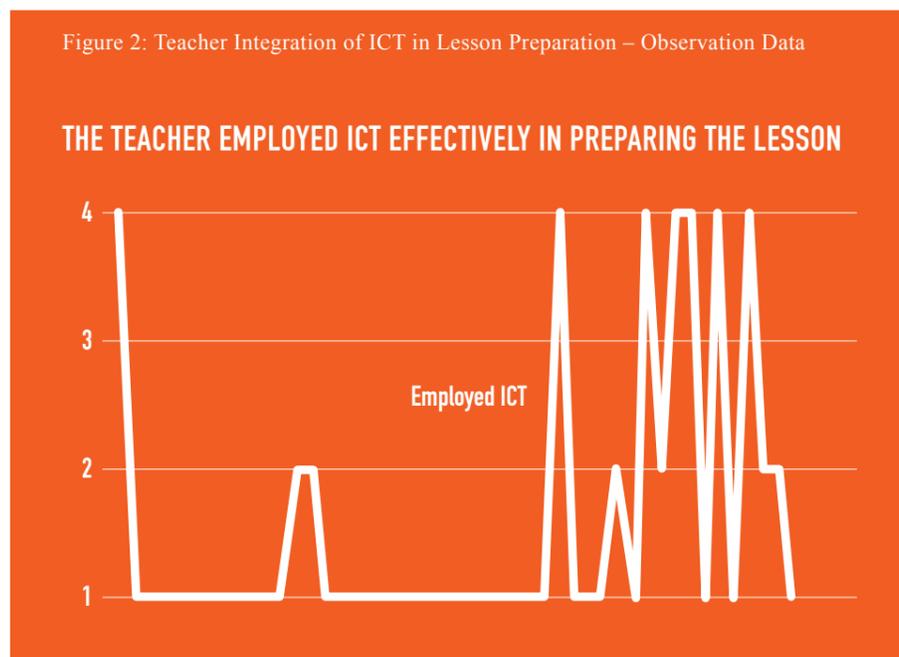
TOTAL	Pre (43 respondents)		Post (49 respondents)			Pre (43 respondents)		Post (49 respondents)	
EXPERIENCE	# Respondents	Percentage	# Respondents	Percentage	COMFORT	# Respondents	Percentage	# Respondents	Percentage
No Experience	3	7%	1	2%	Not Comfortable	0	0%	3	6%
Beginner	16	37%	11	22%	Somewhat Comfortable	5	12%	2	4%
Intermediate	13	30%	10	20%	Comfortable	21	49%	21	43%
Advanced	9	21%	22	45%	Very Comfortable	17	40%	23	47%
Professional	2	5%	5	10%					

Table 10: Teacher Personal ICT Use and Integration of ICT into Lesson Preparation and/or Delivery - Survey Data

TOTAL	Pre (43 respondents)		Post (49 respondents)			Pre (43 respondents)		Post (49 respondents)	
PERSONAL	# Respondents	Percentage	# Respondents	Percentage	IN TEACHING	# Respondents	Percentage	# Respondents	Percentage
Yes	29	67%	42	86%	Yes	9	21%	19	39%
No	14	33%	9	18%	No	34	79%	30	61%

This survey data shows that 39% of teachers are now integrating ICT into their teaching practice, compared with 21% at the start of the project. (Note that almost half of the initial 21% was comprised of ICT teachers.) It also shows an increase in personal use of ICT, indicating that teachers are becoming more familiar and comfortable with computers.

Figure 2: Teacher Integration of ICT in Lesson Preparation – Observation Data



The observation data also reflects, more objectively, the trend toward increased integration of ICT over the project period. Figure 2, based on 53 observations distributed evenly over the course of the entire research project, shows much higher and more regular ICT use by teachers in observed classrooms during the latter half of the project. Survey and observation data suggest that the most common ways the teachers have begun integrating ICT include the following:

Internet research

Teachers used resources found online to develop their notes prior to teaching their classes. In the post-intervention survey, 11 of the 49 teachers (22.5%) reported doing online research and downloading content to prepare their lessons. This is a significant

advance; previously, teachers relied primarily on the textbook content, thus failing to expand or extend the information available to students. However, observations during workshops revealed that teachers often copy and paste large chunks of content from a website into their notes or slides, rather than picking and choosing the most relevant points. More work must be done to further hone their skills of discernment when doing internet research.

Use of Projector

At Uranga, where the teachers have begun integrating ICT most prominently, 5 of the 13 (38%) teachers surveyed in the post-intervention survey indicated using a projector in class to show key points, diagrams, simulations, etc. in the form of a Libre Impress presentation.

Use of Libre Office Writer and Impress to prepare notes and/or exam questions

Of the 49 teachers surveyed, 10 (20%) noted that they used Libre Office Writer or Impress to prepare notes or exam questions. At Uranga, the principal required all the teachers - for the first time - to type their exam questions at the end of the 2nd term using the laptops.

Use of Libre Office Writer to digitize written teaching notes

This was the first step in integrating IT taken by many teachers. The Project Facilitator in Sauri helped teachers at Uranga and Ulumbi initiate this process. One business teacher at Uranga successfully digitized his entire collection of teaching notes.



EVOLVING TEACHER PRACTICE THROUGH ICT – CLASSROOM OBSERVATION HIGHLIGHTS

By Professor Lesley Bartlett
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When teachers integrated ICT in lesson preparation, they were able to provide more information to their students. For example, when we first observed him in February 2013, the Christian religious education (CRE) teacher from Uranga lectured his students, making brief reference to the text; he asked very few questions, and all of them required a factual answer. During our second observation, after his participation in several workshops, the CRE teacher demonstrated his efforts to employ ICT. He had done online research on his topic, the Prophets, and he had typed and printed those notes. Notably, he also used more open-ended questions, such as prompting students to engage their prior knowledge by asking, “Who is Amos and what do you know about him?”

Integration of ICT can significantly expand the classroom time available for instruction. When we first observed him in December of 2012, the physics teacher at Kisyoro was teaching about the reflection of waves. The teacher dictated notes to students and spent a long period drawing a graphic representation on the board, which he required students to copy the image into their own notebooks. The teacher asked no open-ended questions of students that would require higher-order thinking. By the time of our second observation in June 2013, the teacher had become more familiar with resources available

on the internet. He had researched the topic - curved mirrors - on the internet; he saved notes and illustrations on a flash drive, and during the class he projected these materials, saving time usually dedicated to writing or drawing on the board. During our final observation in July, while teaching about measuring the density of water, the teacher had students doing an experiment in small groups. The students used a spring balance, cylinder, string, and water; noting results in their notebooks. During the experiment, the teacher circulated through the room and asked questions; he then encouraged the students orally to share and interpret their results. This sort of active learning is promoted by visual representations of knowledge and by inquiry-based activities, such as experiments. Teachers can save time for such activities spend less time writing or drawing and then dictating notes.

The value of ICT to promoting more active inquiry was evident from one pair of observations. When we first observed him in February 2013, the chemistry teacher at Kisyoro lectured on salt. He drew a PH Scale on the board, 0-7-14, and labeled the areas. While he asked students many questions, all were fact-based. For example, he asked, “What is an indicator? What color does it turn in acid? What is a neutralizer?” As he lectured, students took verbatim notes. The teacher slowly repeated key information several times. Later, students were asked to record answers on the board, taking up significant class time. Students were asked at one point to comment on the correctness of a peer’s answer. There was a strong emphasis in the lesson on

correct information. By the next observation of this teacher in April, the teacher had done some online research using a laptop. The teacher briefly introduced the topic, matter, and gave key definitions. He then demonstrated, on the projector, the three states of matter and how they react with each other. After ten minutes of fielding questions from students, such as a request to explain liquid molecules, the teacher dictated notes for the students to copy in their notebooks. Next, the teacher explained the nature of matter and introduced Dalton’s atomic theory to the class. As he did, he displayed an image of an atom, as well as some radicals and their symbols. This prompted questions from students, such as whether atoms can be seen with the naked eye. The projected images and demonstrations seemed to facilitate moments of student-generated questions, which did not materialize during the first observation. Unfortunately, the power went out suddenly and the class was cut short—underscoring the importance of alternative energy sources.



One method that was used to accelerate integration of ICT among teachers was to incentivize them with flash drive during the workshops. In May, teachers were notified that, at the next workshop, the teacher who had used ICT most effectively over the coming month would receive a flash drive. Teachers were encouraged to communicate to their Project Facilitator when they planned to do an ICT integrated lesson, and to make sure that they checked out the necessary equipment from the ICT lab so that there would be a record of equipment use. The activity continued through the end of the project and proved to be quite effective.

It was observed at all four schools that during demonstration sessions whereby teachers were asked to share their work with the other teachers, male teachers tended to volunteer far more than women. When working in groups made up of men and women teachers, the male teacher tended to be the one selected to present, while the female switched slides. As the research team observed this trend, they made a point to ask women teachers to volunteer during presentations.

For teachers who are deeply practiced in lecture-based methods, and are only just beginning to feel comfortable using ICT, evolution of their teaching practice to be learner-centered and ICT-integrated takes a lot of support and consistency. The time needed for teachers to change their pedagogical practices is well documented in other settings. The teachers have come a significant way, but more support is needed for the changes to truly take root and sustain. One challenge slowing the uptake by teachers

is that teachers rarely have time to use the computers during the school day, and because of family and other commitments after school, staying after the school day to use the computers is not an option for many. This has been partially addressed through the implementation of the check-in/check-out systems at the schools, and school leaders and teachers have been encouraged to explore the possibility of creating systems whereby teachers can check-out computers for use at home.

Common School Characteristics - Teacher ICT and Pedagogy

- Many teachers receive basic ICT training during computer installation, but they need to receive follow up support necessary to sustain their learning.

- Teachers rely largely on lecture-based teaching methods and have few learning resources.

- Many teachers are generally enthusiastic about learning ICT, but also have limited time during the school day to use the computers.

- In workshop settings, women teachers tend to be less willing to demonstrate for their peers.

OPEN SOURCE TEACHING AND LEARNING RESOURCES

One activity early in the project was the redesign of the Connect To Learn Online Resource Library (CTL ORL). Input was received from the research team, MVP staff and teachers to ensure that the homepage was aligned to familiar core academic subjects for teachers across countries. Resources relevant to the country curricula were researched and added to the library, and an upload page was designed to en-

able teacher participation in the site’s population. The research team expected teachers to begin uploading content during the project period, but this goal was not reached.

However, teachers at the four project schools have frequently accessed the Connect To Learn ORL to research learning materials. The Project Facilitator based in Sauri noted late in the project that “most of the teachers are nowadays referring to the Resource Library in the Connect To Learn portal for preparation of notes and delivery of lessons.” It is also notable that, in the post-survey, teachers had more specific requests for the kinds of digital resources they would like to have access to than they did at the beginning of the project; requests included simulations demonstrating biological concepts, videos presenting Ohm’s Law, simulations of plate tectonic movements, and online math exercises, to name a few.

Though there are few online educational resources created for and by African teachers, the collection is growing. One notable discovery during a workshop was that Khan Academy has a huge library of videos that have been translated into Kiswahili. There are also Kiswahili learning websites, though many of them are more relevant for second language learners of Kiswahili. Columbia University Center for African Studies has a collection of educational websites in West African languages. Teacher Education for Sub-Saharan Africa (TESSA) has a great collection of standard-aligned, learner-centered resources for various African country curricula, but they focus on primary schooling only at present.

Early in the project, it was noted by members of the research team that the teachers rarely use lesson plans to deliver dynamic lessons, but rather rely on handwritten notes to deliver lectures. Additional learning resources at the schools are sparse, and include limited science equipment, small libraries, and world maps.

In the second half of the project when the research team began providing flash drives as incentives to teachers, flash drives were also provided to the Principals and ICT teachers loaded with educational content, including Khan Academy videos, an African atlas, and a collection of images and diagrams for a variety of subjects. The Principals and ICT teachers were asked to use the flash drives to load the content onto all the computers, which was done.

Common School Characteristics – Open Source Teaching and Learning Resources

■ The wealth of available, quality, free, online educational resources need to be adapted to make them more appropriate for African classrooms.

■ Teachers rely mostly on handwritten notes and sparse additional resources for teaching.

STUDENT ICT PARTICIPATION AND KNOWLEDGE

Student ICT participation and knowledge was not an area intended for concerted research in this project. However, observations at the schools shed light on some general student use trends. Overall, students tended to show much more enthusiasm for using ICT, and were as a result quick to pick up skills in using the machines. Students were often seen in the ICT labs between classes,

using the computers to play games or, on occasion, use social networking sites like Facebook. Students were never observed using the computers for class-related activities or assignments assigned by their teachers, though occasionally they were seen doing educational research independently. Spending airtime for non-education-related purposes poses a challenge to schools that have limited budgets for airtime, and it is a missed opportunity for learning.

Common School Characteristics – Student ICT Participation and Knowledge

■ Students tend to be savvier about using computers than their teachers, but they do not tend to focus on educational benefits without teacher guidance.

PUBLIC PRIVATE PARTNERSHIP IMPLEMENTATION

Connect To Learn is supported by a team of public and private actors. From the public sector the program is supported by the schools themselves, local and national education officials and organizations like the Earth Institute at Columbia University and Millennium Promise. Private sector engagement comes mainly through the mobile communications industry with Ericsson being a major technology partner supported by local Mobile Network Operators for in-country implementation.

As previously mentioned, the four schools in this study had limited connectivity to the internet through services provided by the local Mobile Network Operators.

For the purposes of this study the research team was expanded to include five key partners, in ad-

dition to the schools themselves. The university-based research team included a Principal Investigator from Teachers College, Columbia University and two lead researchers from Kampala University and the University of Nairobi. The local Project Management was facilitated through the Millennium Villages Project sites in each country, with different approaches taken in Ruhira and Sauri, as described below. The overall project was managed by a small team at Columbia University's Earth Institute, including a full-time staff member.

The Principal Investigator developed the research design and instruments. The Earth Institute team and university partners then worked together to tailor the research instruments and training program and train the members of the research team. Team members then worked at the schools to execute the teacher workshops and collect the survey, interview, and observation data. In addition to the seven visits made by each of the research teams at Kampala University and the University of Nairobi to the fieldsites, the Principal Investigator based at Teachers College worked on site with the research teams at the university and in schools twice, and the Project Manager based at Earth Institute visited the teams and schools five times.

In addition, the Principal Investigator and students at Teachers College worked directly with faculty members at Kampala University to develop a sequence of courses for a BA specialization in ICT and education. The purpose of the specialization is to increase the number of college-educated, certified teachers in not only ICT but also content areas

who understand how to use ICT to prepare and deliver instruction in secondary schools. Over the course of four months, the group conducted a comparative study of ICT in education degrees in the U.S., Europe, and Africa; examined existing policies governing ICT education in Uganda; identified key competencies necessary for graduates; designed a scope and sequence of twenty professional courses; developed five college-level courses to educate ICT in education instructors at the secondary level; and implemented a website containing the lesson plans, course reading materials, lesson activities, and assessments for the five courses. Course topics include:

- Advanced Computer Literacy;
 - Philosophy of Education & Technology
 - Education and Technology Leadership
 - Diverse Contexts and Diverse Learners in ICT
 - ICT, Education and the Ugandan Context
- Each course included lesson plans for fifteen (15) weeks of teaching; An outline for instruction, An activity; At least one link to open source content or copyright-free electronic material, A recommended assessment for learning, and Suggested material (with content) for lab exercises.

The overall goal of this program is to produce qualified secondary level teachers with the ICT inte-

gration competencies necessary to increase the ICT proficiency of and overall quality of core curriculum delivery to secondary school students. The specialization is currently under review at the National Council for Higher Education. This material could easily be adapted for implementation in teacher education programs in other partner countries.

Overall, partnering with in-country universities proved to be an effective way of collaborating with teachers on a frequent and ongoing basis and in locally appropriate ways, at minimal cost. Some lessons learned about the necessary logistics for fostering a successful collaboration are as follows:



THE NEED FOR ICT AS A TEACHER TRAINING SUBJECT IN UGANDA

Dr. Ronald Semyalo
Director of Research, Kampala University

A major obstacle to the overall improvement of Uganda's education system is a lack of an Education policy and as such an underlying philosophy for the different levels. Nonetheless several education reforms have been implemented since the 1920s.

The policy thrust of secondary education is guided by the 1992

Government white paper on Education. The policy thrust of secondary education is guided by the 1992 Government white paper on Education. This paper built upon the recommendations of the 1989 Education Policy Review Report, which sought to transform secondary education by increasing equitable access as well as producing graduates with relevant skills to the human capital needs of the country. The current Education Sector Strategic Plan (ESSP 2007 – 2015) was prompted by among others two policy issues of relevance to the secondary sub-sector; enrolment of primary

seven leavers into secondary schools (equitable access to quality secondary education) and the need to strengthen science and technology.

In a bid to provide a quality education that is relevant to current global economic demands, the ministry of education and sports has undertaken significant changes in the secondary education curriculum. Including an overhaul of the lower secondary education curriculum with a shift from a focus on acquisition of knowledge to a curriculum that prioritizes cognitive competencies including communication, interpretation, problem solving, critical thinking and hypothesis testing. At the A-level curriculum there is a revision to make it more relevant and practical. A-level students are expected to take three (3) principle subjects with a subsidiary in either sub-mathematics or ICT. It is later planned that ICT like Mathematics will also be provided at this level as a principal subject.

In order to provide a limited but effective number of teachers at the secondary level, Teacher training in Uganda for Secondary school teachers emphasizes the

need for two teaching subjects, however teachers of ICT are currently drawn from the crop that specializes in Maths or Physics, who then receive a few weeks of extra training in basics of ICT. As the new curriculum has been implemented it has become clear that there is a definite need for training in ICT as a teaching subject, since these teachers would need to have the ability to train students both in the sciences and the Arts. Pedagogical training in ICT ought to exceed the limited time and material provided, in comparison to Mathematics which is a central component in a number of subjects like chemistry and Economics is recognized as a dedicated subject on its own so should ICT which evidently is relevant both in the Arts and Sciences.

It is envisaged that a well-informed curriculum is required to train this new crop of teachers with the ability to improve the ICT proficiency of secondary school students. Such a curriculum would also provide critical information to the development of a policy for Education in general for the country.

The role of the Project Manager is critical for such a collaborative project. Due to the busy schedules of university faculty, having a project manager working with all partners to manage administration, logistics, and insisting on deadlines for implementation of project activities is imperative to project success.

Workshop schedules should be decided as early as possible through direct communication with Head Teachers.

There will always be cases where workshops need to be rescheduled due to unforeseen events such as teachers' strikes, union meetings, rescheduling of exams, delay in disbursement of research funds, etc. However, as much as possible, working out a timetable early on is critical considering the busy schedules both of the schools and of the university faculty and staff. It should be a goal at the beginning of the collaboration to map out a schedule of workshops for the entire year.

University teams should be small, ideally between 2-4 members.

Small teams have a significant advantage for two main reasons. First, small teams provide consistency in data collection and workshop facilitation. Second, small, consistent teams more easily build rapport with teachers. With regard to the first, it was found that the Kampala University team, composed of three people, provided consistency in the frequency of visits by each member of the research team, with each of the 3 attending between 4-7 of the 8 total visits. The University of Nairobi began with a larger research team of 5 members. In the first phase of the project, 3 of the 5 team members visited only once

or twice. It was difficult for team members to be informed about the school, the teachers, or the learning to date. By the second half of the project, two members of the research team visited consistently. Smaller teams were more informed about what challenges teachers were facing, and thus better able to provide feedback during workshops. Further, they were clearer about which teachers they were following over the course of the intervention, and they did a better job documenting changes in the integration of ICT in lesson preparation and delivery.

With regard to the second point, early on in the project, and throughout the project in the case of Kisyoro in particular, teachers were reluctant or shy to share freely with the research team. This may be attributed to their lack of experience using ICT, as well as to cultural norms in the rural areas in which they reside, among other reasons. This shyness waned over time as the research team members and teachers became familiar with each other. For these reasons, a small, consistent university team is ideal.

It may be advantageous to ensure that the university teams include graduate students, whose duties would be to gather information of relevance to the project and help lead the professional development seminars. This kind of arrangement would increase the breadth of the study's nature, allowing for researchers to attend to a diversity of variables within the project. It would also ensure that the projects build a group of researchers that can provide the necessary type of support to adapt this intervention to different times and settings.

University teams should be trained in up-to-date ICT skills and use of the Linux based computers before the start of the project.

In this project, the teams were provided Linux based computers about halfway through the project. Ideally, they would have had a chance to receive training on the system and explore prior to the start of the workshops in order to better tailor the workshop content and provide more nuanced support to the teachers. Though most members of the research team were quite conversant with ICT, a refresher course covering new educational websites and the LibreOffice software applications facilitated by the Project Manager, for example, would have been helpful.

University teams bring valuable knowledge about existing curricular materials that are relevant to and appropriate for the schools.

Because the university teams included curriculum and pedagogy experts, these team members were able to point teachers to existing digital materials and were able to provide feedback during workshops and after observations on the successful implementation of ICT-enhanced learner-centered pedagogy.

Locally based facilitators play a critical role.

Having a designated point person from the school or a local partner organization (such as the Millennium Villages Project in this case) can help ensure that the teachers have regular support as they begin integrating ICT. Though it may be challenging to find someone qualified to provide technical, administrative and pedagogical support, this should be the goal. Two dif-



ferent models were implemented in this project for the hiring of the local facilitator. In Sauri, a staff member from the MVP was assigned to the role, with his Terms of Reference adjusted accordingly to include the responsibilities of the project position. The benefits of this arrangement included access to MVP resources and his technical expertise; however, his commitment to the more pedagogical elements of the project was not as strong as would have been ideal. In Ruhiira, a teacher from each of the schools took on this role. Though their technical knowledge was not as strong, their daily presence at the schools ensured they were available for more frequent data collection and support of the teachers. They also seemed to be more motivated by the leadership opportunity that the position offered, and they proved themselves to be more proactive and responsible.

Training for such local facilitators should include, at a minimum, the following topics:

- Training on the Linux interface, LibreOffice applications, and introduction to various educational resource websites, including the Connect To Learn ORL and its upload function.

- Learner-centered teaching and facilitation methods, including examples of interactive ICT-based activities

- Classroom observation methodologies and tools

- Online reporting tools

- Communication responsibilities with the project's various stakeholders, including Connect To Learn, university partners, Ericsson, school leadership, teachers, students, PTAs, etc.

Systems for reporting on ICT issues by school stakeholders must be streamlined.

It was found over the course of the project that ICT issues at the schools often went unaddressed for unnecessarily long periods of time. The research encouraged the teachers to communicate when any issues arose, however in several cases issues were only discovered by the research team upon visiting. The research team deduced that school culture may discourage voicing of any frustrations to donors, however, it was emphasized that the goals of the intervention will remain unmet if challenges go unaddressed. A user-friendly online reporting system, coupled with training and support from Connect To Learn, Ericsson and other telecom industry partners could be an ideal way to address this issue.



A young boy in a light blue school shirt and red tie is sitting at a desk, focused on writing in a notebook with a blue pen. The background is slightly blurred, showing other students in a classroom setting.

RECOMMENDATIONS FOR A SCALABLE ICT INTERVENTION MODEL ACROSS SITES

CHAPTER

04

CONNECT TO LEARN AIMS TO SUPPORT STUDENT LEARNING LEVELS WITH ACCESS TO 21ST CENTURY TOOLS AND RESOURCES AND RELATED TEACHER PROFESSIONAL DEVELOPMENT. ICT INTEGRATION STRATEGIES RECOMMENDED ARE TO HELP SCHOOL ADMINISTRATORS AND TEACHERS MOVE FROM BEING TECHNOLOGY-ENABLED TO BECOMING CONFIDENT AND MATURE IN THEIR ICT USAGE AND PRACTICES FOR INCREASINGLY IMPROVED QUALITY EDUCATION AMONG THEIR STUDENTS.

Based on the common physical and cultural characteristics found in secondary school classrooms as described in the findings section, this section introduces key recommendations for implementing a complete ICT Intervention in similar secondary school contexts. The characteristics and recommendations are broken up into the six Key Intervention Areas (Physical Infrastructure, ICT Infrastructure, Teacher ICT and Pedagogical Knowledge and Skills, Open Source Teaching and Learning Resources, Student ICT Participation and Knowledge, and Public-Private Partnership Implementation). Based on findings in the existing literature on ICT adoption in education in Africa, the recommendations assume a three-year model, whereby the first year is focused on the hiring and training of university/NGO partners and the local facilitator, administrative setup, the development of school-level ICT policies and preparation, and the initial installation. The installation is then followed by a second year of intensive training and support to the teachers, concluding with a third year of continued training and support focused on fine-tuning sustainable school-level ICT management and integration systems. This three year timeframe is proposed based on the observations that much pre-work could have been done prior to the initial installation of the computers to facilitate their use, and that after one year of

intensive training, teachers are just getting to a point of comfort with the machines and their use in the classroom. Another year of training and support is necessary to ensure sustainability of the program.

A Logical Framework accompanies these recommendations, offering a roadmap for the phased implementation of a complete intervention integrating these recommendations.

PHYSICAL INFRASTRUCTURE

Develop memorandums of understanding (MOU) and school policies for open access to computer/projector use by teachers and students in collaboration with school leadership and other relevant stakeholders. Prior to full installation of any equipment in a new school, the leadership should be provided a first set of machines and training on how to maintain and manage computers and other equipment in their school, including making computers easily and regularly accessible to all in the lab, creating systems for checking-in and checking-out computers and other equipment for use in classrooms, and, if possible, allowing teachers to check out computers for use during after school hours for lesson preparation. Other regular practices such as unplugging computers when they are fully charged and checking for software updates every month should also be explained. School leaders should commit to this set of best practices. Wherever possible, Parent Teacher Association (PTA) leaders and any NGO and/or university partners should also be engaged in this process in order to ensure that the policies are implemented successfully. Time should be allocated for this process during the first year

of the project prior to installations and subsequent teacher training, and, if possible, the locally based Connect To Learn Facilitator should be brought on board to help facilitate this process.

Equip all classrooms for computer/projector use. This will likely necessitate strategic partnerships with governments, other NGOs, or funders. Some schools may have active PTAs willing to advocate to their government representatives or even fundraise for such a project. At schools with electrified ICT labs, many schools already have the wiring in place in their classrooms, but they may lack the outlets. Extending the wiring to add outlets should be relatively inexpensive in such cases. Partnering with government to ensure that alternative energy sources are available, such as solar, should also be a part of this planning.

Partner with PTA and local government officials to devise fundraising strategies to assist with increased electricity costs. With increased electrification and use of ICT will come increased electricity costs. As part of the MOU development and installation planning processes, work with community and school stakeholders to strategize on how to meet these costs locally.

ICT INFRASTRUCTURE

Provide computers in phases as teachers' integration of ICT increases. During the process of developing MOUs with school leadership, a first step in the installation of ICT should be to provide computers to Principals and department leaders to explore and ask questions. Once the MOUs have been completed and committed to and the first

installation has been made, a first installation should provide at least enough computers for every teacher to use in initial training and lesson preparation. As teachers' skills increase and they begin integrating more frequently in their classrooms and requiring ICT use in their student assignments, it will be important that there are at least enough computers to cater to the average class size at a given school, in addition to the computers already provided for every teacher and administrator. By using the average class size figure as a minimum number for a school integrating ICT frequently, it will ensure that an entire class could use computers at a one to one ratio, and that students could use computers after school for assignments without having to wait.

Schools should have enough projectors for use in each classroom. As teachers increase their ICT use, the number of projectors available should also increase. This can happen in a phased approach to help incentivize increased use, as demonstrated in the Logic Framework. Now that teachers are beginning to use the projectors at the four project schools, having enough available for more than one class to use it at a time will help speed the integration of ICT and benefit the maximum number of students, especially if materials are available on flash drives or local servers. Strategies for covering maintenance costs should be developed by school leaders in collaboration with PTAs and teachers.

Schools should have a multiple-use machine capable of printing, copying and scanning. This was a need expressed by many in the post-intervention survey. As new

users of ICT, many teachers wish to print handouts or copy images or diagrams found online for their students, yet a lack of proper equipment keeps them from using the ICT in this way. Strategies for covering maintenance costs and costs for supplies like paper and toner should be developed by school leaders in collaboration with PTAs and teachers.

Local servers should be installed to enable sharing of learning content when internet is unavailable. Unfortunately, weak connectivity is not a short-term fix, and so, in the meantime, local servers would allow teachers to access pre-loaded educational content provided by Ericsson, Connect To Learn and Teachers College and also download and share content with all computers.

Wifi networks should be provided at the schools such that every classroom is connected. As teachers increase their integration of ICT, students will benefit further if online videos and content can be accessed in all classrooms. At present, only the classrooms in the immediate vicinity of the ICT lab receive the wireless signal. Connection can be expanded in a phased approach as teachers increase their skills and use, as demonstrated in the Logic Framework, until every classroom is connected.

Budget for adequate airtime should be included in the overall project budget. Over the course of this project, the cost of airtime increased significantly by the end of the project due to the increased use of the internet, particularly with teachers streaming and downloading high-bandwidth educational videos. Teachers and students should be informed of how to

minimize video quality to conserve airtime, and school leaders and project managers must monitor use to ensure that airtime isn't being wasted on non-educational browsing, but efforts must be made to ensure that learning can go on uninhibited as usage increases.

Where possible, hire school-based ICT teachers to act as project facilitators. This is the best approach for creating sustainable change at the school. Though these teachers may lack a desired level of technical expertise, targeted training can be provided to them, and their location at the school ensures that they will be able to offer consistent support to teachers, monitor their progress, and organize workshop and installation events. This is likely only possible with teachers who are not on government contracts and who work part-time in their teaching role. In rural schools however, it was found that such part-time positions are rather common, particularly with regards to teachers of ICT.

Use logins to understand computer usage patterns. While Ericsson cloud solution data exists to show the general ways the computers are being used, it has also been noticed from in-person experience that men tend to use the computers more than their female peers, and that students tend to use them more for non-education related purposes when outside of school hours. It has also been observed that it is challenging for teachers to remember the generic login, meaning that individual log-ins for every teacher and student could discourage use. Rather, it may be ideal to have the login screen include a space to check "Student" or "Teacher" and

"Male" or "Female" while inputting the generic login. The login could also take a stamp of the current time to know whether the computers are being used in certain times during the school day, before, or after school. If possible, frequently visited websites could be categorized as "educational" or "non-educational" to offer analysis of how the internet is being used.

TEACHER ICT AND PEDAGOGICAL KNOWLEDGE AND SKILLS

Teachers should be engaged in ongoing, practical professional development facilitated through partnerships with local universities and/or NGOs. Once the necessary physical and ICT infrastructure is in place, teacher training is the most important program element for improving the quality of education for students through ICT. As busy adults with many responsibilities, the commitment involved in building computer literacy can be intimidating for many teachers, and so training must be consistent and ongoing in order for teachers to master the basics and move beyond them to the point that the computer becomes invisible, and they can rather focus on the educational value of the content they find and adapt and the collaborative opportunities they can create through ICT. In addition, professional development should equally emphasize learner-centered pedagogy, since teachers can easily integrate ICT in ways that repeat traditional teaching practices and do not maximize learning. Since a majority of rural teachers begin the training program with little if any experience, the expectation after a year of training should be that teachers will reach a level of "E-Confidence," able to type and save documents,

create simple presentations, and search for content online. With continued guided practice beyond this first year of basic training, teachers will hone their skills and become bolder in moving beyond their teaching comfort zone. After about two years of consistent, monthly, ongoing training and support, teachers and schools should reach a point of being able to self-sustain their continued professional development and integration.

Teacher trainers from local universities and/or NGOs should also receive capacity building training from Connect To Learn. For large-scale change in the integration of ICT to take root, educational professionals highly skilled in ICT and who integrate ICT learning into teacher training programs will be critical. Teacher trainers should be equipped with the necessary ICT skills, including knowledge of the Linux interface, and understanding of the latest technologies and educational resources in order to impart the highest quality training to teachers. Either this knowledge should be a prerequisite for choosing university partners, or training should be among the first steps in the overall project implementation. The deepening of ICT integration training at the tertiary level should be a collaborative undertaking over the course of the overall project, followed by dedicated training to the project facilitators.

Local facilitators (see program management recommendations) should observe classrooms regularly in order to encourage and support use of learner-centered methods and integration of ICT. Changing the general teaching practices of teachers who have

been trained and practiced in lecture-based methods throughout their experiences as teachers is a long and challenging process. Consistent follow up and support will help teachers stay motivated to try new approaches. Observations will also provide feedback to the teacher trainers, allowing them to see whether the training is taking hold in actual classroom practice. Facilitators could engage a “coaching” approach, modeling best practices in learner-centered, ICT enhanced pedagogy.

Teachers should be incentivized with ICT tools and educational content, such as pre-loaded flash drives. As an incentive to participation in workshops and subsequent integration of ICT, teachers can be offered small prizes such as flash drives pre-loaded with educational content.

School ICT Policies should enable easy access to computers during the school day, and possibly after school as well. As stated in the Physical Infrastructure recommendations, school ICT policies must facilitate use of computers in classrooms by teachers, and also, if possible, allow for teachers to check out computers for practice on their own time after the school day is over. Such practices would of course need to be carefully thought through, with strict accountability measures.

Should there be a recommendation to ensure that students are aware and trained in responsible use of the internet?

OPEN SOURCE TEACHING AND LEARNING RESOURCES

Workshop facilitators should encourage typing and enhancement of teaching notes and lesson plans through online research as a

starting point. Teachers are more likely to integrate ICT if they are encouraged to start from where they are comfortable and move from there. Between workshops at Uranga, the facilitator led teachers through the transfer of their handwritten notes to digital copy, helping them master the basic skills of typing. Teachers were also encouraged during workshops to enhance their notes and to create lesson plans and presentations by doing online research. During and between workshops, teachers should be encouraged to choose topics that they are planning to teach in the near future and use ICT to enhance what they already planned in order to make it more stimulating and learner-centered through the use of resources found online.

Partners from African Faculties of Education should expand the availability of quality, online resources for secondary teachers. In the way that TESSA has created a vast library of high quality, locally relevant resources for primary school, so African Faculties of Education partners can be tapped to collaborate on the creation of such a library for secondary school teachers, to be available on the Connect To Learn ORL and shared widely with other organizations working with secondary education in African countries.

STUDENT ICT PARTICIPATION AND KNOWLEDGE

Teachers should be encouraged to assign online/local server research or information presentation assignments that utilize Libre Office software to their students. Once teachers understand the basics of what is possible, they can begin assigning online/local server research and ICT-integrated projects to their students. It should

be emphasized throughout teacher training workshops that they do not have to be experts before beginning to integrate ICT. They simply need to understand what is possible, and be able to provide guidance to their students on where and how to find relevant information. Core subject teachers should be encouraged to implement such student projects with the help of the ICT teacher, so that ICT learning can be relevant to what students are learning in other subject areas.

Teachers and students should be encouraged to use computers for education-related purposes in order to preserve conservation of airtime. Because budgets for airtime are limited, students and teachers should be encouraged to use the internet for educational purposes only.

PUBLIC PRIVATE PARTNERSHIP IMPLEMENTATION

Local facilitators should be hired in each site or cluster of schools to provide ongoing professional development and support – both pedagogical and technical – to administrators and teachers. This recommendation lies at the core of the rest of the work to be done. The facilitator should be hired through local University and/or NGO partnerships, and ideally will have both pedagogical and technical expertise. During the first six months to a year of the project, the facilitator would be responsible for helping to facilitate school policy development, training of school leaders, and the initial installation. Once the initial installation is complete, the facilitator would be responsible for conducting teacher professional development workshops, interim training support, and classroom observations, while providing technical support and acting as a liaison between the school, Con-

nect To Learn, Ericsson, and any other partners.

Partnerships with in-country Faculties of Education and telecommunications companies should be nurtured, and professional development in the integration of ICT should be institutionalized at the tertiary level with support from industry partners. When Faculties of Education develop ICT Integration components of their teacher training curricula, countrywide integration of ICT will follow. Their capacity to do this must be developed. Connect To Learn, Ericsson and telecommunications industry partners should consider providing this kind of support as part of an overall ICT intervention in the countries where they work, building capacity for education faculty, as well as collaboratively devising recommendations for curriculum and policy development at all education levels.

Partner NGOs and Universities/Schools of Education should be located as near the project schools as possible. One important way to implement an ICT intervention effectively and at lower cost is to select NGO and/or university partners that are located near the project schools. This move would cut down significantly on transportation and lodging costs, and it would also ensure that the partners will be able to make more frequent visits to the schools to offer more consistent support. This will also help facilitate community and school sensitization to the importance of ICT.

Deepen partnerships within the ICT industry, especially local Mobile Network Operators (MNOs), to provide infrastructural and program support to the schools. During the course of the study Ericsson has been the prime technology supporter through such measures as

the provision of a cloud-based ICT solution, devices, technical support, teacher training and project management services. To ensure continual improvements in 3G and even 4G connectivity the private sector component of the program needs to be strengthened through further support from Ericsson and local MNOs to do the following:

- Prioritize mobile network improvements in areas where schools are located in order to provide robust mobile broadband connections
- Introduce affordable tariff plans that enable schools and their sponsors to pay for mobile internet access
- Provide technical solutions that allow schools to access specific education websites at greatly reduced, even zero-rated, tariffs
- Collaborate with faculties of education and program facilitators to develop teacher training content that advises on best practices for responsible use of the internet and conservation of airtime data.

The Logic Framework to accompany these common characteristics and recommendations is laid out such that it begins left to right by defining the common characteristics, key stakeholders and input recommendations for each of the six Key Intervention Areas, and continues by defining the desired outputs, output indicators, measurement tools and team member requirements. From here, the input recommendations and associated activities are plotted on an implementation timeline spanning three years. In the first year schools become “E-Enabled,” in the second “E-Confident,” and in the third, they reach an initial level of “E-Maturity,” at which point the school should have the institutionalized skill sets and systems necessary to sustain their integration of ICT into all aspects of the curriculum and student learning experience.

MONITORING & EVALUATION INDICATORS

The established set of indicators for measurement are provided in the table below to accompany

these recommendations. These indicators are organized in accordance with the six Key Intervention Areas of the ICT in Education Study, and are intended to be

measured on a termly or annual basis with methods that include surveys, interviews, observations, and cloud-based tracking of computer usage.

INTERVENTION AREA	OUTPUTS	OUTCOMES	INDICATORS
Physical Infrastructure	Reliable electricity supply through alternative sources Adequate outlets/electrification in all classrooms School ICT policies by school leadership with participation from teachers and partners	Project schools are fully electrified and able to make optimal use of ICT resources Schools attract and retain more qualified teachers	Number of school days per week that school experiences problems with power Number of classrooms at the school, # of classrooms with electrification & outlets at the school School has ICT policy Average numbers years teachers stay on staff at the school
ICT Infrastructure	Schools equipped with computers for use by all teachers and a classroom of average size at 1 to 1 ratio Schools equipped with projectors in all classrooms and multi-use printer/copier/scanner Schools equipped with reliable connectivity that reaches all classrooms and adequate airtime	ICT Resources at the school are adequate to meet the needs of all teachers and students, and serve to incentivize quality teaching and learning ICT resources are used frequently and equitably across grade levels, subjects and genders	Student to functional computer ratio, Teacher to functional computer ratio Classroom to Projector ratio, number of printers at the school Average number of hours per day that there is a problem with connectivity Number/Percentage of total classrooms that can access internet connection Number computers that can access internet at any one time Number of weeks since last software updates were run on all computer How many teachers at school are equipped to provide technical support and/or repairs?
Teachers ICT & Pedagogical Skills and Knowledge	Teachers are skilled in various ICT applications, internet research, and learner-centered pedagogies Classrooms practice involved ICT more frequently, and is more activity-based and learner-centered Both women and men teachers integrate ICT at the same rates	More ICT-integrated, learner-centered lessons lead to improved student performance	How many teachers have used ICT to prepare or deliver a lesson in the past week? Past month? Teachers experience using ICT? Comfort level using ICT? Percentage time spent in classrooms each week using ICT Percentage of time spent in classrooms each week on groupwork / interactive activities Time of day computers used most frequently
Open Source Teaching & Learning Resources	A majority of teachers digitize all of their teaching notes Teachers and University partners submit adapted online resources to the Connect To Learn ORL on an ongoing basis	Teachers have robust collection of locally-relevant digital education resources for improved student learning	What resources do teachers access most frequently for lesson prep/delivery? How many resources? How many hours do teachers spend each week on lesson preparation?
Student ICT Participation & Knowledge	Teachers assign ICT-integrated project/assignments at least once per week Students spend a majority of time using ICT at school on education-related activities	Increased ICT literacy among students and improved student learning	Number of students graduating from one form to next last year Average student performance level in each form, in each subject last year/term, boys/girls Number of ICT integrated student assignments/week Time of day computers most frequently used by students, broken down by gender
Public/Private Partnership Implementation	ICT-integration training infused into teacher training curricula at tertiary level Local facilitators working weekly with project schools Strengthened ICT in education policy and program infrastructure in project countries	Widespread ICT integration in project countries	Does university partner have a ICT component to their teacher training program? Percentage of education students taking ICT integration course as part of their teacher training Percentage of new teachers entering workforce skilled in integration of ICT



LOOKING FORWARD



05

THE USE OF ICT IN CLASSROOMS CAN CLEARLY HAVE POSITIVE EFFECTS ON EDUCATION WITH APPROPRIATE AND SUFFICIENT SUPPORT. CONNECT TO LEARN IS ONLY AT THE BEGINNING OF ROLLING OUT ITS PRACTICAL SOLUTIONS GLOBALLY. FOR CONTINUING SUCCESS, IT IS IMPERATIVE TO EXPAND EXISTING PARTNERSHIPS AND FORM NEW ONES, WORK WITH EDUCATORS, NATIONAL EDUCATION MINISTRIES AND PARTNERS TO ENSURE ADEQUATE TEACHER TRAINING AND LEARNING MATERIALS, AND ENSURE ADEQUATE ICT AND DATA RESOURCES.

The potential for positive change through the use of ICT in classrooms is clear, our African and US university partners in research believe, with sustained teacher professional development, and the support and participation of key public and private partners who will play a critical role in ensuring that schools have the requisite physical and ICT infrastructure and resulting access to quality online learning resources.

A year of in-depth work was conducted hand-in-hand with teachers at four East African secondary schools to increase their ICT skills and pedagogical breadth. At the launch of this project, the schools had been in possession of the computers for about a year, and yet significant progress had not yet been made with regard to the integration of ICT in the teachers' daily practices. Over the course of the year and as a result of consistent training and support, integration of ICT by teachers in classrooms increased by 18%, with much of that increase occurring in the last few months of the project once teachers had been given more access to the computers, learned the basics, practiced their ICT and learner-centered pedagogical skills in supportive groups, and gained access to projectors.

Though notable change has occurred, this is only the beginning for Connect To Learn schools. For the change to sustain and grow, it is imperative that new partnerships be forged to ensure that teachers receive ongoing training that evolves along with their skills and pedagogical practice, and that they have adequate ICT and data resources at their schools to keep pace with their increasing levels of integration.

This necessitates partnerships with all key stakeholders - the telecommunications industry must help develop appropriate infrastructure and provide ad-

equate broadband connectivity data packages to the schools; with policy makers and teacher training colleges to help institutionalize ICT integrated teaching across all subject areas for the next generation of teachers; with like-minded organizations, school leaders and teachers to provide ongoing professional development and technical support to teachers; and with parents and community members to assist in driving school-level leadership to ensure that school policies facilitate increasing levels of teacher ICT skill and utilization.

This report has presented a set of recommendations that, if fully implemented with the partnership of all key stakeholders, will lead to sustainable integration of ICT in participating schools and, ultimately, improved student learning outcomes. It is the hope of all partners and visionary leaders involved in Connect To Learn and among all of the participating researchers that these recommendations will help inspire a new wave of public-private partnership that can help narrow the global academic achievement gap by closing the digital divide, thereby ensuring that students worldwide have a fair chance at success.



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