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USING TECHNOLOGY TO DELIVER EDUCATIONAL SERVICES TO CHILDREN AND YOUTH IN ENVIRONMENTS AFFECTED BY CRISIS AND/OR CONFLICT

FINAL REPORT

December 2013

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DISCLAIMER

The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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This study draws on the knowledge, experience and shared references from many people, to whom I am greatly indebted. No fieldwork was conducted for this study, either for carrying out primary research or for observing the chosen case studies in action. Instead, the study is based on semi-structured interviews and conversations with education technology experts who have extensive experience in developing countries, including those countries affected by crisis and/or conflict. From these conversations flowed suggestions and references to review certain case studies and documents, on which this study is based. In some cases the interviewees kindly shared their documentation, and in other cases independent on-line research was carried out to find the information needed.

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To the extent this report offers some useful guidelines for education program planners to design and implement educational technology programs in countries affected by crisis and conflict, it is entirely thanks to the above-named people. Any weaknesses or errors are the sole responsibility of the author of this report.

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EXECUTIVE SUMMARY

The goal of this paper is two-fold: (1) to compile and review illuminating case studies of technology-supported interventions to deliver education services that promote equitable access to children and youth in environments affected by crisis and/or conflict; and (2) to provide recommendations for the design and implementation of technology-supported education interventions. The intended audience is education program planners in developing countries, particularly those affected by conflict or crisis.

Through a country case study approach, this report examines three types of educational technology programs, specifically:

- Mobile phone-based delivery of educational content for improving student learning, aimed at both students and teachers;
- Internet-enabled computer labs supporting K-12 education and youth employment-focused training; and
- Interactive Radio Instruction (IRI) in primary education.

In addition, the report provides a discussion of certain emerging educational technologies (e.g. tablets).

This study uses an analytical approach which combines contextual and conceptual “lenses”. Most important is to understand the Conflict Affected and Fragile Environment (CAFE) in which these educational technology programs are implemented, and to analyze how the programs adapted appropriately (or not) to that environment. Students, teachers, schools, language of instruction, curricula and ministries of education are all affected by crisis and conflict, and educational technology programs must take these effects into account if they are to succeed. Secondly, the study examines the extent to which, conceptually, the educational technology programs reviewed align with and reflect seven research-based principles for effective teaching.¹ The essential message from this research is that learning is not something done *to* students, but rather something students themselves *do*. These seven principles are consistent with the Minimum Standards for Teaching and Learning agreed to by the International Network for Education in Emergencies (INEE). Based on both contextual and conceptual analysis, the advantages and disadvantages of each type of educational technology are derived, along with lessons learned and guidelines for future design of educational technology programs in CAFE.

Educational technology, when it is appropriately applied in contextually relevant ways, has been shown to enable positive learning experiences and improve learning outcomes, including in countries affected by crisis and/or conflict. However, there are more un-evaluated than evaluated educational technology programs; the evidence base remains quite thin. The fast-paced evolution of educational technology suggests that future programs can be more effective than in the past. Also, for students in countries affected by crisis and conflict, simply the opportunity to engage with educational technology can be a positive and worthy experience, particularly if it promotes human connections and community-building.

For education program planners in countries affected by crisis and/or conflict considering educational technology as a means to improve student learning, this report offers ten guiding principles, including: (1) clarify educational objectives to be achieved through technology; (2) design the technology program as a function of those objectives; (3) maintain flexibility, learn by doing and adapt as necessary; (4) specify the program time horizon; (5) prioritize the “human-ware” over the hardware and software; (6) ensure contextually-appropriate educational content; (7) maximize and exploit connectivity; (8) keep the technology as simple as possible; (9) minimize power requirements; and (10) avoid the mistakes of previous educational technology programs (aka “do not re-invent the flat tire”).

¹ “How Learning Works: Seven Research-Based Principles for Smart Teaching”, Jossey-Bass (2010).

I. INTRODUCTION

The goal of this paper is two-fold: (1) to compile and review illuminating case studies of technology-supported interventions to deliver education services that promote equitable access to children and youth in environments affected by crisis and conflict; and (2) to provide recommendations for the design and implementation of technology-supported education interventions. The intended audience is education program planners in developing countries, whether in official or non-governmental development agencies, and their counterparts working in ministries of education. In particular, this report is aimed at education planners working in countries affected by conflict and/or crisis.

Technology is increasingly used to enhance delivery of education services to children and youth in developing countries. Conflict- and/or crisis- affected environments are particularly challenging, but information and communication technologies (ICT) have considerable potential to improve the quality of education in these settings, as this study will show. This activity is intended to provide USAID with an analysis of the various ICT programs practices that have supported education in conflict- and crisis-affected environments, along with lessons learned and recommendations for future programs.

While many different types of ICT interventions could be examined, this study focuses on specific ICT interventions aimed at (i) increasing equitable access to basic education, (ii) improving literacy, numeracy, life skills, safety and peace building or violence prevention and conflict mitigation in education settings, and (iii) strengthening institutional capacity. These three objectives constitute key elements of Goal 3 of USAID's education sector strategy.

This study is intended to complement other work commissioned by USAID in the area of ICTs for development, such as the recently released *Mobiles for Youth Workforce Development Landscape Review*. It will not examine the use of ICTs to improve management and administration of education services in countries affected by crisis and conflict. While such use can certainly result in improvements in the quality of education (for example, ICT-enhanced management information systems can rationalize teacher deployment for better coverage of under-served areas), the focus here is on the use of ICTs in the classroom by teachers and students to enhance learning.

This study examines three types of educational technology programs, which cover some of the range of possibilities, specifically:

- Mobile phone-based delivery of educational content, aimed at both students and teachers, for improving student learning;
- Internet-enabled computer labs supporting K-12 education and youth employment-focused training; and
- Interactive Radio Instruction (IRI) in primary education.

Each of these types of educational technology programs are reviewed in terms of their alignment with (i) the conflict-affected and fragile environment (CAFE) and (ii) effective teaching practices. As will be discussed in Section II, the CAFE presents specific challenges for educational technology programs which must be pro-actively considered and addressed. Secondly, evidence-based research and recent findings from the neurosciences are applied to assess how these different educational technologies enable and promote specific principles of effective teaching and learning. Then each type of technology program is analyzed with respect to its impact on student learning processes and outcomes, the availability of information permitting. This, in turn, generates lessons learned and recommendations for the future integration of ICTs into education programs in conflict- and crisis- affected environments.

A word of caution: the available literature for this exercise is quite limited. The studies and information sources reviewed here do not meet the "gold standard" of independent, peer-reviewed impact

evaluations with carefully randomized experimental trial designs. Much of the information comes from the program implementers themselves, which unavoidably entails some subjectivity. This should be kept in mind, particularly when considering program results.

The choice of the country case studies was driven largely by the availability of information and the recommendations of educational technology experts interviewed for this report. Most, but not all, of the countries included in this report are affected by conflict and/or crisis in some way, to varying degrees. The countries include India, Pakistan, the Philippines, Haiti, Kenya, Somalia, Sudan and Afghanistan. Four of these countries (Haiti, Somalia, Sudan and Afghanistan) are listed as “Fragile” by the World Bank, Asian Development Bank and African Development Bank. The other four countries (India, Pakistan, Kenya and the Philippines) are not considered “fragile”, but they all suffer from sustained regional conflicts within or just outside their borders that have affected their education systems, teachers and students. Equally important, these four countries offer a wealth of experience in the use of educational technology to improve student learning which cannot be ignored, particularly in light of the paucity of empirical data elsewhere.

The choice of technologies reviewed was also driven largely by the availability of information. There are many other educational technologies worthy of review but are not included here, such as community-based educational radio, simple educational videos displayed on televisions, or educational software used on stand-alone computers. Some of these technologies are arguably better adapted to conflict-affected and fragile environments because of their simplicity, affordability, reliability and independence from telecommunications infrastructure. They were not included here for the main reason that very little information exists regarding their recent implementation and impact in developing countries, even less so in developing countries affected by conflict or crisis. This would be an area where additional field-based primary research could be quite useful. With regards to what technologies are reviewed here, the focus on mobile phones stems from the fact that these are perhaps the least studied until now in terms of actual learning impact; some of the findings provided here are altogether new and as such offer additional value to education program planners.

The rest of this report is organized as follows. Section II describes the analytical approach used to assess the three types of educational technology programs through specific country case studies. Section III presents the country case studies themselves, and after each set of case studies is a summary of the technology’s advantages and disadvantages. In addition, Section III offers a forward-looking discussion of the potential of certain emerging technologies to improve learning in challenging environments. Section IV presents Lessons Learned, based on the cases studies reviewed, and Section V offers policymakers and educational program designers Ten Guiding Principles for designing educational technology programs in crisis- and conflict-affected countries.

II. AN ANALYTICAL APPROACH FOR ASSESSING EDUCATIONAL TECHNOLOGY PROGRAMS IN CONFLICT AND/OR CRISIS AFFECTED ENVIRONMENTS

This section describes an analytical approach for assessing educational technology programs in conflict and/or crisis affected environments which uses two complementary “lenses”: (i) how these programs are designed and implemented within the very challenging educational context and learning conditions of conflict-affected and fragile environments (CAFE); and (ii) how these educational technology programs reflect and integrate specific principles for effective teaching. The first lens is contextual, taking into account country- and school- level learning conditions. The second lens is conceptual, assessing the degree to which educational technology programs promote teaching and learning practices which research indicates are highly correlated with student achievement.

Lens I: Conflict-affected and fragile environments (CAFE) present extraordinary challenges for teachers and students for even the most basic education service delivery, never mind educational technology. As the World Bank’s 2011 World Development Report on Conflict, Security and Development reported, students in CAFE are more than three times as likely to attend school on an irregular basis as those in other developing countries, more than twice as likely to be under-nourished, twice as likely to have a sibling die before age 5, and more than twice as likely to lack clean water. Taken together, these aspects negatively affect students’ cognitive, physical and psycho-social well-being, which in turn negatively affects their learning. Similarly, teachers are directly affected by conflicts and crises. They may be displaced, highly mobile and frequently absent. Their own education and professional development may have been disrupted, resulting in low levels of content knowledge and teaching skills. More seriously, they may be directly targeted during conflict and require psycho-social support themselves, which reduces their capacity to alleviate the impact of conflict or crisis on learners. (Zakharia and Bartlett, 2013).

As for the schools themselves, they may have no basic facilities at all, such as water, electricity, lighting and toilets, making educational technology programs logistically very problematic. Where those facilities are available, planning for an educational technology program must consider and manage the challenges of maintenance, financial sustainability, the risk of theft, the reliability of telecommunications, etc.

Beyond challenging school-level conditions, CAFE is often associated with unstable governments with weak institutional capacity, scarce material resources and limited infrastructure. This negatively affects, for example, a ministry of education’s ability to plan, execute, supervise and assess educational programs, particularly in geographic areas far from the capital city. In addition, there may be high ministerial turnover, weak controls on corruption, and multiple political entities to manage. Information systems and data to inform programming may be scarce, out of date or both (Zakharia and Bartlett, 2013). All of these conditions make any educational technology program more challenging to design, implement and evaluate.

There are additional factors to consider in conflict- and crisis- affected environments, such as language of instruction and curriculum. At the school level, the official language of instruction may actually worsen perceptions of inequality and exclusion, and intensify conflict. A student’s native language may be an indicator of ethnical or political identity, which could make him/her a target for violence. On the other hand, “international medium” education policies (e.g. English or French as the language of instruction) may exclude certain groups and favor others, which can also exacerbate conflict. With respect to curriculum and related educational materials and textbooks in CAFE, they often reflect conflict between groups in the form of unfair representation, stereotyping, exclusion and even the use of offensive language (Zakharia and Bartlett, 2013). Students displaced by conflict and/or crisis may find themselves caught between differing language policies and curricula. In non-conflict countries, educational technology programs typically aim to align with the official language of instruction and official

curriculum; where either or both of these elements are linked to the conflict itself, educational technology programs risk being undermined. Thus, the first lens for assessing educational technology programs is the extent to which they can adapt to and succeed in these exceptionally challenging circumstances.

Lens 2: The second analytical lens is derived from a recent publication, entitled, “How Learning Works: Seven Research-Based Principles for Smart Teaching” (2010).² These principles have been adopted for this study because they reflect both extensive empirical classroom-based research and the latest findings from the neurosciences. In addition, while educational program assessments would normally use actual student performance data (e.g. scores on standardized tests), this information is not available for all case studies examined in this report, so a proxy indicator is required. Because international education research consistently points to teaching practices as the most important factor in determining student learning outcomes, it makes sense to examine the links between the educational technology programs reviewed here and these principles for effective teaching. Moreover, this particular research was favored over other approaches because it draws on research from a wide range of disciplines and perspectives such as cognitive psychology, developmental psychology, social psychology, anthropology, demographics, organizational behavior and educational research. Such a range was considered appropriate given the multiple cognitive, psycho-social and organizational challenges of teaching and learning in CAFE described above. Finally, as will be seen below, the seven principles for smart teaching are, in fact, nicely suited to assessing educational technology programs.

Educational research clearly indicates that learning is a process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning (Ambrose et al, 2010). That is, **learning is not something done to students, but rather something students themselves do**. A teacher can promote learning only by influencing what the student does or thinks. Furthermore, the research suggests that the seven principles for smart teaching described below are domain-independent (they work across all subjects), apply to all educational levels, and are cross-culturally relevant. They are:

1. Students’ prior knowledge can help or hinder learning.
2. How students organize knowledge influences how they learn and apply what they know.
3. Students’ motivation generates, directs and sustains what they do to learn.
4. To develop mastery, students must acquire component skills, practice integrating them, and know when to apply what they have learned.
5. Goal-directed practice, coupled with targeted feedback, is critical to learning.
6. Students’ current level of development interacts with the social, emotional and intellectual climate of the course to impact learning.
7. To become self-directed learners, students must learn to assess the demands of the task, evaluation their own knowledge and skills, plan their approach, monitor their progress, and adjust their strategies as needed.

These seven principles are fully consistent with the Minimum Standards for Teaching and Learning agreed to by the International Network for Education in Emergencies (INEE). Specifically, these INEE standards include: (1) socially and linguistically relevant curricula, appropriate to the particular content and needs of learners; (2) periodic, relevant, and structured training for teachers’ professional

² Ambrose, S., Bridges, M., DePietro, M., Lovett, M., and Norman, M. “How Learning Works: Seven Research-Based Principles for Smart Teaching,” Jossey-Bass, 2010.

development; (3) design of instructional learning processes so that they are learner-centered, participatory, and inclusive; and (4) use of appropriate methods to evaluate and validate learning outcomes. In particular, the educational technology case studies reviewed in the next section align most closely with INEE's third minimum standard for teaching and learning regarding learner-centered, participatory and inclusive instructional learning processes.

As mentioned above, these seven principles are nicely suited to educational technology interventions. For example, learning can take place in and out of school, driven by children's experiences. Mobile phones, radios and even computers are far more prevalent outside of schools than in, and can offer a range of educational experiences accessible to students wherever they are. Given that student and teacher absenteeism is frequently a problem in CAFE, educational technology can provide learning opportunities which might otherwise be impossible. In addition, educational technology has been repeatedly shown to increase student motivation, at least in the short term, and in some cases to catalyze activity-based, student-centered approaches. This suggests considerable potential in crisis- and conflict-afflicted countries where traditional schools relying on traditional teaching may not be functioning on a regular basis.

At the same time, this analytical approach requires us to be very aware of the living and learning environment for students in conflict- and crisis-affected countries. Students arrive in school not only with prior knowledge, skills and abilities, but also with social and emotional experiences (some perhaps traumatic) that influence what is important to them, how they perceive themselves, and how they will engage in the learning process. Therefore, it is worth examining each of these principles in the context of crisis- and/or conflict-affected countries:

1. Students' prior knowledge can help or hinder learning.

Many students in this CAFE context may not have developed a strong foundation for learning, in terms of basic literacy and numeracy skills, or they may have been exposed to poor instruction. For example, they may have attended English classes taught by non-native English speakers with poor pronunciation. In addition, students may be displaced or had their schooling interrupted, or their teachers may have been absent over long periods. A weak foundation for learning makes it more difficult to acquire new knowledge and suggests that educational content and methods should be adaptable for different learning levels, rather than rigid and purely grade-specific. This first principle highlights the opportunity offered by educational technology to conduct simple low-stakes diagnostic assessments of students' prior knowledge, provide accurate information (e.g., correct language pronunciation) to students, and offer sequential competency-based learning activities which allow students to begin at the appropriate level and to progress at their own pace.

2. How students organize knowledge influences how they learn and apply what they know.

Students need to make connections between pieces of knowledge, between their daily experience and the content they are asked to master. If the content is too removed, abstract, or theoretical for their reality, which may be focused on subsistence, physical and/or emotional security and other immediate concerns, students may not be able to organize knowledge correctly and apply what they learn. This raises the need to provide locally relevant content and argues for caution in simply importing educational content from another culture or language, which is easy to do with educational technology. Recall that in CAFE language can be a driver of conflict and a social, political and economic divider among groups, as well as an instrument of marginalization. Thus, the extent to which educational technology programs can be easily and affordably contextualized is an important factor. The flip side of this is that educational software can be used to rapidly produce relevant, contextualized educational materials, whether by teachers, students or local experts. In this case the technology enables localization and knowledge organization.

In addition, this second principle highlights the importance of accompanying any technology with activity guides that require students to apply their learning to their daily reality. For example, learning activities should aim at establishing inter-connections with students' families, communities and physical environments, which help students to organize their knowledge.

3. Students' motivation generates, directs, and sustains what they do to learn.

When students have a positive experience achieving a learning goal or activity, if they expect to be able to learn and succeed in school and perceive support from their learning environment, they will be more motivated and more likely to learn. Educational technology can offer students a more stimulating, active learning process, generating a more positive experience than is frequently the case in traditional teacher-centered classroom settings where students mechanically and repeatedly engage in "call and response," or simply copy from the blackboard into their notebooks and memorize. Technology can also provide access to positive role models and sources of information (for example, regarding personal health or even sport scores) that could be important ingredients in a learner's motivation for learning. In addition, it offers students who have some prior experience with technology opportunities to facilitate classroom and even community instruction, which can be very empowering and motivational. If nothing else, ICTs can provide variety in the learning process and positive, non-judgmental feedback, helping the school become a place where children can succeed and feel safe. This may be in stark contrast to the environment outside of school where conflict and/or crisis often provide strongly negative and demotivating messages to children.

4. To develop mastery, students must acquire component skills, practice integrating them, and know when to apply what they have learned.

Well-designed digital learning resources can present content and learning activities in a logical and sequential fashion, which breaks apart broad concepts into component skills in ways a traditional teacher working in a remote rural classroom might not fully understand or attempt. This is the potential of technology to supplement and enrich what the teacher can offer. In addition, this principle emphasizes yet again that students not only need to learn facts, but they also need activities to apply and integrate their learning. Activity guides that prompt students to apply and integrate their knowledge are critical if students are to retain their learning, gained either through traditional lecture-based instruction or through educational technology. In addition, educational technology offers the potential for repeated practice and application in the absence of a teacher, or when only a volunteer or unqualified teacher is present.

5. Goal-directed practice, coupled with targeted feedback, is critical to learning.

Somewhat similar to Principle 4, learning activities need to be directly linked to learning objectives, not just undertaken for their own sake. In addition, students require feedback, whether from the teacher, their peers, technology, or even their own self-assessment, to determine if they have actually learned the content at hand. This suggests that students should not be allowed simply to view, listen to, or read educational content passively, but rather they must be required to practice it and receive some form of feedback. Collaborative learning exercises and self-assessment rubrics, of the sort offered by good interactive radio instruction and video-enhanced teaching, can serve this purpose, while computer labs can provide students with opportunities to easily edit and revise their work in response to feedback provided locally or from a distance. Traditional lecture-based, memorization-oriented instruction often omits the practice and feedback elements required to reinforce learning.

6. Students' current level of development interacts with the social, emotional, and intellectual climate of the classroom to impact learning.

This is a critical aspect for addressing student learning needs in countries affected by crisis and/or conflict. Students and their teachers may be struggling with strong emotional and social issues when they enter the classroom setting and require a safe, positive learning environment if they are to succeed. Students' psycho-social well being must be considered along with their cognitive development. In fact, exposure to violence and trauma has been shown to have a negative impact in learning and information processing and is significantly correlated with a decrement in IQ (Delaney-Black et al, 2002). Potentially offsetting this negative impact, educational technology can provide a positive learning environment and generate positive learning experiences, through humor, reassuring messages, non-judgmental feedback, engaging and considerate fictional characters, and short, sequenced activities that focus on student success rather than on identifying student failure. In addition, in some cases, technology can offer students and teachers the chance to communicate with family and friends who may be far away, allowing them to express and release some of the stress they may be feeling. The potential positive learning impact enabled by this communication capacity should not be under-estimated.

7. To become self-directed learners, students must learn to assess the demands of the task, evaluate their own knowledge and skills, plan their approach, monitor their progress, and adjust their strategies as needed.

While this principle applies more to upper education levels, it nonetheless has relevance for basic education. One of the most important positive features of educational technology is the potential to develop self-directed learners. Such self-direction may be especially important in crisis- and conflict-affected environments where teachers, much less qualified teachers, may not be present on a regular basis, or may be so emotionally strained themselves that their teaching practices suffer. Using technology, students can replay and review electronic lessons, follow learning activities and prompts provided by educational software at their own pace, and access new educational content when they are ready. Self-directed learning is particularly important for older students who typically take greater responsibility for their own learning, but activity-based learning programs at the primary level (e.g., Tamil Nadu's activity-based learning program in India, which does not rely on any ICTs at all) demonstrates that students of all ages can become self-directed learners. Related to this point, educational technology can also be useful for non-teachers who are trying to help students learn, inside and outside of school settings.

The next section applies the two "lenses" described above to analyze three sets of country case studies of education technology programs. At the end of each set of country case studies is a summary of the advantages and disadvantages of the specific educational technology reviewed. Subsequent sections derive both lessons learned from these country case studies and guiding principles for the design and implementation of future educational technology programs in conflict-affected and fragile environments.

III. COUNTRY CASE STUDIES: MOBILE PHONES, INTERNET-ENABLED COMPUTER LABS AND INTERACTIVE RADIO INSTRUCTION

As mentioned in the Introduction, there is a wide range of educational technologies worthy of review, but only some of them are examined in this section. The specific case studies below were selected because they were judged to be highly relevant for conflict-affected and fragile environments, and because they offered sufficient information on program design, implementation and impact from which to derive lessons learned and generate recommendations for future educational programs. More generally, Table 3.1 below highlights some of the typical challenges faced by teachers and students in conflict-affected environments, and maps possible educational technologies to address these challenges. This is not an exhaustive list – the challenges are many – but it highlights the importance of carefully considering the nature and extent of the environmental conditions when choosing what educational technology might most effectively support student learning.

Table 3.1: Educational Challenges and Technological Responses in CAFE

Typical Challenges of Education in a Conflict-Affected and Fragile Environment (CAFE)	Possible Educational Technologies Which Can Address These Challenges
Lack of security in schools and risk of theft	Low-cost mobile phones are less valuable and easily locked up, so are less at risk of theft than, say, computers. On the other hand, their small size and popular use outside of school make them easily concealed and re-sold if they are stolen. School lockers are required.
Frequent school closures	Mobile phones, tablets and radios can easily be transported and used outside of school for learning purposes in case of school closure. This is not the case with desktop computers.
Lack of reliable power in schools	Mobile phones and tablets can be re-charged using solar panels; radios can be re-charged using wind-up and solar technologies.
Frequently absent or unqualified teachers	Self-directed instructional educational software can be delivered by a wide range of hardware options, using the Internet, cell phone infrastructure, USB flash drives and radio.
Threatened psycho-social well being of students	Simple, easy-to-use technology builds self-esteem; contextualized educational software reinforces student's identity. Technology which includes two-way connectivity enables personal communication which may be highly beneficial for students.
Unavailable or expensive telecommunications infrastructure	Educational radio, videos and educational software can be played on stand-alone devices (radios, TVs and computers) requiring no connectivity. Such stand-alone devices may already be available at the school or within the school community.
Lack of qualified maintenance personnel	Mobile phones, radios and desktop computers are relatively simple technologies which are available and typically already serviced in the local marketplace, as opposed to say, tablets.
Lack of textbooks and educational materials	Computers (and tablets, to some extent) enable teachers and students to develop and share their own educational content.
Scarcity of trained experts to develop local educational content	Computers (and tablets, to some extent) enable teachers and students to develop and share their own educational content.

While perhaps somewhat unorthodox, the case studies below are presented in order of decreasing technological sophistication. That is, the more sophisticated and cutting-edge technologies are presented first and the simpler, more traditional educational technologies are presented last. In part, this is done to highlight new educational research results which have not been widely disseminated

elsewhere. But in addition, given that technologies are constantly evolving and in some cases becoming obsolete, it seems logical that the latest technology is the best indication of where educational technology is heading into the future. It is with regard to the future that this report is most concerned.

USE OF MOBILE PHONES FOR IMPROVING TEACHING PRACTICES AND STUDENT LEARNING

Over the past 10 years mobile telecommunications has spread worldwide, enabling developing countries to leapfrog traditional landline telephone infrastructure. The low cost of mobile phones and their penetration into rural areas has prompted experimentation with their potential to improve teaching and learning in resource-constrained countries in Asia, South Asia, Africa, and the Caribbean, including in CAFE. Several of these experimental programs have been well documented and researched, providing a wealth of lessons for future educational technology interventions. This first set of case studies examines five such programs, in India, Pakistan, the Philippines, and Haiti.

INDIA CASE STUDY I³

This program was chosen in part because it is well documented with a strong formative evaluation component, and it is relatively easy to envision its application in countries affected by crisis and conflict. India is not, as a whole, a conflict- or crisis-affected country, although some states within India with populations far greater than most countries are experiencing conflict and violence and present extremely challenging educational environments. Furthermore, there are huge inequalities in India, based on social, religious and ethnic identity, which divide society and can trigger unrest quickly. Given that this pilot program is still underway, truly conclusive findings will require more time to emerge. Nonetheless, it is highly innovative and has demonstrated very positive initial results in terms of student learning and teacher practices at very low cost, which makes it appropriate as the first case study for this report.

Program Design: The India BridgeIT program began in 2011 and will run for three full academic years. Improved student learning of the fifth and sixth grade English and Science curriculum is the program objective. BridgeIT is a collaboration between Nokia, the Pearson Foundation, EZVidya (local partner), and the State Departments of Education in Tamil Nadu and Andhra Pradesh, involving 86 urban, semi-urban, and rural schools in the two states, plus 17 control schools in a quasi-experimental trial. During the first two years of the program, 160 teachers were involved, engaging more than 4,800 students. The program will scale up further in 2013-2014.



There are three components to the program: hardware, software, and training/support. The hardware is a Nokia mobile phone with TV-out port, a pre-paid SIM card, TV-out cable, TV monitor or LCD projector, and cloud-hosted Nokia Education Delivery (NED) server. NED is free, open-source software. The content is a curriculum-based catalog of approximately 400 educational videos, 90-100 videos for each grade and subject, developed by the Pearson Foundation and contextualized by EZVidya, broadcast via 2G mobile phone technology to the Nokia phone, and shown to students via the TV or

³ This case study is based on the report, "Summative Evaluation of the NOKIA and Pearson Foundation BridgeIT Project, Year 2, 2012-2013 School Year," prepared by EZVidya, authored by Matt Wennersten and Dr. Zubeeda Banu Qureshy.

projector as part of the teaching process. Each video is two to four minutes long, followed by classroom-based activities, mapped to topics in the syllabus and listed in “pacing charts” by the expected month of instruction and corresponding textbook lesson. Teachers receive training and support in how to (i) use NED software, including ordering and downloading videos, (ii) integrate the videos with the syllabus, and use the Activity Guides and Syllabi Pacing Charts, and (iii) access remote support Help Desk. School site visits are also conducted to provide technical support as needed.

Careful evaluation design, which included collection of students’ socio-economic status, parental educational attainment, pupil-teacher ratios, teacher experience and qualifications, school size, and other factors, means that student learning in the absence of the intervention would be expected to be similar across treatment and control schools. A “difference in difference” method was used to compare the changes in pre- and post- test scores across the treatment and control groups. Test scores were gathered through supervised on-site test administration and blind marking. Test papers were matched within each class, subject, and teacher by student name to measure the individual learning growth of students from the beginning to the end of the school year.

Results: *The program had a strong, positive, and statistically significant effect on student learning for both Science and English. Students in BridgelT schools out-gained those in control schools by an average of 8 percentage points ($p=.01$, 0.36 standard deviations) in English, and by an average of 15 percentage points ($p=.01$, 0.98 standard deviations) in Science. Moreover, BridgelT was an “accelerator,” raising average BridgelT student learning from below the average starting achievement level of control students to equal or higher levels in one year.*

In addition, *BridgelT was observed to improve the quality of teaching.* Standardized classroom observation instruments, applied in BridgelT schools at the beginning and end of the school year, showed that the amount of direct teacher instruction went down and the mean number of effective teaching indicators increased. The Activity Guides were described by teachers as “essential” for the application of the lessons offered in the videos. Qualitatively, teachers reported increased student motivation and engagement, and greater willingness to use the technology over time. Once downloaded, teachers could replay the videos several times, as needed. In addition, teachers reported using the phone’s web browser to download and present additional educational videos from YouTube, along with other phone applications. In this important aspect, the technology was a catalyst for a change in pedagogy, an accelerator of alternative teaching practices that improved student learning.

Assessment: It is possible to see several of the seven principles for smart teaching described above in Section II at work here. For example, the English language instructional programs compensated for teachers’ poor English pronunciation skills and remediated students’ prior learning of incorrect pronunciation. The videos were highly contextualized by local Indian content developers, after the initial use of directly imported educational videos proved less than fully successful. The videos were engaging and stimulating, and the accompanying activity guides enabled students to apply and organize their knowledge. In addition, the technology enabled access to a huge range of educational videos (rather than being restricted to proprietary curriculum or content), which allowed teachers to supplement and enrich their lessons.

With respect to how the technology adapted to the challenges of a complex environment, the use of simple mobile phones and a television enabled teachers to integrate the educational videos into their lessons. Most teachers were already familiar with how to use the mobile phone and the schools were required to provide their own television sets, which reduced costs and promoted ownership of the program. Use of inexpensive and reliable 2G telecommunications infrastructure avoided the higher costs and lower reliability of Internet connections. On the other hand, the success of the program so far is in large part due to the quality of the local educational content produced. The capacity to produce such content may not be available in many conflict- or crisis- affected countries.

Costs: To its credit, the BridgeIT program has carefully documented most of its investment costs. Per student costs for the hardware, SIM card, training, site visits and program overhead (all costs except for video development, electricity, and TV monitor or projector) were US\$21. This works out to US\$3.11 per child per tenth standard deviation of improved learning, which is very favorable compared to other interventions such as computer-assisted learning (CAL), girls' scholarship programs, and textbook provision.⁴ However, the cost of development and localization of the educational videos and Activity Guides can be quite significant, in addition to time-consuming. India is fortunate to have advanced educational video production capacity at relatively low cost, which may not be the case in many countries affected by crisis and/or conflict. Countries interested in replicating this program should examine this question carefully as part of technical and financial feasibility assessment.

INDIA CASE STUDY II⁵:

This second case study examines the use of mobile feature phones to improve literacy in English as a Second Language, specifically among girls and "disadvantaged" women. Feature phones are more advanced than basic phones which only allow voice call and text messaging, but cost far less than smartphones, typically between US\$40-80 when new and far less on the second-hand market. A key advantage over basic phones is their "programmability," which allows customized literacy learning games to be developed and downloaded. In addition, feature phones allow language games to be played off-line, without connectivity, lowering costs and significantly increasing usability.

Program Design: Literacy learning games were developed for these phones, aligned with the state curriculum of Andhra Pradesh for fifth grade English, and carefully adapted to the culture and learning styles of rural children. Learning content targeted phonetics, letters, oral vocabulary knowledge, and word reading, considered as "literacy sub-skills." First, for each sub-skill (e.g., vocabulary, letter-sound correspondences), a series of screens were designed to familiarize the learner with that sub-skill. For example, the screens sequentially explain word meanings using pictures and explanations in the native language, then display letters and words that contain these graphemes while playing voiceovers of these words. Second, for each sub-skill, one or more games were designed in which the player had to rely on their mastery of the given sub-skill in order to win the game level, after which a "congratulations" screen would be displayed. The screens and games were sequenced, based on when the sub-skills were expected to be learning during the academic year. Thirdly, revision modules were designed, so as to reinforce and consolidate knowledge of English literacy after the games.

The first pilot study took place during an afterschool program with 27 rural Indian children between second and ninth grades (Kam et al., 2009b), while the second pilot study involved 250 fifth grade students in four low-fee private schools in the city of Hyderabad in the state of Andhra Pradesh.

⁴ See Banerjee et. al., 2007 for CAL; Kremer et.al., 2009 for girls' scholarships; and Glewwe et. al., 2009 for textbooks.

⁵ This case study is from Matthew Kam, "Toward Programme Design: Mobiles for Women and Girls' Literacy" (draft manuscript), UNESCO, 2013.



Source: www.wired.com

Results: In the first study, *students achieved statistically significant post-test gains on spelling skills*, associated with an effect size that corresponded to slightly over two thirds of a letter grade on a normalized grading scale (Kam et al., 2009b). In the second pilot study, *students made significant post-test improvements on writing and vocabulary*. This suggests that technology can indeed offer large positive learning benefits when it is designed such that it aligns with the prior learning of the participants.

While these two pilot programs were undertaken in poor or rural areas, they were not tried in crisis- or conflict-affected environments. On the other hand, they suggest that mobile phones offer new opportunities for mass-delivery of educational services to underserved learners, especially for those sub-skills and knowledge areas in literacy, math, science, and other subjects that are compatible with the mobile phone's small screen and keypad. It should be possible to replicate this study in more challenging environments, so long as there is mobile phone connectivity and digital content production capability (in-country or abroad).

Assessment: This program nicely reflects several of the principles for smart teaching. The lessons were carefully adapted to local culture and learning conditions, and reflected the prior learning of largely disadvantaged girls. The lessons broke down literacy instruction into sequential learning activities which developed literacy sub-skills in a scaffolding process. There were graphics, animation and stimulating voice-overs in the lessons, as opposed to simple text. The program allowed learners to begin at their appropriate level, no matter their age or grade, and to advance at their own pace, in and out of school. Finally, they provided positive feedback and the experience of success for students, which encouraged them to continue with their lessons.

Costs: Once the educational content is developed and rolled out, the cost of the production of the digital content can be spread over a very large number of learners so that unit costs can be extremely low. Specifically, as estimated by the program implementation team, for a cost of approximately \$1 per learner per grade level, effective, locally-appropriate mobile learning content can be developed, based on educational and contextual research as well as government-mandated standards, and then mass produced and distributed at scale. The primary costs are related to the development of the educational content, which means per student costs decline quickly as the program scales up (Kam, 2013). Using the mobile phone as the distribution channel is quite cost-effective. Furthermore, it is not difficult to imagine a mobile phone or telecommunications provider supporting this program through corporate social responsibility initiatives.

PAKISTAN⁶

The case of Pakistan presents another interesting scenario. While the country as a whole cannot be described as affected by crisis or conflict, there are certainly pockets of the country where this is the case. Furthermore, certain traditional views prevail in many part of the country, and some parents remain opposed to sending their children (particularly girls) to school on a regular basis. This has resulted in extremely low literacy rates: 50 percent overall and just 36 percent for females.

Program Design: In the mid-2000s UNESCO piloted a project to enhance girls' literacy skills through the use of mobile phones. A group of 250 semi-literate girls located in three districts (evenly distributed between rural and semi-urban areas) was provided with mobile phones to receive text messages in Urdu, that they then copied into workbooks. Girls were encouraged to create and send text messages.



Source: www.news.olivebranch.com

Results: Over the four-month program, *girls' literacy skills improved by a weighted average of 67 percent* (no control group was included in this pilot so it is not clear how much of this improvement can be attributed to the program as opposed to other factors). While a majority of girls and their family members initially doubted the effectiveness of the technology, in the end 87 percent of them were satisfied with the phone-based approach.

Assessment: The key insight here is that literacy skills deteriorate quickly after formal literacy programs end, due to a lack of appropriate and interesting reading opportunities for newly literate learners. This is analogous to a formal primary school that cannot operate on a regular basis because of conflict or crisis, which results in young learners losing their newly acquired literacy and numeracy skills. The mobile phones gave the learners activities to **do** with their literacy skills that were motivating, engaging, and effective, enabling the students to learn outside of school as self-directed learners. In a small but significant way, it is possible to see the principles for smart teaching at work in this case study.

Costs: Educational opportunities exist when technology is already widespread, popular and inexpensive. For example, the cost of the phone was just US\$33 and could be re-used for new cohorts of learners after each four-month program, while the SIM card cost US\$3 per phone, and the cost of sending 600 messages to all program participants over a four-month period was just US\$5 per learner. UNESCO did not have to invest heavily in either technology or communications but rather could take advantage of existing infrastructure. This allowed the program to focus on developing appropriate local content and activities that engaged learners.

⁶ This case study draws extensively on the 2012 report prepared by Ichiro Miyazawa for UNESCO.

PHILIPPINES⁷

The precursor to the BridgeIT program described above was the Text2Teach program, launched in 2003, and supported through multiple phases. Text2Teach is a country-specific program supported by a consortium comprised of Nokia, the Pearson Foundation, the International Youth Foundation, UNDP, USAID, and local partners (e.g., Ayala Foundation, an SMS software provider and a satellite-based communications provider).

Program Design: Clusters of 10 to 12 selected schools in both urban and rural areas received an ICT package, which enabled teachers and students to view educational videos which had been previously downloaded on a mobile phone. The package included a dual-band mobile phone, pre-paid phone cards, television monitor, digital satellite recorder and access to a Nokia-managed server through which mobile phones could access the videos. The mobile phone could then be connected to the television monitor and the videos shown during the class lesson.

Videos were selected and adapted according to their alignment with the national fifth and sixth grade curricula, covering English, Mathematics, Sciences, and civic values. Each video was approximately five minutes long. Ultimately, over 900 educational videos were available to teachers. Teacher guides and user manuals were also provided, along with a three-day cascade model of teacher training; trainers/school supervisors were trained who then trained the teachers. Training covered how and when to use the videos in the lessons, what learning activities to link to the different videos, ways to stimulate learners' interests and motivation using exploration and collaboration, and various technological components. Teachers were encouraged to communicate extensively with their peers to share experiences and lessons learned. An explicit objective was for teachers to adopt a more learner-centered approach.



Source: Courtesy of Text3Teach, www.engineeringforchange.org

Results: A total of 440 schools were included in the program, almost 1500 primary teachers were trained, involving almost 1 million students. Third-party evaluations were conducted for each of the

⁷ This case study draws from a report written by Eilean von Lautz-Cauzanet of UNESCO.

three phases by the National Institute for Science and Mathematics Educational Development, the Demographic Research and Development Foundation, and external consultants. Specific evaluation results include:

- *Increased learning gains on standardized Math, English, and Science examinations*
- Reduced dropout and absenteeism rates
- Improved student engagement and motivation with fewer discipline issues
- Improved teacher competence and attitudes towards use of technology as a teaching tool
- Development of a “community of practice” among teachers and increased sense of connectedness, particularly in rural areas
- Positive attitudes from community, school officials, and parents about use of technology to improve learning

Assessment: The Text2Teach program was one of the earliest attempts to use mobile phones for education, dating from 2003. Its longevity reflect strong partnerships established between the ministry of education, funding agencies, private sector companies and NGOs, and the positive results as documented by third-party evaluations, which also generated lessons for improving subsequent phases of the program. On the other hand, while the alignment of the educational videos with the official curriculum and the learner-centered aspect of the program design are to be noted, it might be even easier and less costly to provide educational videos through stand-alone technologies such as a television and DVD player that could be supplied by the school and/or community. Program cost information was not available to verify whether or not this would be the case. The use of radio to distribute the videos enabled fresh educational content to be inexpensively distributed to the schools, but it is not clear additional educational videos continued to be developed during the program’s lifetime.

HAITI⁸

Haiti provides a good example of a country beset by natural disasters (earthquakes, hurricanes), social unrest, poverty, and very poor infrastructure. It is, unfortunately, a country persistently affected by crisis and conflict. Rural Haitian schoolchildren are among the most poorly served in the world. In February 2012 Nokia, the International Rescue Committee (IRC), the Haitian Ministry of Education, Pearson Foundation, and other local partners launched a technology-based program to improve the quality of primary education in rural areas, particularly the first three years of schooling. The specific objective is to improve teachers’ practices through participation and application of techniques learning in a school-based teacher training program, delivered through mobile phones.

Program Design: 220 teachers from 32 rural public and private primary schools have been involved, reaching approximately 13,000 students. Schools receive a Nokia smartphone with the Nokia Education Delivery application pre-loaded on it, battery-powered Pico LCD projector, and solar-powered battery charger. IRC’s training curriculum has been translated into Creole, contextualized for rural teachers, and converted into short video formats by a local video production company. After receiving basic training in how to use the technology, teachers watch these short training videos in classroom techniques for learner-centered education, including physical layout of the classroom, student grouping, interactive pedagogy, formative student assessment, etc. Teachers then meet once a month in Learning Circles with other participating teachers to watch additional videos and share their experiences (positive and negative) in learner-centered education.

⁸ This case study is drawn from oral interviews with program managers at Nokia and International Rescue Committee.



Source: www.mercycorps.org

Results: While this project is ongoing and too new to generate any summative evaluation results, early monitoring information suggests both strengths and weaknesses of the program. On the positive side, *teachers have embraced the use of video as a training tool and demonstrated their ability to use the mobile phones and LCD projectors to access this training.* Particularly for very hard-to-reach, rural schools, this is quite promising. Secondly, use of the Nokia data gathering application (translated into Creole) allows teachers to enter and send all project monitoring information from their phones to a central server, greatly speeding up data collection and analysis and identifying which schools need on-site support. Thirdly, training of the Ministry's Pedagogical Advisors who then train the teachers has increased the program's acceptance by the Ministry of Education and its eventual sustainability. Some of the weaknesses in the program include teacher motivation (there are no incentives to participate in the program, which is not to suggest there should be), apprehension of the technology on the part of the school principal and teachers in some cases, and poorly functioning technology in some schools (linked to mobile phone connectivity and some software issues).

Assessment: This program is different in that it targets teachers and their teaching practices, not students. Interestingly, the same principles for effective teaching described in Section II apply for teacher training programs. For example, teachers' prior experience and knowledge of technology can help or hinder their learning and ability to integrate technology into their teaching. Their level of motivation is a key factor in determining what they actually learn and apply from their training. To develop mastery, teachers must first acquire component skills, practice integrating them, monitor their own progress and adjust their strategies as needed. A key lesson learned is the importance of adapting technology hardware and software to the rural context, making the material as user-friendly as possible, and preparing schools to both use and take care of the technology. The use of a battery-powered LCD projector and solar-powered re-charger is an excellent example of compensating for the challenging rural environment where electricity supply is unreliable and costly.

Going forward, the program intends to incorporate the Ministry of Education's own teacher training program into the videos and obtain the Ministry's official certification of this teacher training program. This should improve teachers' motivation levels because salary increments typically accompany training certification. Because the software provided by Nokia is open-source and requires no licensing fee, it should be possible for the Ministry of Education to sustain this program. In addition, users can obtain

the source code and modify/customize the software as needed. Obviously, studies of the impact of this teacher training program on student achievement need to be conducted in the near future.⁹

To summarize this set of case studies, the table below presents some of the advantages and disadvantages of mobile phone-based interventions to improve student learning. (Note: these are just lists; it is not intended for each advantage and disadvantage to be juxtaposed directly against each other.)

Advantages	Disadvantages
Simple, low-cost hardware uses existing mobile phone infrastructure, and software/content development costs can be spread widely as the program scales, to keep unit costs very low.	To date, there has been no large-scale implementation of mobile phone-based educational technology in countries affected by crisis and conflict, so the concept remains unproven. Further, in some countries, mobile phones are banned in schools.
Students learn to use the educational software quickly and can access it inside and outside of school, as self-directed learners.	Development of local, context-specific videos can be time-consuming and expensive, preventing quick roll-out in a crisis.
Ease of use and popularity of mobile phones reduces training time, accelerates teacher adoption, and facilitates development of teacher “communities of practice,” presenting a possible alternative to historically ineffective cascade teacher training models.	Essentially a one-way content delivery system; lacks full interactivity and Internet access. This could reduce impact of teacher training activities, which often require reflection and research to succeed.
Educational videos can offer high-quality audio-visual content which teachers (and radios) sometimes cannot, e.g., for foreign language, science, history, etc.	Depends on reliable mobile phone infrastructure penetration into rural areas. Phones can easily be used for non-educational purposes, taking students off-task. Ensuring security/ownership/control of distributed phones is a potential issue.
Because mobile phones are multi-use technologies, important in daily life, people find ways to keep them charged. Furthermore, they can be charged using renewable energy. This is typically not the case with full-scale computer labs.	The small screen of a mobile phone is a limiting factor, leading to a lack of “depth” of the learning experience. In addition, the lack of a keyboard makes inputting data difficult and/or time-consuming.
Activity guides accompanying mobile phone-delivered videos facilitate interactive, collaborative learning experiences.	Much of the currently available educational content is repurposed from other sources, and may not be well-adapted to the particular functionality of mobile phones.

⁹ Author’s Note: In September 2013 Microsoft purchased Nokia’s phone business, including all hardware, software and human resources. Given Microsoft’s extensive engagement in applying educational technology in developing countries (see next case study below), there is considerable scope for envisioning an eventual integration of mobile phones, tablets and computers for education in crisis- and/or conflict-affected countries. But it is too soon to tell if such an initiative is planned, and if so, how long it might take to develop integrated solutions adapted for the classroom environments covered by this study.

COMMUNITY TECHNOLOGY ACCESS (CTA): INTERNET-ENABLED COMPUTER LABS FOR EDUCATION AND TRAINING IN AFRICAN REFUGEE CAMPS

While refugee camps present a physical, social and economic environment distinct from government-run public schools, students and teachers in those camps are certainly affected by the crises and/or conflicts around them, which gave rise to the refugee camps in the first place, and so applications of educational technology in refugee camp settings are very relevant for this study.

Since 2003 UNHCR, Microsoft and other key partners have collaborated to establish Community Technology Access (CTA) programs in more than 22 countries located in Africa, Eastern and Central Europe, Asia and the Middle East. While every country program is different and adapted to local realities and needs, they all aim at enhancing access to education, life skills and ICT skills. Distance education is a key component, as is enabling people living in countries afflicted by crisis and/or conflict to communicate with the outside world. Initially, a global model was attempted with standardized hardware, software, and training solutions. For example, for some countries computers were pre-loaded with educational content and shipped in a container which became the computer lab, but experience suggested a case-by-case approach was more effective. This study examines the particular case of the CTA center in a large refugee camp in Kenya.



Photo Credit: Rocco Nuri

Program Design: Dadaab Refugee Camp currently hosts approximately 475,000 people, many of them children. Given the enduring nature of the circumstances in Somalia and Sudan which generated these refugees, UNHCR offers education and training services to tens of thousands of children, with a goal of reaching a primary enrollment rate (ages 6 to 13) of 68 percent. To support this effort, three CTA centers were opened in the camp. The basic CTA contains 20 computers (donated by Hewlett Packard), all of which are connected to the Internet through a server, basic printer, video projector and the suite of Microsoft software (donated). Ensuring a stable supply of electricity has been one of the biggest challenges, which inspired an additional partnership with a local solar power company that installed solar panels to provide most of energy required (air conditioners still require generators).

According to the UNHCR, networked computers connected to a multi-point server are preferred to smaller, less expensive tablets because of the need to offer secondary education, which typically requires extensive writing, research, and file-saving/storage. The insecurity of the computer centers is another challenge: frankly, it is more difficult to steal a desktop computer than a tablet.

The CTAs offer formal education, basic digital literacy, long-distance learning, vocational education, resume and job search skills, and international communications. Primary, secondary, and even on-line tertiary educational programs are offered. For primary and secondary education, the host country curriculum is offered so that diplomas can be offered through the host country Ministry of Education (MOE). For example, the Kenya Computer Studies Program, aligned with the Kenyan MOE curriculum is offered, as are science and physics through the Kenya e-Learning Centre.

In addition, the CTAs offering distance-based teacher training so that refugee camp teachers can be certified by the Kenyan MOE. Year I is remedial education and includes: English language for academic

purposes, ICT, and research skills. Successful completion leads to a non-university Certificate of Completion issued by a Kenyan NGO, and enables students to continue on to higher education. One-, two-, and four-year programs are available, offering certificates and diplomas in elementary, early childhood, and secondary education. Students can also enroll in Bachelor Degree programs in Education, Health, Business, Public Administration, Community Development, and Science.

The first cohorts are expected to complete their studies in 2017. While too new to evaluate, experience shows the potential of ICTs to upgrade teaching skills and knowledge at all educational levels in an extremely challenging environment, largely through distance methods. Equally important, it provides a degree of hope to youth who complete secondary education, offering avenues of work opportunities for better lives and alternatives to frustration and possibly violence.

Results: Formal impact evaluation has not been conducted at Dadaab, in part because the CTA program is relatively new and the focus has been on start-up and implementation. However, early results are promising. *Primary and secondary level retention rates have increased, as has girls' enrollment in Science classes.* Several refugee teachers have improved their own educational levels and teaching skills along with computer literacy (although this is anecdotal and not generalizable yet). Approximately 400 teachers in the camp are engaged in the “borderless” higher education program in partnership with Canadian and Kenyan universities described above. Older youth are pursuing certification in computer and solar panel maintenance, opening up future employment opportunities. This will be extremely important for ensuring the long-term technical sustainability of the CTA centers.

Assessment: In the case of the CTA program, it is important to highlight its relevance beyond formal schooling and learning. The CTA is a form of “tele-centre” which has a much broader range of functions and applications than just education, that can be highly complementary and attractive to children and youth. The tele-centre can provide access to employment and job-creation opportunities, and to other “development-related” information concerning health, agriculture, micro-finance, etc. The tele-centre can also serve as a critical location for conflict- or crisis-related information and communication, and students/youth may find their technological skills highly valued by other community members. In a very real, practical way, the tele-centre can provide students with contextualized opportunities to apply and enrich their learning in meaningful ways. This sort of value and benefit should not be under-estimated, particularly in environments affected by conflict and/or crisis. Much more information can be found regarding tele-centres at www.telecentre-org.

The following table provides a summary of the advantages and disadvantages of the Internet-enabled computer lab approach.

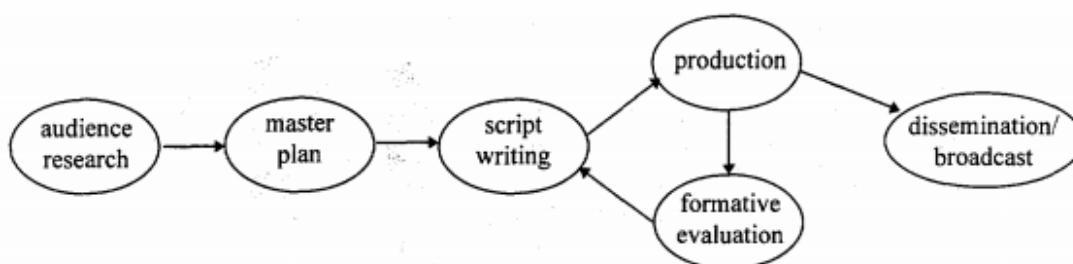
Advantages	Disadvantages
Internet-enabled computer labs provide a wide range of possible educational applications, including research, the full suite of productivity software, distance-based learning, etc., in addition to strengthening youth employment skills.	Computer labs are much harder to integrate into actual classroom teaching than more mobile devices, as they require moving the whole class to the lab, which then cannot be used by any other group. Many teachers simply do not want to take this time away from other classroom learning activities.
Desktop computers are well established and reliable technologies, and technical support for repair and maintenance is often locally available.	Computer labs require reliable and affordable electricity from the grid or from generators, and the amount they require typically cannot be generated using renewable energy sources. In addition, they often require air conditioning to prevent over-heating, which requires even more energy and increases

Advantages	Disadvantages
	operating costs.
Most teachers, students and parents are somewhat familiar with desktop computers by now – they are what would now be considered as “standard” technology and therefore perhaps more readily accepted.	Compared to mobile phones and radios, computer labs are much more expensive, sometimes requiring a separate room to be constructed and typically involving much higher delivery costs to schools. In addition, they have higher maintenance costs and greater susceptibility to issues such as dust, heat and humidity.
Computers are frequently used in a wide range of industries and businesses, so skills in their use help older students find jobs.	Desktop computers typically require full Internet connectivity (although some data can be exchanged via low end cellular networks), as opposed to mobile phones and tablets which are designed to exchange data using 2G-4G cellular technology. This increases both investment and recurrent costs.
Desktop computers are bulky and relatively heavy, which increases the difficulty of theft (i.e., makes them more secure).	The bulkiness and weight of desktop computers make them non-portable, as opposed to mobile phone, tablets, and radios, so that out-of-school learning with the technology is not possible.

INTERACTIVE RADIO INSTRUCTION (IRI)

Interactive radio instruction (IRI) has a long history and has been extensively reviewed and evaluated elsewhere (Bosch, 1997, 2001; Perraton, 2000; Dock, 1999; Fryer, 1995; Potter, 2002; Potter and Naidoo, 2006). The intention is not to repeat this history here, much of which will already be familiar to education program planners in developing countries. Rather, the focus is on use of IRI in countries affected by crisis and conflict. As described in the case studies below, IRI has been shown to work in such countries, albeit with limitations of the medium and the challenging environment itself.

IRI is an instructional methodology which combines an audio component, delivered by an “audio teacher” by radio, audio cassette or MP3 player, with learning activities carried out by students, facilitated by the classroom teacher. IRI was first developed in the 1970s in Central America, designed to offset poor teacher preparation, low student achievement and scarce resources, all of which characterize CAFE. Its focus is on improving educational quality as opposed to access, which requires active learning and purposeful teaching practices. Educational content is organized and distributed across lessons so that learning is built upon prior knowledge through “scaffolding”. Learning activities are tied to measurable learning objectives. The audio “characters” model the activities and problems first before students carry them out, linked through storylines, music and other attributes. Successful programs require careful development, including audience research, focus groups, and field level formative evaluation to make sure audio lessons and learning activities are engaging, contextually relevant, and effective in promoting learning. This process, which may go through several iterations, is illustrated in the figure below.



Source: Bosch, 1997.

Many of the principles for effective teaching can be seen in this methodology. The sequential competency-based learning activities allow students to build on their prior knowledge. The lessons themselves are based on a deliberate process of localization and contextualization, with feedback loops to make revisions to scripts as needed. The activity guides help students to organize their knowledge and apply what they know. The programs include humor, engaging narratives and variation from traditional teacher-centered instruction. Learning activities are directly linked to learning objectives and require students to speak, write, sing and act during the lesson itself, as opposed to just passively listening to the teacher.

The IRI methodology is well-adapted to conflict-affected and fragile environments. It explicitly takes into account the likelihood of poorly trained or even absent teachers, and uses reliable, low-cost and flexible delivery models (broadcast radio or audio files pre-loaded onto MP3 players). Once the development phase is over it can be scaled up quickly to support large numbers of students, with low recurrent costs. For example, an IRI program in South Africa underway since 1992 reaches approximately 1.3 million learners every year (Potter and Naidoo, 2009).

In terms of costs, earlier studies indicate a range of \$1.50-3.00 per student per year, including both development and recurrent costs (Bosch, 1997), which is very reasonable. Another study (Adkins, 1999) of the cost-effectiveness of seven different educational interventions found that, in terms of incremental improvement, the impact of one dollar spent on IRI is 70% higher than that of one dollar spent on textbooks and over 11 times higher than one dollar spent on teacher training.

CASE STUDIES: INDIA, SOMALIA AND SOUTH SUDAN

INDIA

As mentioned earlier, India may not be considered a fragile country beset by conflict or crisis, but certain states in India with populations far greater than most African countries, such as Chhattisgarh, Bihar, and Jharkhand, do suffer from both persistent civil unrest (Naxalite rebels) and natural disasters (e.g., floods). Lessons learned from educational technology programs in these very challenging and resource-constrained states are highly relevant and applicable to other countries affected by crisis and/or conflict.

Program Design: The Technology Tools for Teaching and Training (T4) Project was designed and implemented between 2002-2011, across a range of Indian states (both high-tech and low-tech), including Chhattisgarh and Jharkhand. Funded by USAID with extensive co-financing provided by participating Indian states, and implemented by the Education Development Center in collaboration with a long list of local and international partners, the T4 program initially focused on the potential of interactive radio instruction to improve students' English-language skills. It later grew into a multi-faceted, multi-media program covering English, Math, Science and life skills implemented across eight States, engaging almost 300,000 teachers and reaching more than 40 million students. This study looks only at the program's impact in the "weaker" states of Chhattisgarh and Jharkhand, both of which experienced significant civil unrest during program implementation (Naxalite rebellion), where it was implemented in more than 34,000 schools.



Source: Royer, 2012.

Program Results: Students were tested in English, Mathematics and Environmental Sciences, before and after the T4 program was implemented. On a scale of 1-100, Grade 4 and 5 students in Chhattisgarh (2008-2009) increased their mathematics scores by an average of 29 points after the program, and in Environmental Sciences they improved their scores by 16 points. Meanwhile, Grade 3 and 4 students in Jharkhand (2008-2009) increased their English comprehension scores by 17 points after the program; Grade 4 and 5 students improved their Mathematics scores by 15 points and their performance in Environmental Sciences by 11 points. These are large statistically significant improvements in learning outcomes. However, because the program was implemented state-wide there were no control groups against which these gains can be compared, so learning gains should be attributed to traditional teaching and normal cognitive growth, in addition to the IRI program. Generally speaking, both girls and boys benefitted equally from the program, although there were minor gender differences by subject.¹⁰

Assessment: This is an impressive example of the potential of interactive radio to reach very large scale within a relatively short timeframe. Key to the T4 program was the learner-centered pedagogical approach integrated into all of the programs products and professional development activities, which emphasized learners' individual differences and the need for learners to construct their knowledge through a variety of learning experiences. This aligns perfectly with the principles for effective teaching described in Section II, and is consistent with the INEE Minimum Standards for Teaching and Learning referred to earlier. Furthermore, the T4 program applied an incremental, iterative approach to program design, learning by doing and making adjustments as indicated by the monitoring information gathered and analyzed. After audience research and consultations with teachers, students and parents, all of the audio lessons went through several rounds of design-revision-testing-revision-finalization. This was essential for ensuring successful contextualization and localization. Finally, the program included extensive capacity-building for teachers, state and district-level officials, which enhanced the programs' technical and financial sustainability and scale, including in the most challenging districts affected by Naxalite violence.

Costs: Detailed cost information was not available for this report. What is known is that total program costs over the 5 years of the second phase of this project were approximately \$5.4 million, to which should be added approximately \$9 million in counterpart funding from the Indian states involved, for a total of \$14.4 million. Using a very conservative estimate of 85 million students reached through this

¹⁰ T4 India Chhattisgarh Student Performance Results 2009, Education Development Center, Washington, DC 2009.

program over the course of the 5 years of Phase II, this works out to just \$0.17 per student. Achieving the learning gains described above at such a cost is quite impressive.

SOMALIA

Somalia certainly ranks among those countries negatively affected by crisis and conflict. Civil war, drought, weak government institutions, and other factors have created a “perfect storm” for schools, teachers, and children. Student enrollment rates and public financing for education are both among the lowest in the world.

Program Design: In 2005 the Somali Interactive Radio Instruction Program (SIRIP) began, funded by USAID and implemented by the Education Development Center (EDC). The program lasted until 2011 and provided interactive audio programs to 330,000 children in Grades 1-5 attending formal, non-government, Koranic, and community schools. Radio programs were broadcast daily (three hours per day, up to five days per week) or supplied on digital media players to students and teachers. Basic literacy and numeracy skills were covered, along with life skills, health, conflict prevention, and mediation. Attractive readers and teachers’ guides were also provided, along with teacher training in active learning pedagogy.

Implementation: The teacher (or designated “facilitator”) used a radio to receive the broadcast or inserted a flash drive loaded with that day’s program into the radio. Where AC power or batteries were unavailable, wind-up and solar-powered radios were used successfully. The 30-minute program addressed a specific learning objective, and was composed of a series of activities, songs, poems, dramas, and interviews, delivered by a consistent set of radio characters, including a “radio teacher” and “radio students” who modeled instruction and activities. The teachers’ guide suggested post-broadcast learning activities which enabled students to apply the lesson, further reinforced by the readers.

Results: *Grade one SIRIP learners scored 15 percent higher than non-SIRIP learners on standardized literacy tests, and 20 percent higher in Math.*¹¹ In addition, according to the implementing agency, it has “helped to stabilize fragile communities by providing a consistent, attractive and reliable service; engaging families and communities; and teaching knowledge and skills that both children and adults need in order to move out of conflict and poverty.”

Assessment: The choice of this educational technology was appropriate for this challenging context. It is hard to envision successful introduction of full-scale Internet-enabled computer labs or mobile-phone based educational programs in Somalia at that time. The security situation, available Internet connectivity, unreliable electricity supply, limited local expertise to develop contextually relevant videos, weak institutional capacity and other factors all argued for an IRI approach. While its impact may be limited and its sustainability unclear, IRI appears to have provided educational services which would not have been available through traditional educational methods. Cost information is not available.

SOUTH SUDAN

Sudan is another country deeply affected by 20 years of civil war and drought. The Comprehensive Peace Agreement of 2003 ultimately led to the establishment of South Sudan in 2011. The Southern Sudan Interactive Radio Instruction (SSIRI) program, implemented by the Education Development Center with funding from USAID, lasted from 2004-2012.

Program Design: Similar to the Somali case study described above, the program broadcast 30-minute interactive radio programs for grades one through four in literacy, numeracy, English, and life skills. Shortwave and FM radio, compact discs, and wind-up radios with MP3 players and memory cards were

¹¹ Ho, J., & Thukral, H. (2009), *Tuned in to Student Success: Assessing impact of interactive radio instruction for the hardest-to-reach*. International Development Division, Education Development Center.

all used to deliver audio educational content. All content was in English, which required the teacher to translate the dialogue and activity instructions into the local language.



Source: www.philanthropy.com

Results and Assessment: No information is available with regards to the program's impact on student's learning of language. However, with only about half of the teachers having completed primary school, not all teachers understood English well enough to translate the audio educational content accurately, so it is safe to say the program likely had very little impact. On the other hand, this same high percentage of untrained teachers made IRI potentially relevant: it supplemented and enriched what the classroom teacher could offer to students on his/her own. *Unfortunately, in the view of the funding agency, this program did not adequately address the specific challenges of a conflict-affected and fragile environment, and was ultimately closed down. This is an important cautionary tale.*

Advantages	Disadvantages
In a highly mobile and oral culture, radio offers continuity of instruction, both inside and outside of school. Even in a fragmented country, a network of radio stations plus wind-up radios with MP3 players can reach students and youth with learning activities wherever they are.	Timing can be a challenge. It can be difficult for teachers to manage class-time so it is aligned with the specific time of the radio broadcast, or for students outside of school to be by a radio when the lesson is broadcast.
Radio provides great opportunities for development of local language educational content.	Programming is very supply-driven; users do not have much flexibility or choice in the broadcast content.
Interactive audio can be combined with offerings featuring mobile phones or computer labs.	Programs typically last 30 minutes, raising the question of what teachers and students do for the remaining hours of the school day.
The quality of programming can be controlled, unlike the quality of teachers (who may be untrained, unmotivated or frequently absent), offering a multiplier effect for the best educators.	IRI is best suited for disciplines that are highly oral in nature, such as native and foreign languages, while less effective in disciplines requiring visual aids, such as science.
IRI can be implemented in formal schools with teachers, or through informal community learning centers using trained facilitators.	Radio just is not as "sexy" as other technologies, and teachers may be more reluctant to incorporate it into their classes than they might be with, for example, mobile phone-delivered videos.
IRI provides a form of daily, school-based teacher professional development, by modeling classroom	IRI appears to be less effective and engaging for higher levels of education classes, which typically require

Advantages	Disadvantages
management, interactive pedagogy, and gender-balanced learning activities.	higher order thinking skills, as opposed to early grades, which focus on basic language skills and engage students with songs and short skits.
The cost of IRI programming is very low, especially compared to content development costs for mobile phones or computers, or to the costs of providing textbooks, constructing schools, or certifying teachers.	Quality programming takes considerable time and money to produce initially (as is the case with all educational software), and local capacity to do this may be lacking.
IRI is simple and easy to use: so long as the radio is switched on at the right time (or the content loaded into the MP3 player), both teachers and students can participate in guided, interactive learning activities.	

EMERGING TECHNOLOGIES

One of the challenges of assessing the impact of educational technology and drawing lessons for future initiatives is rapid and continuous technological change. In many respects, by the time an educational technology program is old enough to be seriously evaluated it may be considered to be technologically obsolete. So this section is more forward-looking in terms of emerging educational technologies. It is not evidence-based but rather focused on potential impact.

So-called “tablets” are perhaps the most interesting. They offer wireless connectivity using mobile phone infrastructure for download and upload of educational content, larger screens than mobile phones for easier viewing, keyboards for typing, the ability to store and serve a wide variety of educational applications (with up to sixteen gigabytes of memory), portability, smaller secure storage requirements, and re-charging via solar power or car batteries (see photo below of solar-powered lab using tablets). Certain tablets use very strong materials, such as “gorilla glass”, to prevent breakage and have very high temperature tolerance. Their costs range between US\$100 and US\$200, making them even more affordable than many smartphones. Their strong visual capabilities make it possible to offer learning content that might not be available locally. Several pilot programs using tablets in developing countries are underway and should be closely monitored.¹²



Source: www.realclearpolitics.com



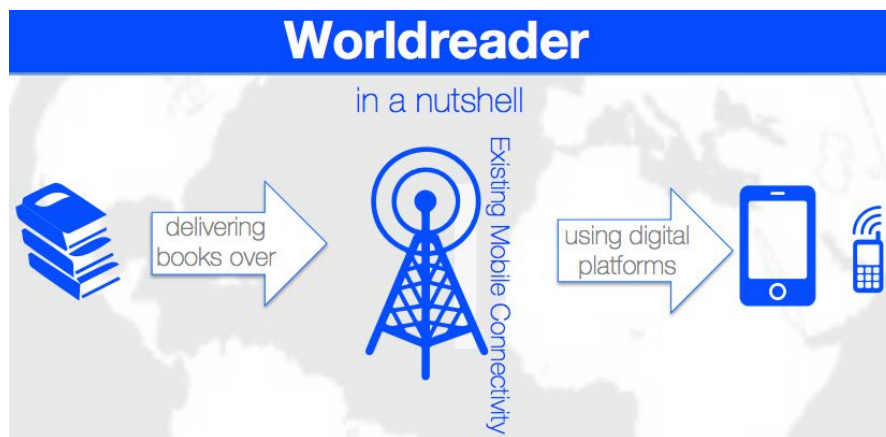
Source: www.dailywireless.org

¹² Phone conversation with Kurt Moses, education technology specialist with FHI360, July 29, 2013.

Tablets offer the storage space for educational software which mobile phones cannot, and the ability to download new applications easily without the Internet connections that computers require. For example, a teacher's tablet can include an application blocker and monitoring function to see what each student is doing with their tablet, as well as a one-touch classroom-control feature to lock students' screens and post a message saying "eyes on teacher."¹³ This allows the teacher to keep all the students on-task and to supervise each child's learning, while allowing students at different levels to proceed at different paces.

Another interesting example is the use of e-readers (which could be thought of as "dumb" tablets). Worldreader has been on the front lines of this effort, distributing e-readers (Kindles and other such devices) pre-loaded with thousands of e-books to schools in Anglophone Africa. As of June 2013 the program has reached over 4,300 students in Africa, effectively putting in their hands a total of more than 600,000 books, from both African and non-African authors.

Recently, Worldreader launched its Mobile program, which allows readers to download books directly to their mobile phones and avoids the challenge and expense of distributing e-readers. Using a new software (biNu) which enables low-end mobile phones to function more like smartphones, Worldreader Mobile currently serves approximately 500,000 readers (mostly in Africa and India) who collectively read about 20 million pages each month, a quite remarkable figure. For hard-to-reach students in conflict- and crisis-affected countries, it is not hard to envision how reading skills could be strengthened through readily available and inexpensive mobile phones supported by Worldreader's programs.



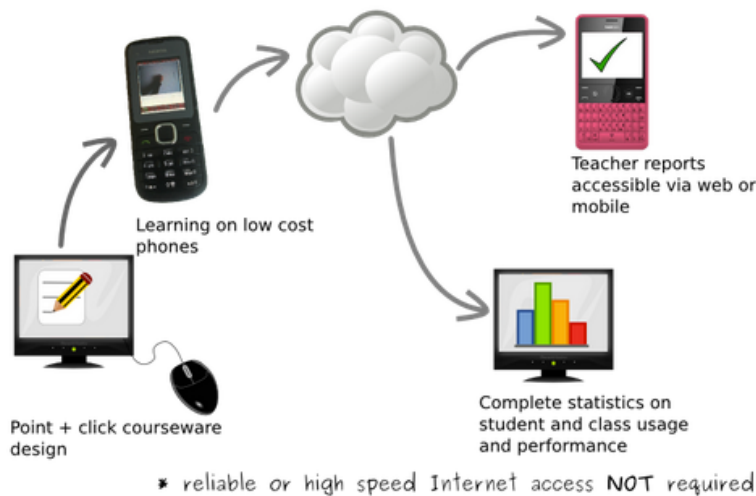
Source: www.worldreader.org

In 2012 an evaluation of the Worldreader program in Ghana was conducted among approximately 500 students in 9 public schools. Overall, students and teachers reported a "positive experience" with the e-reader. It substantially increased access to books, increased students' enthusiasm for reading, provided additional teaching resources, improved participants' technological skills, and increased performance on standardized tests of reading skills at the primary level. In addition, e-reader loss and theft was less than anticipated. On the other hand, almost half of the e-readers broke, and certain e-reader functions generated frustration for students and teachers, such as book deletion and improper use of Internet and music during class time (ILC Africa, 2012).

¹³ The New York Times Magazine, "No Child Left Untableted," Carlo Rotella, September 15, 2013.

Using a sturdier device would address the breakage problems and the price points for e-readers continue to fall, so the outlook is promising for the use of the e-reader (or mobile device with e-reader software loaded on to it) to distribute textbooks, reading books and other educational materials to schools in CAFÉ.

Given their ubiquity, the use of mobile phones for learning will almost certainly expand, and the example of Ustad Mobile in Afghanistan suggests considerable potential for rapid scale-up in countries affected by crisis and conflict. Ustad Mobile aims to extend students' time-on-task and enable out-of-school learning to complement what students learn in school. Local language literacy curricula have been converted into digital format using a courseware editor (Exe) that is adapted for feature phones. The curricula, learning activities (games, fill in the blank, Q&A, etc.), and usage software can be loaded onto any feature phone via a memory card. Students can then practice their literacy lessons whenever and wherever, with or without connectivity. Student performance information is automatically sent to the teacher's phone so individual learning can be monitored and remedial activities undertaken in school if necessary. The next step is training more educators in local content development so Ustad can be used for formal primary schooling, as well as for training in other sectors, e.g., health. This program is just getting underway and no results exist as yet of their impact on student learning.



Source: www.ustadmobile.com

The One Laptop Per Child (OLPC) program, undoubtedly the highest profile global educational technology initiative of the past decade, received extensive media coverage when it was first launched in 2004 with the promise of expanding the availability and use of computers throughout the developing world. The computer was specially designed to be durable, low-cost, low-power, and easily connected to the Internet using free, open-source software. Initially, the small green and white laptops were supposed to cost just \$100 each, but actual costs have averaged closer to \$200. OLPC has been introduced in various ways to a diverse set of countries, including Uruguay, Afghanistan, Rwanda, Paraguay, Nepal, Peru, Honduras, and others.

In 2011 the Inter-American Bank carried out the first large-scale evaluation of OLPC, based on a randomized assessment of 319 public schools located in small, poor communities in rural Peru. (IDB, 2012) Using data collected 15 months after implementation, no evidence was found of the program's effects on student enrollment or test scores in Math and Language, although some positive effects were

found on general cognitive skills. There was no change in students' reading habits, although the computers substantially increased availability of books. There was also no observed change in the quality of teaching practices. A much smaller study conducted in Nepal of OLPC covering three grades in 26 schools (Sharma, 2012) also found no impact on Math or Language achievement, although another study conducted in Uruguay (Fernando et al, 2011) in 27 schools found minor positive statistical effects on Math and Language. While it is true that 15 months is a relatively short timeframe to expect significant gains in Maths or Language attributable to the laptops, the fact that there were no observed gains at all is quite disconcerting.

The major weaknesses in the programs studied appear to be insufficient teacher training and lack of curriculum-relevant software. In many cases, teachers simply did not know what to do with these machines in their classrooms. This underscores the important point that computers by themselves do not increase student achievement (IDB, 2012), a fundamental lesson for all educational technology program designers. Furthermore, by now the technological advances in production of standardized, low-cost hardware, such as with tablets, have made the OLPC hardware obsolete in many respects. Finally, many of the high-level technical staff behind OLPC have left for various reasons, so the future of this program is unclear at this time, greatly complicating considerations of new educational programs based on OLPC hardware.



Source: www.one.laptop.org

Looking further ahead, experiments in U.S. schools with technology suggest that the potential for improving learning is even greater than previously thought, largely through the ability of technology to tailor the curriculum and learning activities to students' individual learning needs and styles. This allows students to progress based on their demonstrated competency, at their own pace, rather than simply based on a standard amount of time allocated by a teacher to learn something. More adept students can progress more quickly on their own, while the assessment instruments enable teachers to identify those students who need additional face-to-face help. While perhaps futuristic in the context of developing countries affected by crisis and/or conflict, this sort of educational technology could be just what students in those countries actually need: guided, self-paced, engaging, portable, rugged, collaborative,

active learning programs that can overcome the “bottleneck effects” of a poorly trained, unmotivated, or absent teacher, or of a school frequently closed due to conflict or crisis.

IV. LESSONS LEARNED

The case studies examined in Section III offer a wealth of experience from which numerous lessons can be drawn for the consideration of future educational technology programs in countries affected by crisis and conflict. Some of the most important lessons learned are detailed below.

1. Educational technology, when it is appropriately applied in contextually relevant ways, has been shown to enable positive learning experiences and improve learning outcomes in some of the most resource-constrained environments, including in countries affected by crisis and/or conflict. There remain, however, far more un-evaluated pilot educational technology programs than evaluated ones; the evidence base is still quite thin.
2. Some (not all) large-scale educational technology programs indicate greater cost-effectiveness in achieving those improved learning outcomes relative to other possible interventions, such as textbook provision. Once appropriate digital learning resources have been developed there is very little marginal cost in expanding the program to reach more students (unlike, for example, printed textbooks), which quickly reduces unit costs. Successful large-scale programs keep the technology as simple as possible so users can train each other.
3. Interactive radio instruction has a long and well-researched track record of successful implementation in very challenging environments spanning many years. The functionality of the technology in terms of student learning opportunities is limited compared to newer technologies, but there are fewer risks in program design and implementation so long as careful and iterative contextualization and localization of the audio lessons is carried out.
4. Mobile technologies (feature phones and tablets) have shown initial positive impact on student learning and offer even more potential in the future. With respect to mobile phones, their popularity, ease of use and re-charging, and relatively low cost make them well-suited for large scale interventions, although small screen sizes will continue to restrict certain educational applications.
5. Traditional networked computer-lab programs may be more costly and harder to establish and maintain than IRI and mobile phone-based programs, but they offer a richer and more engaging learner experience with potentially greater impact on learning outcomes across a wider range of learners. In addition, they enable a wider range of uses for economic and social development.
6. Successful programs have engaged local content developers to develop digital learning materials that are relevant, appropriate, and accepted by teachers, students, and the broader community. In addition, the replication of well-performing programs still requires the due diligence of localization, which requires both additional time and money.
7. Strong monitoring and evaluation systems, coupled with programmatic flexibility, are necessary so that content delivery, teacher training, hardware provision, maintenance, and other elements can be adjusted as circumstances require (particularly in high conflict situations). The best programs keep learning and adapting in a constructive, iterative process.
8. For educational technology, past experience is only a partial indicator of future potential. What worked yesterday may not be relevant tomorrow, and what did not work yesterday might work tomorrow. Furthermore, technology and our understanding of how to use it in the classroom is evolving rapidly and positively, in terms of functionality, mobility, ease-of-use, cost, and content, so program effectiveness and impact are likely to grow over time.

Beyond the specific facts and lessons of these case studies, for students trying to learn in countries affected by crisis and conflict, educational technology programs offer some tangible hope, which may in fact be one of their most important contributions. Just having the opportunity to learn how to use a computer, a tablet, or a smart phone, regardless of their educational applications, can stimulate their curiosity and interest to learn more. It can light a spark. This is particularly so if the technology enables them to communicate with people beyond their immediate surroundings. In challenging, conflict-affected situations where many young people may be inclined to despair, the chance to engage with educational technology is itself a positive experience and worthy in its own right.

V. GUIDING PRINCIPLES

For the education program planner this section offers a set of 10 common-sense guidelines for designing an educational technology project or component in a challenging resource-constrained environment. They are not necessarily new but they are well substantiated by the case studies reviewed above and remain too often overlooked.¹⁴ Adhering to them, while adapting them to the specific country in question as needed, would greatly increase the likelihood of the program's success.

1. **Clarify Objectives:** In conflict- and crisis-affected countries, there can be a broad spectrum of valid objectives a Ministry of Education, development agency, or non-governmental organization may want to achieve with the support of educational technology, such as: simple stabilization of a deteriorating education system; providing minimum levels of learning opportunities; increased tolerance and understanding among youth in a post-conflict environment; improved learning outcomes for students at specific educational levels; expanded youth employment opportunities; etc. Different forms of educational technology have been shown to be useful in achieving different objectives – it is necessary to clarify the highest priority objective of the program and then consider whether educational technology is the best option to achieve it. If it is, define the causal link between the educational technology and the desired objective, and avoid the temptation to add on additional objectives just to build the case for funding.
2. **Fit for Purpose:** Once the objective is clear, specify the target educational levels, disciplines and geographic areas to be reached through educational technology and design accordingly. If improving English-language skills among remote rural primary schoolchildren is the objective, IRI supplemented by mobile phones for teachers may be both cost-effective and educationally sufficient. If formal and informal secondary education, along with skills training, for adolescent youth is the objective, tablets or computer labs may be more appropriate so that a wider range of content and learner activities can be provided. Oral-oriented disciplines such as language arts are obviously better adapted for IRI than visually-intensive subjects, such as biology. Define the technology as a function of the needs of the program's beneficiaries; do not let the functionality of the technology define the program's objectives.
3. **Be Willing to Embrace Failure:** Implementing an educational technology program in a country affected by crisis or conflict is inherently difficult; if it was easy to do it would have been done already, and such countries have seen “failed” projects of all kinds. A key ingredient for success is the ability and willingness to recognize and learn from failure – and then change course as needed. This requires a programmatic commitment to learn and adapt through experimentation and iteration, supported by robust and regular monitoring and evaluation. Not everything can be known or anticipated. Develop short implementation milestones followed by honest review, learn by doing, and make adjustments as necessary.
4. **Know Your Time Horizon:** Are the program objectives short- or long-term in nature? In some situations educational technology can quickly and cost-effectively be deployed to help stabilize a deteriorating classroom environment and provide a minimum of learning opportunities for students which may be required for a relatively short time, for example 12-24 months, until “normal” school functioning is re-established. In this case, sustainability is not a primary issue, and developing local content may not be either. But if the goal is to make a

¹⁴ These guidelines are consistent with, and in some cases build upon, other educational technology research. The author is particularly indebted to the EduTech Blog maintained by Mike Trucano of the World Bank, including the “10 principles or approaches to consider when planning to introduce ICTs into remote, low-income educational environments,” first posted in July of 2013.

lasting impact, sustainability has to be a first-order concern, which means planning for equipment breakdown, the end of technical and pedagogical support, reductions in funding, etc., and consideration of incentives among program participants and local communities to keep it going.

5. **Prioritize the Human-ware:** The people involved are infinitely more important than the technology. The question to be asked repeatedly is, *“what will the student do and experience as a result of this educational technology that cannot be achieved otherwise?”* A related question is how easy and helpful is this technology for teachers to incorporate into their daily lessons. If teachers are not both trained in how to use the technology and sufficiently convinced it will help their students learn, it is unlikely to be used appropriately. Investing in high-quality, iterative, multi-method training for teachers should not be skipped. This would include face-to-face, peer-based, on-line, and self-paced training. At the same time, emphasize how technology can create improved learning experiences for students, and can enhance the capacity of non-teachers to aid in the learning of students – especially within community and family settings outside of school.
6. **Content is King:** The educational content and learning activities made possible through technology have to stimulate and engage students. Program designers need to clarify what educational content can and should be accessed by technology and how it will be used by students to learn. Local content is key – if it does not exist it must be created, at least to complement content imported and adapted from other contexts. The technology is just a delivery mechanism for a learning experience. Make sure the content is relevant, interesting, activity-oriented, and in the appropriate language.
7. **Connectivity is Queen:** In addition to content, the great advantage of technology is the ability to make (i) *connections* to content and people located far away in space and time, and (ii) *communities*, such as students collaborating with each other on-line or teachers supporting other teachers through email distribution lists. Particularly in crisis- and conflict-affected countries, the possibility of communicating and connecting with other people can be a huge motivational factor, and it can help address some of the social and emotional stresses children experience in these environments. Wherever the spread of telecommunications infrastructure makes connectivity possible, even in countries affected by crisis and conflict, exploit this advantage.
8. **Simplicity is Golden:** Particularly if achieving large scale is an objective, keep the technology as simple, easy to use, and reliable as possible, because maintenance and technical support cannot be guaranteed. Design for the hardest-to-reach classroom environments; what works there will likely be scale-able to more favorable classroom conditions. Choose technology that will work in every classroom, even if it compromises what students might learn in the more advantaged classrooms.
9. **Power Up:** Related to Principle 8, never overlook the issue of reliable power. Grid-based electricity is great, but often unreliable or unavailable in conflict- or crisis-affected countries, forcing schools to spend scarce funds on diesel fuel to run generators, which quickly becomes unsustainable. A better option is to choose devices that use less power in the first place and to prefer those that can be re-charged through solar or wind-up mechanisms. For example, smartphones, radios, and small LCD projectors can now be re-charged through renewable energy sources such as solar, wind and human-powered (wind up) energy, which offer a big advantage.
10. **Do not “Reinvent the Flat Tire:”**¹⁵ Experience with educational technology has generated a lot of “worst practices” – what does not work. Dumping hardware in schools, offering one-

¹⁵ Reference to an Andrew Binstock interview with Alan Kay, July 10, 2012.

time teaching training on the cheap via a cascade model, considering educational content only after the hardware has rolled out, making a big bet on an unproven technology or single vendor just hoping to avoid 'lock-in' – these are recipes for failure, yet they seem to be repeated...repeatedly. They are tempting, because they appear to save money, time, effort, and other resources, but ultimately they result in failure to achieve the program's objectives.

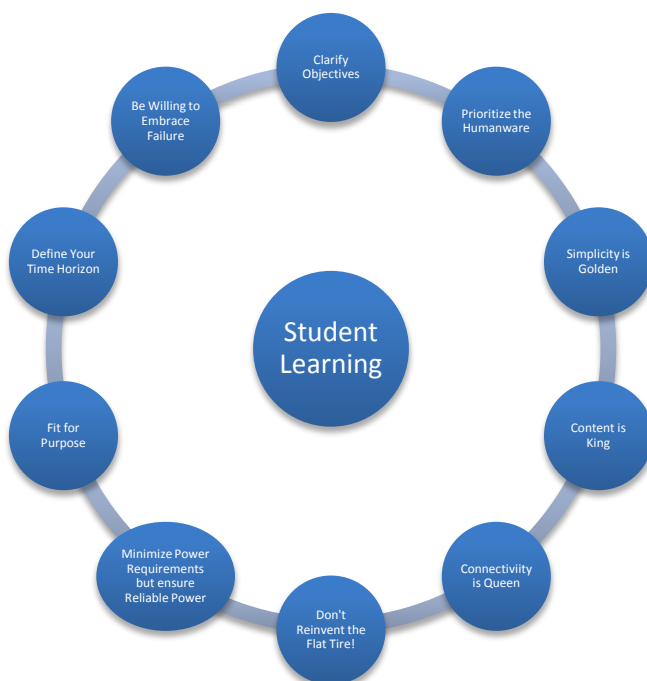


Figure 1: Ten Guiding Principles for Educational Technology in CAFE

VI. CONCLUSION

This study demonstrates that educational technology programs in countries affected by crisis and conflict can be successfully designed and implemented cost-effectively and at scale. Furthermore, the case studies reviewed indicate that educational technology offers considerable potential to apply the principles of effective teaching for improved student learning outcomes. The evidence base for these conclusions, however, remains quite limited in terms of methodology, impartiality, and duration; positive results should be tempered with a healthy skepticism. Success, scale, cost-effectiveness, sustainability, more effective instructional practices, and increased learning are far from guaranteed.

Reflection on the lessons learned from the case studies reviewed in this report, and careful consideration of how to apply the guiding principles presented above to a specific country context and programmatic objective, should help the education program planner to design and implement more successful educational technology programs in the future.

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