International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 120-141

Planning and Evaluating ICT in Education Programs Using the Four Dimensions of Sustainability: A Program Evaluation from Egypt

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ABSTRACT

This paper presents the findings from a program evaluation of an ICT in education project within the USAID-funded Girls Improved Learning Outcomes (GILO) program. The evaluation uses a framework of four dimensions of ICT sustainability to examine the appropriateness of the design and implementation of the project, which provided simple, relevant technology to 166 schools in Upper Egypt. Project implementation, as described in this article, was carried out with a view towards both rapid and efficient rollout and long-term sustainability. The evaluation study aimed to determine the extent to which the ICT component inputs were still in place and being used by the school and community one year after direct project support had ended. The findings suggest that ICT in education projects must favor neither the hardware nor the pedagogical aspects of the technology. Instead they layer the pedagogical use of technology on top of a deliberate technology infrastructure. The technical and pedagogical aspects of the program should be treated as two distinct efforts with separate, but complementary goals. Paying attention to social, political, economic, and technological dimensions during the process can make a difference in sustainability and, ultimately, success of the initiative.

Keywords: *Egypt; ICT in Education; Hardware; Infrastructure; Maintenance and Support*

INTRODUCTION

School-level expectations driving the adoption of information and communication technologies (ICT) in education worldwide include: increased quality of learning through access to more—and more effective—learning resources; more student-centered, active, and constructivist learning environments; improved critical thinking and analytical skills (Jonassen, Peck, & Wilson, 1999; Newhouse, Trinidad, & Clarkson, 2002); enhanced productivity through classroom and system management tools (Hepp, Hinostroza, Laval, & Rehbein, 2004; Jhurree, 2005); and increased student motivation, student productivity, and learner independence (Newhouse et al., 2002; Passey, Rogers, Machell, & McHugh, 2004). At a broader level, national ICT in education policies and strategic plans are often linked to such ambitious development goals as: supporting economic growth; promoting social development; advancing education reforms, including promotion of 21st century skills; and supporting education management (Jhurree, 2005; Kozma, 2008; Neil Butcher and Associates, 2011).

Yet, integrating ICT in education is not simple. Choosing the right technology, training the right people to use it and maintain it, and adjusting classroom and school schedules to accommodate it are just a few of the steps required for educational planners. Many reports of ICT in education projects suggest that too much emphasis is placed on the hardware provision, without sufficient attention to what it was expected to accomplish to the associated staff development necessary to effectively use the hardware (Hepp et al., 2004; Warschauer, 2003). As important as it is to consider ICT in education from a pedagogical perspective, one cannot neglect to adequately plan for the supporting information technology (IT) infrastructure, including the people, processes, and technology that successful use depends upon (Lacey, 2006; Microsoft, 2003). The planning and preparation that precedes technology integration may in fact be the key driver of success

(Jhurree, 2005; Rusten, 2010; Venesky & Davis, 2002), but elements of IT planning are under-documented in international literature focusing largely, if understandably, on pedagogical use and outcomes. Most case studies look at what happens after hardware and training are delivered and at what may have contributed to or prevented desired outcomes. This leaves important questions unanswered. For example, what are the specific consequences of certain courses of action during the planning stage? What configurations are likely to lead to sustainability? How does one select an appropriate technology package?

This evaluation study attempts to fill this gap by taking a close look at the planning processes of an ICT in education program embedded within a larger educational improvement project. In particular, this study focuses on the IT that was selected to support improved teaching and learning. It discusses the largely hardware-related processes of procuring and delivering equipment, providing software and training to manage the infrastructure, and creating an enabling environment in which to use that infrastructure. The GILO case is viewed through the lens of sustainability factors identified in prior research of ICT in development projects, thereby putting GILO's approach into a larger context and allowing a reliable framework for planning and evaluation of such programs to emerge.

THEORETICAL FRAMEWORK FOR SUSTAINABLE ICT IN EDUCATION

The ultimate goal of any short-term, externally funded project should be to enable stakeholders to benefit from the project inputs—both material and intellectual—long after project funds and technical assistance have ceased. ICT in education programs often receive attention for being unsustainable, due to costs or poor long-term planning at the outset (Adam, Butcher, Tusubira, & Sibthorpe, 2011). Sustainability commonly evokes the financial aspects of a project, such as ensuring adequate sources of funding for recurrent costs, maintenance, and upgrades. However, adequate staff capacity and management systems to support use of the equipment, as well as leadership and commitment from school leaders and community, are also part of observable sustainability (Rusten, 2010). In the case of ICT investments, "sustainability" arguably means that, at minimum, the project is still functioning and the equipment is still in use. Ali and Bailur (2007), however, argued for a broader view, de-emphasizing sustainability in favor of planning for and supporting capacity to innovate and respond to change in a constantly evolving environment. Ali and Bailur's point of view is particularly important for ICT in education projects, which will inevitably be affected by rapidly changing technologies and usage habits. Unused ICT may be "sustainable" in the sense that it remains in working condition, but it is hardly a worthwhile investment. True sustainability is a function of both longevity and use.

A review of ICT in development and ICT in education literature does uncover some recurring lessons learned and considerations that can guide program planning towards success and/or sustainability (for example, Derndorfer, 2010; UNESCO, 2009). To evaluate GILO's technology component, this program evaluation uses the following dimensions of ICT sustainability - technological, individual and social, economic, and political - which capture the most common recurrent themes.[1]

Technological Dimensions of Sustainability

Technological dimensions of sustainability concern choosing technology that will serve for an extended period because it is in demand, appropriate to the context, and easy to use, maintain, and repair. This involves complex choices between the latest technologies on the market vs. more tried and tested ones; locally available materials vs. products imported through donations or grants; centrally located computer labs vs. mobile, shared technologies; and more cost-effective bulk purchases of a standard set of equipment vs. more tailored packages that meet the needs of each school or classroom. Hepp et al. (2004) and Strigel, ChanMow, and Va'a (2004) warned of the "one-size-fits-all" approach and externally imposed technology that ignores the local realities. Centralized labs may be less complicated and expensive to maintain but also less conducive to teacher involvement and cross-curricular use of technology at the expense of teaching computer literacy (Hepp et al., 2004). Cossa and Cronjé (2004), Hosman and Cvetanoska (2013), Richardson (2011), and Rubagiza, Were, and Sutherland (2011) also highlighted the importance of addressing the human and financial costs of maintaining equipment, lest the technology remain off-limits for fear of breakage.

Individual and Social Dimensions of Sustainability

Introducing ICT in education is a process often surrounded by excitement and curiosity, as well as caution and criticism. For this reason, addressing community needs, creating ownership, managing expectations, and providing adequate training are all considered part of the individual and social dimensions of technology that should be addressed in program planning and implementation. Cisler (n.d.) linked successful projects to the degree to which a community takes responsibility for them. This is especially important, as described above, to ensure that technology meets the needs of the target beneficiaries. Similarly, Adam et al. (2011) emphasized the connection between imposed technology, lack of ownership, and high levels of waste; along with Jhurree (2005) and Hosman and Cvetanoska (2013), they recommended that schools develop their own plans to integrate technology based on identified needs and involving all stakeholders. Hepp et al. (2004) also pointed out that an active application process can require teachers and administrators to think carefully about costs and potential use of the technology; thus, giving importance to the future investment, and boosting motivation, ownership, and commitment. These elements can also be considered "demand drivers", which have also been cited as a key factor in sustainability (Healey, 2013).

Regardless of technology choice, there will always be different levels of capability among target groups, and implementing technology in education requires careful attention to initial and ongoing training and support, covering technical, pedagogical, and content knowledge (Kohler, 2011). It can be very difficult to change teachers' pedagogical culture and beliefs about ICT (Hepp et al., 2004; Hosman & Cvetanoska, 2013); yet, a growing body of experience suggests that delivering training through a series of classes or incorporating follow-on support can be more effective than one-time workshops and that peer learning can be effective for school-based training (Guskey, 2002; Hepp et al., 2004; Pouezevara & Khan, 2008; Strigel et al., 2008). Hosman and Cvetanoska (2013) went one step further in insisting that teachers be recognized as the key agents of change in a process that may take years, citing evidence that the more teachers are involved in the planning and implementation processes, the greater the chances of successful outcomes.

Economic Dimensions of Sustainability

The economic dimensions refer to costs, cost recovery, and the overall financial environment in which the project is situated. External projects aiming simply to introduce ICT in schools are in particularly sensitive positions regarding economic dimensions of sustainability because while they may have funds to provide equipment and support at first, by their nature, that support is going to end. It is common in ICT programs to focus too much on the initial fixed costs—purchase of equipment, construction or retrofitting of physical facilities, installation, security, insurance, and materials production—while ignoring the recurrent or variable costs such as those associated with replacement/upgrade, operation, change management, insurance, security, and disposal (Paterson, 2007). Studies of the use of computers in classrooms show wide variance in how to calculate total cost of ownership, but some estimates of recurrent maintenance range from 15-20% (Moses, 2003) to 30-50% of the initial purchase costs (Tinio, n.d.). A study of the Jordan

Education Initiative concluded that hiring computer technicians was the most significant cost associated with computer labs. Total recurrent costs were about 47% of the total budget, with projectors being the single most expensive hardware input due to maintenance requirements and replacement bulbs (USAID, 2007). Costs must be calculated for each particular context, without neglecting some of the less evident costs such as training, equipment maintenance and security, staffing of computer labs, virus protection, insurance, and responsible disposal of non-functional hardware in the future. The Samoa SchoolNet project found that since enrollment fees play a role in overall school budgets, technology packages need to be aligned with school enrollment rather than providing equivalent packages to all schools; if not, small schools may end up with too much equipment that they are unable to sustain. The same analysis of sustainability noted the importance of personal and institutional “demand drivers” for creating the motivation for schools to allocate financial resources to initiatives that they feel are most important (Healey, 2013).

Many ICT in education programs are also designed to earn revenue, or offset costs through community participation or by charging fees for use of the school equipment after school hours. After estimating initial and recurrent costs and potential sources of revenue, schools and school districts need to secure funding through regular budget channels, which usually requires significant lead time.

Political Dimensions of Sustainability

Budgets, training programs, and pedagogical objectives at the school level are ultimately highly political issues that must be aligned with national policies and favorable to local political leaders. ICT in education plans can be the product of attractive political promises, but oftentimes plans do not materialize into programs because politicians have misjudged the scale of needs, are under pressure from vendors, or cannot mobilize funding (Hepp et al., 2004; Jhurree, 2005). Within schools, new governance structures and change management processes may have to be put in place to foster an enabling environment for technology integration. According to Cisler (n.d.), political dimensions of sustainability involve ensuring support for the project through local and national politics, policies, and individuals. This can be accomplished, in part, through promoting achievements and successes. Strigel et al. (2008) noted that raising awareness and generating champions had an important effect in Samoa. Moreover, establishing channels of communication and collaboration between schools and the central ministry’s technology integration department accelerated technology adoption in the participating schools and provinces.

Political dimensions also involve the policies that either support or prevent effective use of technology for education. As previously mentioned, at the institutional level, stakeholders including teachers, school administration, and parents should be involved in decision making about technology management and usage policies (Jhurree, 2005; Strigel et al., 2008). Taking it one step further, political dimensions concern long-term administrative support for change management, which also should be considered at the outset of all projects (Hosman & Cvetanoska, 2013). Managing technology within the school generally involves one of two basic choices: either require a teacher to serve as a technology coordinator in addition to teaching duties, or recruit a technology coordinator directly through the school system or outsourced through a private contractor. Schools that try to save money by implementing the first choice (i.e., volunteer teachers as ICT coordinators) may find that the demands on the teacher’s time are too great and therefore not sustainable (Hepp et al., 2004; Strigel et al., 2008). However, the alternative (i.e., hiring a technology coordinator) is also a potential tradeoff in terms of opportunity costs, and finding a person with the appropriate technical (hardware and software operation) and pedagogical (technological integration) skills can be challenging.

ICT IN EDUCATION IN EGYPT AND THE GILO PROJECT

Egypt was preparing for 21st century education through technology as early as the 1990s. Together, the Egypt Education Initiative (2006–2009) and the Egyptian Information Society Initiative included many programs targeted at specific populations and sectors, including rural and disadvantaged communities. Programs aimed to: increase access to ICT-related services, improve ICT competencies, promote innovation in IT, and expand access to educational opportunities through e-learning (Ministry of Communications and Information Technology [MCIT], 2005). More recently, the convergence of government policies and private sector support for ICT in education in Egypt offers new and promising opportunities. All ICT in education efforts have been shaped by the MOE's guiding principles of standards-based content, active learning methodology, and integration of ICT, assessment, and learning materials. The five-year MOE National Strategic Plan for Pre-University Education Reform in Egypt, 2007/08–2011/12, reflected government and citizen aspirations for better education. A new strategy covering the period 2012–2017 aims at investing in Egyptian potential and achieving digital citizenship through innovative technology applications. Table 1 provides key terms and definitions of important concepts in the Egyptian educational system referenced throughout this paper with abbreviations.

Table 1: *Definition of Terms and Concepts Related to Education in Egypt*

Ministry of Education (MOE): Responsible for the quality of pre-university education in Egypt.
Technology Development & Decision Support Center (TDC): Established under the MOE in 1994 under the name Technology Development Center. Has a presence in all of the governorates and is responsible for providing technical support for school multimedia labs and computer lab computing equipment.
General Authority of Educational Buildings (GAEB): Part of the central MOE, responsible for school design, construction, maintenance, and furniture. GAEB has offices in each governorate (muderiya).
Board of Trustees (BOT): A school board, which is democratically elected at each school, typically consisting of school staff /principal, parents, and community members.
Muderiya: One of 27 educational administrative divisions between the district (idara) level and central MOE level, equivalent to the political governmental unit of muhafaza.
Idara: A district, or sub-governorate (smaller than muderiya) administrative division that has authority over a cluster of schools.

Equitable Access to Education: The GILO Project

In line with these reforms, GILO, a five-year program funded by USAID[2] that began in 2008, aimed to expand equitable access to education by focusing on girls, to improve early grade reading as a foundation to learning, and to improve community partnerships with the schools. The inclusion of an ICT component aimed to improve teacher lesson planning, teaching, continuous learning, and professional development. A secondary goal was to provide student and community access to computers to enhance communication, problem solving, and research skills. The project design assumed that immediate implementation objectives depended on empowering the GILO schools to use, support, and maintain the technology; without this foundation, the teaching and learning goals would not be achieved. Two main principles that guided the IT approach taken were:

- provide simple, reliable, and sustainable school IT systems, infrastructure, maintenance, support, and capacity building; and

- carry out all GILO IT activities in partnership with the government (GAEB, TDC) and schools.

GILO[3] committed to supporting 2,700 to 3,000 classrooms in kindergarten, community, primary, preparatory, and basic education schools in the four muderiyas of Beni Sueif, Fayoum, Minia, and Qena, in selected idaras. Schools were selected following a process agreed upon by GILO, the Ministry of Education, and USAID. First, priority communities were identified. Priority schools within the communities were then identified (based on rural locations and current girls' enrollment rates). Next, schools were selected based on a demand-driven application process using an objective scoring mechanism. Finally, GILO selected schools to be phased into the program in three cohorts (2008, 2009, 2010).

In practice, there was a clear distinction between IT (hardware, infrastructure, functionality, etc.) and its applied use in the classroom (for convenience, referred to as ICT) in the GILO project. The IT team focused on computer and network design, site preparation, and the creation of a maintenance and support team to support the network, computers, and applications. The GILO IT team also developed IT management applications such as asset management software and a maintenance and support helpdesk. All of this was done in collaboration with the ICT team responsible for classroom-level pedagogical use of the technology. The ICT team focused on building teacher skills in using ICT to improve professional development, designing specific computer-based media to meet critical professional development needs, and developing skills of the administrative staff to use school management information system software. The ICT team also identified and supported at least two staff per school to provide ongoing mentoring and support to other teachers and administrators to encourage them to integrate ICT in their work. Between the IT and ICT teams, there was a constant exchange of ideas to ensure the infrastructure met the required goals.

The GILO Technology Implementation Process

The process of providing the IT packages to schools took more than 18 months[4] and proceeded in three main phases: (a) site preparation; (b) procurement and installation; and (c) Internet connectivity, training, and asset management. This was all done within a guiding framework of a memorandum of understanding between the Technology Development and Decision Support Centers (TDC), representing the Ministry of Education, and GILO. The memorandum of understanding outlined each party's contribution towards the realization of the ministry's strategic plan within GILO-supported schools. In doing so, the ministry stipulated that GILO would make use of the resources already existing in these target schools and that the ministry would complement GILO's contribution. For example, the Ministry of Education would secure a commitment from its TDC and the Educational Computer Department to fast track their hardware, software, and capacity building efforts within GILO's project lifespan. To prepare for the purchase of the technology, the IT team of GILO IT specialists, school staff, and local TDC staff led an equipment inventory and site survey of each of the GILO schools. This assessment looked at existing computing equipment and infrastructure conditions, security, cooling, electrical supply, staff capacity, availability of other digital media (TV, digital cameras, etc.), and available IT services in the school community.

According to GILO's vision to improve the education process within the school, the project allocated technology across school entities (e.g., teacher room, administrators, library, classroom, student/community ICT lab, dedicated computer for kindergarten) in a flexible way that met the expressed needs of each school. A redundant (not dependent on a single source—whether hardware, software, or human resources) and flexible design for the IT system was intended to maximize resource sharing and use by providing, for example, a combination of desktops in a computer lab and several laptops with a projector that could rotate between classrooms. There were also dedicated teacher and administrator computers and a printer, scanner, and digital camera that were in a separate teacher room. The final package of technology for each school (see Table 2) was dependent on the number of classrooms and "educational floors" in the school and on the existing inventory of functional and appropriate hardware (including peripherals). For example, small schools received two laptops and two projectors; large schools up to nine laptops and five projectors. Hardware inputs were associated with appropriate software applications and training. GILO also provided Internet access to 92 of the 166 schools and provided IT training in three phases to the two identified maintenance and support staff per school.

Table 2: *GILO Basic IT Package Provided to Each School (166 schools)*

Equipment Item	Quantity
Desktop computers	1,380
Notebook computers	858
Projector, spare lamp bulb, display screen, and laptop	1 per educational floor (max. 3 per school)
Laser printer	332 (2 per school)
Flatbed scanner	330 (2 per school)
Universal power supply	332
Digital camera	166 (1 per school)
Webcam; headsets	996 (6 per school)
Dust covers (for each desktop and printer)	1,712
1 voltage stabilizer (each computer, printer, and network component)	2700 total
Warranty package	3-years, including in-school service
Filtered Internet service (target 50% of schools with ADSL coverage)	In 92 schools

Evaluation of the IT Component

The program evaluation design included the use of interviews, document review, and follow-up phone calls with the schools and school staff. Instruments included a questionnaire with qualitative and quantitative interview questions aligned to the four dimensions of sustainability described above. The program evaluation design and instruments received RTI International Institutional Review Board exemption. The aim of the evaluation was to determine how the technology and associated interventions were being sustained in the schools one year after GILO had transitioned out of direct support to the schools.

One of the criteria for inclusion in the evaluation sample was that the school had M&S staff remaining. The GILO team called all 166 schools in advance to determine which schools met these criteria and at the same time inquired informally about how many operational computers they had. Out of 166 schools total, there were at most 15 schools[5] that no longer had GILO-trained M&S staff. There were 156 schools that reported having fully operational computer equipment (approximately 94%). The formal evaluation proceeded to determine in more depth what factors contributed to the sustained use of the technology.

Fifty-three out of 166 GILO-supported schools (31.9%), covering all 15 TDC idara and 4 muderiya staff, were included in the interview sample. Three different interview groups (see Table 3) answered questions together as a group interview with multiple respondents. School selection depended on the number of schools in each of the 15 idaras, so the distributed weight of the sample is equal to the weight of schools of each idara.

At the start of the study, the GILO IT evaluators gave a verbal overview about the study and the entirely voluntary nature of the participation. The participants were then asked for verbal consent. Additional document review including GILO project reports, the warranty vendor report, school equipment logs, and follow-up phone calls with each of the 53 school contributed to the full program evaluation presented in this paper.

The program evaluation activities took place from March to May 2012, which corresponds to four years after the project began, about a year before it ended, and 18 to 21 months after hardware was first installed in the schools. All information was collected on paper, reviewed, and then entered (with data validation checks) into the project monitoring and evaluation system, and then the results were exported into Excel worksheets for data analysis and interpretation. Limitations of the evaluation design include the exclusion of the 15 schools without maintenance and support (M&S) staff. Because of lack of variation among the schools, the evaluation could not compare differences in circumstances between schools with apparent sustainability versus those without. Finally, all of the authors were involved in implementing GILO and draw on these experiences in describing the processes and in interpretation of the findings, therefore some bias may be present.

Table 3: *Total Questionnaire Sample Size Distribution by Group*

Questionnaire Groups	Participants per Group	Group Sample Size
M&S team in the school	1 to 4	53 groups (92 individuals)
Management, administration, and BOT team in the school	2 to 11	53 groups (221 individuals)
TDC idara and muderiya staff	1 to 6	13 groups (21 individuals)

PROGRAM EVALUATION FINDINGS

In this section, we first describe GILO activities related to each aspect of the sustainability dimensions; and then report relevant findings for that dimension. Most of the evaluation findings are informed from the aggregated results from the questionnaires, with additional information provided from the warranty vendor report, school equipment logs, and follow-up phone calls noted separately.

Technological Dimensions

Procurement and configuration. GILO worked with schools and the Ministry of Education in selecting technology matching the schools' needs, yet consistent with a set of standards and hardware models that could be purchased in bulk. Schools were expected to raise funds (direct or in-kind) and contribute to site preparation by, for example, securing windows and doors; upgrading existing computer memory, storage, or networking configurations to meet the standards of the new equipment; making curtains; or hosting fundraisers in the school. Site preparations were done by the Ministry of Education and communities under the technical supervision of a General Authority of Educational Buildings (GAEB) engineer with cooperation from the GILO IT team.

According to the evaluation, schools and ministry of education stakeholders were satisfied with the technology configurations provided. Distributing the equipment across multiple cadres within the school (teachers, students, and administration) emerged as very positive and was one of the differences that a majority of respondents observed between GILO and non-GILO schools. Respondents most frequently rated the laptop/desktop mix the most satisfactory and considered least satisfactory the schools' email and websites.[6] Very few schools re-arranged the equipment after it was delivered, but instead found the original semi-circle seating arrangement the optimal way to accommodate students.

Maintenance and support. GILO developed school-based expertise equally in preventative maintenance, troubleshooting, and repairs. According to evaluation data, most schools had no major problems with the technology for at least 18 months. When they did, they were able to get warranty support or solve them with their school maintenance and support team or the Ministry of Education's Technology Development and Decision Support Center (TDC). Respondents rated the communication between schools, the TDC, and the warranty provider as very positive. The main sources of breakdown or support were malfunction of the projector lamp, operating system boot errors, print errors, and viruses. These were usually solved through the school maintenance and support teams or idara TDC staff by installing a new disk image, referring back to video training materials, or activating technical support from the vendor.

A notable finding from the questionnaires was that schools were asked what they had done before GILO to deal with equipment malfunctions. 51 schools answered that before GILO they would have had to file a report on malfunctions to TDC and the General Authority on Educational Buildings (GAEB) and then wait for officials from GAEB to activate a solution. Because of slow responses to such reports, many schools had existing, but sometimes obsolete or malfunctioning equipment. After GILO, however, schools solved malfunctions through the school-based maintenance and support team, contacting the TDC for additional support (such as license activation), or dealt directly with the warranty company for hardware maintenance.

Social and Individual Dimensions

Community involvement. GILO involved the community at each step, starting with the IT site survey, then ongoing follow up and site preparation, and finally the IT training. The latter was delivered in three phases aligned with the IT installation and rollout schedule. Prior to the start of each phase, GILO conducted an orientation first at the MOE, and then shared the plan for implementation of the next phase with idara, school staff, and school boards. These sessions were intended to create awareness, gain credibility, and select the best candidates from each school to receive the training and join the maintenance and support team. All subsequent visits included follow-up on the prior phase as well as orientation to the next phase.

As a girls' project working in more rural and closed traditional areas, GILO was proactive and held many orientation sessions about filtered Internet for school and community access to avoid any misunderstanding or resistance. Beyond only involvement in planning and installation, the community was considered a key stakeholder, vital to ongoing support and sustainability, since the computer labs were intended to be open to the community when not in use by the school. Each school maintained an access and usage log for the computer labs. These logs show that community use was mainly for accessing the Internet (Internet search, email, voice/video calls for out-of-the-country family members, social networking). Some schools delivered software training programs for the community. Asked whether the technology was meeting the needs of the community, the answer was rated positively across all schools surveyed.

Training and alignment with needs. When maintenance and support teams were asked whether the technology met the needs of different groups (teachers, students [male and female], community, school management, and the Board of Trustees), more than 80% of respondents answered yes, except in the case of the community, where only 73% of respondents felt it met their needs. A limited number of hours of access was most likely one of the reasons why it was rated less suitable for communities.

Training under GILO began early and was ongoing. From orientation sessions for the school staff and TDC during the site survey and prior to any IT delivery, to formal training workshops, GILO embedded several approaches to ensure the trainees were able to apply what they learned. These included:

- customizing training topics to school needs and developing a custom GILO IT training curriculum;
- having GILO training representatives from each muderiya work together as a team and train outside of their own region;
- approaching the training in phases, each phase having a small number of training topics;
- leaving sufficient time between trainings to ensure the GILO IT team could visit the schools for coaching and mentoring;
- including trainees as active participants in post-training implementation of specific activities (such as hardware installation);
- providing a school troubleshooting reference handbook and digital reference materials;[7] and
- partnering with the TDCs from idara and muderiya levels, and encouraging them over time to deliver some of the training modules.

The results of the evaluation showed that training programs were effective, with maintenance and support teams increasing their comfort level nearly two-fold in providing IT maintenance and support after working with GILO. The evaluation showed that approximately 40% of participants requested additional training time on expanded topics covering more IT skills as well as other preventative maintenance strategies.

Interestingly, the schools engaged by their own initiative in cascade training, expanding the number of trained individuals by at least 45% outside of program efforts (at least 284 people). Although the survey data did could not verify these reports nor make any assumptions about the quality or completeness of these cascade trainings, the fact that so many additional people were trained on hardware maintenance can only improve the chances for sustainable use of the technology in the future. Digital training materials were reported useful and contributed to the ability to cascade training to others.

Improvement at the school level also created pressure on idara and muderiya staff to spend more time and effort on their own professional development in order to keep up with the knowledge and capabilities of the school staff. This was done outside of project efforts (as reported during TDC interviews). On the other hand, these government entities were provided training without being provided the same equipment as schools. This limited their ability to practice and created some resentment (to be discussed further below).

Feedback from a concurrent ICT program evaluation[8] (looking at teachers' pedagogical use of the equipment and its effect on teaching and learning within GILO) found that teacher interest in using technology for teaching and learning was very high, with 87% to 91% of surveyed teachers confirming that the IT was aligned with the needs of the school because:

- computers improve student learning and the education process;
- Internet use enhances research and study;

- they feel comfortable using ICT in teaching;
- they want more ICT information and training; and
- computers save them time and effort and make them more productive.

Economic Dimensions

Costs and cost recovery. GILO invested in forward-looking solutions that would support the project's goals after it closed. For example, the digital training resources and management applications mentioned above helped to support professional development in the long term. The procurement process also ensured that the initial investment in hardware, software, and networking costs included some spares as well as an extended three-year warranty and an anti-virus subscription covering the period after the project was expected to end. GILO also negotiated a reliable Internet speed at a cost that would be affordable to schools after GILO (about $20–22 per month, with email and domain services at about $70/month with local support service).

To address fixed versus recurrent cost issues from the start, GILO underscored the need for schools to supply their own funds over time, even though the Ministry of Education does allocate funds for technology and support. Although project funds were available to do all Phase 1 site repairs and retrofitting, GILO required schools to contribute to site preparations (see above). Respondents indicated that, on average, schools contributed 8,236.00 Egyptian pounds (approximately $1,183) towards the site preparation process.[9] As a result, GILO only spent a fraction of what was budgeted and reinvested those funds into other areas. More importantly, although this process created some delays in implementation, it was expected to strengthen the sense of ownership of the equipment at the school by all stakeholders. Similarly, GILO delayed delivery of supplies (i.e., paper, ink cartridges, USB flash drives, etc.) to schools until 6 to 10 months after they received the technology to encourage them to find sources of funding for these supplies—which many did. The lack of project-funded supplies did not delay use of the equipment, according to monitoring activities and the evaluation.

The evaluation indicated that Internet access had been factored into fewer than half of the schools, even though administrators may consider it critical for the school. Of those who did not think Internet access was critical before GILO, 44.4% now think that it is. The top three anticipated sources of funds for paying for new supplies (e.g., paper, DVDs, etc.), as indicated by the school management team and Board of Trustees respondents were: (1) technology development funds allocated by the Ministry of Education to each school, (2) community participation (fees to use the computer lab), and (3) the board of trustees. Therefore, these findings suggest that it can take a long time to work with schools to factor recurrent costs into their budgets with available funds and tied to their budget cycle.

Political Dimensions

Management and support. GILO opted to train maintenance and support teams within the schools rather than rely on outsourcing to external vendors. The selection of the maintenance and support team was carried out during the IT site survey to recruit the most qualified individuals within each school based on their prior experience with computers and motivation to fill the role. GILO emphasized women's participation in the maintenance and support team. By the third phase of training, 14% of team members were female. Appropriate staffing of computer labs was important since GILO intended to give the community access to the labs; some schools refused to do so without sufficient staffing out of concern for the safety of the technology.

The evaluation showed that 52.8% of school management teams said that they had made changes to give maintenance and support teams more support for their work. The top examples of changes included:

- providing monetary and moral support;
- reducing the number of classes assigned to them; and
- facilitating collaboration with other colleagues in attending training on how to use hardware to minimize efforts of maintenance specialists.

According to maintenance and support team interviews, 79.2% of respondents noticed changes in how other staff perceived the role of the maintenance and support team within the school. Most common was that the team was recognized and appreciated, receiving full cooperation from other staff in the school. Overall 42 schools reported 45 positive changes, and 13 schools reported negative or no changes. Some challenges to providing support occurred where the law did not allow the school to change the number of classes for teachers and where there was already a shortage of teachers and no way to provide additional support.

Local political engagement. All GILO IT activities were conducted in close partnership between implementers at central, muderiya, idara, and school levels. Local political stakeholders were involved in the site survey and preparation activities, encouraging them to cascade training they had received to other non-GILO schools, and involving ministry of education and Technology Development and Decision Support Center (TDC) technical staff in the delivery and installation activities. This was important for capacity building and ownership and as a clear demonstration that GILO IT staff were not trying to supplant the TDCs' role. TDC staff was responsible for reviewing the equipment usage logs, random spot-checking the IT equipment to make sure it was working, and reviewing the schedule and balance sheet of the community access component. The General Authority of Educational Buildings (GAEB) was instrumental in getting approval for classroom allocations for IT labs or creating new labs when an existing room was not in the original school blueprint or had been allocated for other activities.

The questionnaires revealed that in 96.2% of all schools the board of trustees got involved in workshops and meetings to discuss community usage of the IT package. The three most common reasons given for board participation were: as a service to children, community, and country. Most TDC respondents reported that cooperation was positive, specifically in the areas of equipment delivery and training. The TDC at idara and muderiya levels and GAEB got involved in the site survey, site preparation, and site installation to different levels; the TDC staff was most involved in installation, and GAEB with the site preparation (as reported by the management and administration [MGT]/and Board of Trustees [BOT] (see Figure 1).

Of note, GILO had not provided equipment to the TDCs at the idara and muderiya levels, which was raised as an issue and led to some perceptions of insufficient GILO collaboration with the TDC. Providing a computer with the school management information system software on it for the school principal proved to be a good a way to encourage school technology usage and reduce running costs. A similar strategy at the TDC level might have helped to achieve a greater impact on cascade training and support to schools.

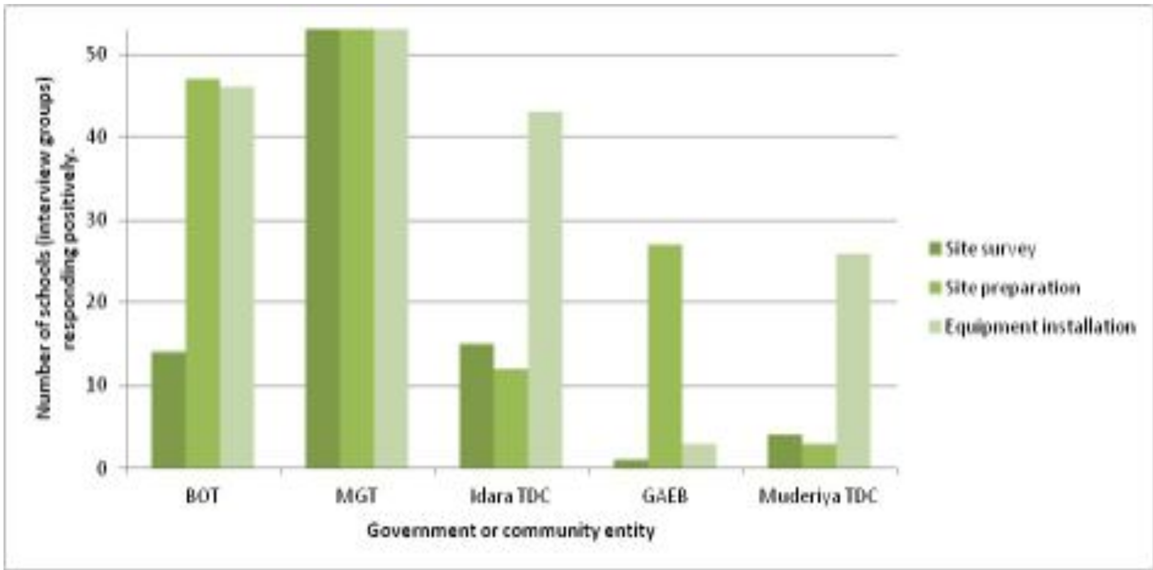

Figure 1: *Participation in IT Planning and Implementation Processes*
Source: GILO ICT evaluation data (management and administration and BOT survey)

Policy alignment. The GILO program was aligned by design with national policies and priorities. Decisions and approvals by MOE on all procurement choices, all software content, and Internet/email school schema usage at times slowed down program implementation but were critical for ensuring this alignment. The IT activities, specifically, supported the Egyptian Education Initiative and the ICT strategy, especially the focus on increased access for rural schools, activation of the use of technology in the education process, and provision of community access to technology. The Technology Development and Decision Support Center staff from each school reported one to three examples of the way in which the GILO work was integrated with national and regional education strategies.

Local government officials were important to maintaining maintenance and support teams by minimizing transfer of trained staff from one school to another, which is common in Egypt where a large number of teachers are contract teachers. There was only about 10% turnover in the maintenance and support staff in GILO schools.

DISCUSSION

If sustainability is considered a function of longevity and use of technology, then the GILO IT program could be considered sustainable at the time of this evaluation. Maintenance and support teams were still active in most schools where they were established and equipment was still functioning and being used despite the political upheavals that took place in the last year of the program. Impressive personal efforts were made by schools to protect their equipment during the 2012 political revolution and ensure that it was put back in use as soon as possible afterwards. Additional follow-up is needed to confirm long-term sustainability and use, but the findings to date suggest the following implications for IT planning within each dimension.

Technological Dimensions

Locally appropriate technology can be implemented successfully in rural schools by working with schools and the government decision-makers to provide a package tailored to school size, needs, and a range of users rather than a one-size-fits-all approach. Working within the existing IT support systems, after determining how these currently operate at every step, from equipment selection and installation to maintenance and support and monitoring and evaluation, is an effective way to ensure appropriate and sustainable technology. Training school-based maintenance and support teams is critical to ensuring sustainable use of the equipment. This does not mean that maintenance and support teams need to know how to repair the technology themselves. It can simply mean planning for warranties and ensuring that maintenance and support teams know to activate the warranties and get support from local vendors. Empowering these teams to make decisions independently with regards to the technology emerged from this evaluation as a key factor in for ensuring equipment upkeep.

Individual and Social Dimensions

Establishing school-based maintenance and support teams is the first step. Ensuring that they have training in basic as well as advanced topics is the next. A focus on preventative maintenance is as important as troubleshooting and fixing malfunctions. Having a team (i.e., more than one person) ensures that maintenance and support are not subject to a single point of failure, and less susceptible to staff turnover. The phased approach to training with more frequent, but more focused content each time contributes to sustainability. Although it is tempting to try to adopt existing, broad curricula for IT training, a customized and focused approach enables training on more complex IT activities that require an important degree of depth, such as imaging of equipment, virus checking, and filtered Internet services - these skills were highly valued. Reusable digital training materials can encourage trainees to cascade training to other schools or other individuals within the schools.

Proactive communication and school stakeholder involvement with all intervention activities proved beneficial. Most schools saw the benefits of participating and understood that not just the school, but also the community (including students who are community members) would benefit. They also found the constant communication ahead of activities helped them participate in all activity rollout. By matching community efforts with project inputs, GILO demonstrated that the technology belonged to the school and community and not the project, and showed that it was therefore the community's responsibility to help maintain it. This also helped establish and foster demand for the technology.

Economic Dimensions

Financial sustainability takes time. Deliberate efforts to encourage long-term financial planning such as requiring counterpart funds for site preparation, delaying delivery of supplies to schools, and discussing financial planning were necessary, if not sufficient, to see results. The GILO experience supports other literature that emphasizes the importance of long-term financial planning for sustainability, but the qualitative feedback also suggests that schools must first be convinced of the value of the investment (i.e., Internet connectivity) before they will allocate the budget for it. For this to happen, schools need enough time to work with the technology to see the benefits while the recurrent costs are covered, which also includes time to include these required recurrent costs into their school's budget cycle, and time for the MOE to ensure these line items are included in budget models. Therefore, projects may provide an important service by covering recurrent costs at the outset, but will do a disservice in the long-term if they have not built the capacity of schools to gradually adopt these costs under their own funding mechanisms, which includes both own source funds as well as MOE (or local government) provided fund allocations.

Projects and their beneficiaries must understand budget cycles for public institutions, or they may run into surprises with delays in budget allocations and transfers.

Political Dimensions

Managing IT equipment involves economic dimensions as well as political and social ones such as policies related to access and use. Constraints to accessibility of the equipment limit sustainability in terms of use, although they can be necessary for sustainability in terms of longevity of the equipment.

The evaluation confirmed other findings that suggest finding and supporting local champions at national and local levels is important. Importantly, these leaders need to have and use the same technologies that they are expected to promote, so that they can maintain their own skills and lead by example. Although collaboration with government entities may slow down implementation at times, it is important for sustainability. The fact that the Ministry of Education issued a decree preventing the transfer of GILO-trained staff is a strong example of how government participation can impact sustainability through creation of an enabling environment. Cooperating with the central ministry to get approval for all GILO IT activities ensured that the activities fit within the ministry's short- and long-term strategies, even as priorities changed. Encouraging the ministry's decentralized Technology Development and Decision Support Centers' at idara and muderiya levels to partner in training delivery and, over time, to deliver some of the training modules themselves strengthened their role as backup IT support to the schools and built their relationships with the school IT maintenance and support teams. In this way, during training and installation activities GILO received meaningful interaction from the staff at the schools because they were not just informed, but consulted, in advance.

The phased approach to site preparation, installation, and training had positive repercussions in terms of managing expectations, garnering support, and providing effective training. This was not limited to administrative approvals or showing token interest in local participation; it was a proactive and sustained process of change management. This has emerged as one of the most important factors in technology integration. There are many agents of change from national governments to teachers themselves; and change management processes need to align and communicate roles, responsibilities, and expectations effectively.

CONCLUSION

To conclude, we are faced with trying to answer the question: does technology that is sustainably planned and implemented lead to more (and more effective) use of technology in the classroom, or does a clear need based on personal and institutional demand drivers of technology use in the classroom ensure sustainable technology implementation? It is well documented that technology alone is not a magic bullet that improves teaching and learning by its presence. Yet ultimately, it is basic computer literacy that serves as a toolbox from which the teacher draws to make appropriate pedagogical decisions and enhance the learning objectives of a lesson through the affordances of technology. Without first having made the right configuration of hardware and infrastructure, and supporting their sustainable functionality through effective maintenance and support, the teachers would not even be in a position to either use or not use the computers. ICT in education projects must favor neither the hardware nor pedagogical aspects of the technology, but instead layer the pedagogical use of technology on top of the IT infrastructure as two distinct efforts with separate, but complementary goals.

GILO's experience supports findings from other experiences along the technological, individual and social, economic, and political dimensions, and the evaluation process demonstrates that these four dimensions can be a useful framework for IT implementation from a sustainability perspective. Even though the GILO IT component focused specifically on hardware and software provision, aligned with the national IT strategy, it was done in a way that also facilitated school-community coalitions, recurrent teacher training programs, and school-based support. All of these areas were addressed early and fostered throughout GILO's duration through a balanced approach that neither favors nor neglects the technology aspect. GILO's focus on separating technological and pedagogical aspects of implementation ensured a strong foundation upon which to build appropriate pedagogical use of the technology.

ENDNOTES

[1] Drawn primarily from Chasquinet, cited in Cisler (2010). However, the authors felt that the Chasquinet dimensions were missing a pedagogical dimension, or ensuring that teachers' knowledge and use of computers evolves and continues after initial training or support ends. For the purposes of this paper, we have combined what they call "knowledge and organizational sustainability" within the "social dimensions" category, and renamed it "social and individual dimensions."

[2] The implementing partners, led by RTI International, included World Education, Inc., Keys for Effective Learning, and CID.

[3] Given principles mentioned, it should be assumed that throughout this report, any mentions of "GILO" or "the project" means a collaborative effort between program staff and national counterparts.

[4] Four months to process procurement waivers while GILO completed the schools site survey and ICT inventory, then one year from December 2009 to December 2010 for procurement, site preparation, and installation. Due to the Egyptian revolution in January 2011, the filtered Internet was completed in April 2011.

[5] Eleven confirmed and four that could not be reached.

[6] Due to the political revolution, installation and set-up of email and Internet services were delayed until a few months before direct GILO support to the schools had ended; therefore, insufficient time for training and use most likely explains this finding.

[7] A DVD containing all training materials, including video footage of all the trainings, with a HTML interface to allow users to quickly locate the training module of interest.

[8] The evaluation also took place in May 2012, but was in a different sample of schools and using different evaluators.

[9] This figure includes one school that listed the cost for site retrofit as 150,000 Egyptian pounds. If this school is not included, the average decreases to 5,546.00 pounds. Self-reported figures were not verified.

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SUPPLEMENTARY TABLES

Table A1: *Findings Related to Technological Dimensions of Sustainability*

Question/Evaluation Metric	Finding	Number of Respondents (Source)
Time since last report of broken, unrepaired, or obsolete equipment	18 months	NA (Warranty Vendor)
Requests for assistance through warranty vendor	6 calls in 2011; 4 calls in 2012 (up to July only)	NA (Warranty Vendor)
How do you rate the computers, network, and peripherals installed with GILO in your school?	3.8/5.0	91 (M&S)
Have you re-arranged the lab chairs and computer tables? (If yes, provide reason).	No: 92.5%	92 (M&S)
Did the GILO IT M&S training help with your problem solving for IT issues?	Yes: 93.8%	85 (M&S)
IT M&S team solves equipment and software problems or contacts TDC, warranty vendor for support	100%	221 (MGT/BOT)

Table A2: *Findings Related to Social Dimensions of Sustainability*

Question/Evaluation Metric	Percent Affirmative Responses or number of schools	Number of Respondents (Source)
Was technology a component of the decision to get involved or not?	94.3%	210 (MGT/BOT)
Did BOT participate in site survey activities, site preparation, equipment installation? *(Number of schools)*	Equipment Installation: 46 Site Preparation: 47 Site Survey: 14	221(MGT/BOT)
Did the BOT participate in workshops and meetings to discuss how the computers, networks, and peripherals could be used by the community?	96.2%	221 (MGT/BOT)
Did the school management and administration team (MGT) participate in site survey activities, site preparation, equipment installation? (*Number of schools*)	Equipment Installation: 53 Site Preparation: 53 Site Survey: 53	221(MGT/BOT)
Does the technology GILO provided meet the needs of teachers, students (male and female), community, school management and BOT?	All – 80.8% Teachers – 85% Male students – 81% Female students – 81% Community – 73.4% MGT and BOT – 88.2%	88 (M&S)

Table A3: *Reported IT Training and M&S Indicators*

Question/Evaluation Metric	Percent Affirmative Responses	Number of Respondents (Source)
Have you used the GILO digital training materials?	84.6% 94.3%	35 (TDC) 92 (M&S)
Did you find the DVD materials useful?	98.1% 100%	92 (M&S) 35 (TDC)
Before GILO, were you comfortable providing IT maintenance and support?	49.1% 92.3%	92 (M&S) 35 (TDC)
Has your comfort level to provide IT maintenance and support increased since attending GILO IT training?	96.2% 92.3%	92 (M&S) 35 (TDC)
Did the GILO IT M&S training help with your problem solving for these issues?	94%	85 (M&S)
Do you consider the GILO IT M&E training, better, similar, or worse than other IT trainings you have taken?	94.2% Better, 5.8% Similar 69.2% Better, 30.8% Similar	90 (M&S) 35 (TDC)
Have you taken what you learned about IT maintenance and support under GILO, and offered any training to other teachers or staff in your school?	60.4%	92 (M&S)
Have you shared what you learned with teachers or staff from other schools in your idara?	7.5%	92 (M&S)
Did you share these DVDs with others in your school, community, or other schools?	45.3%	92 (M&S)
Can you describe the school communication/correspondence (requesting support) with TDC/GAEB and computing equipment vendors before and after GILO?	Before GILO: Either wait for GAEB to visit, or file report with TDC/GAEB After GILO: 100% deal directly with warranty company, 62% just deal with school M&S team	221 (MGT/BOT)

Table A4: *Findings Related to Economic Dimensions of Sustainability*

Question/Evaluation Metric	Percent Affirmative Responses	Number of Respondents (Source)
Did you think Internet access was critical before GILO?	15.1%	221 (MGT/BOT)
If no, did you change your mind about the Internet service benefits to your school after GILO Internet service?	44.4%	185 (MGT/BOT)
Do you think that the Internet connection is critical now?	96.2%	221 (MGT/BOT)
If yes, is this a high priority line item in your budget request?	84.9%	221 (MGT/BOT)
Has the Internet access been factored into next year's budget as a line item?	43.4%	221 (MGT/BOT)
Can you estimate the cost of your contribution to the site preparation activities?	8,236.00 Egyptian pounds (approximately $1,183)	217 (MGT/BOT)

Table A5: *Findings Related to Political Dimensions of Sustainability*

Question/Evaluation Metric	Percent Affirmative Responses or Number of Schools	Number of Respondents (Source)
Did the idara TDC participate in site survey activities, site retrofit, equipment installation?	Equipment Installation: 43 Site Preparation: 12 Site Survey: 15	221 (MGT/BOT)
Did GAEB participate in site survey activities, site retrofit, equipment installation?	Equipment Installation: 3 Site Preparation: 27 Site Survey: 1	221 (MGT/BOT)
Did the muderiya TDC participate in site survey activities, site retrofit, equipment installation?	Equipment Installation: 26 Site Preparation: 3 Site Survey: 4	221 (MGT/BOT)
Can you describe 2-3 examples (such as IT strategy, policy, activities, MOE approvals) that the IT work you were doing with GILO was linked to the MOE? (top 3 reasons)		
Activation of use of technology in the educational process by using laptops and Data Show inside classrooms	38%	35 (TDC)
Planning monthly meetings with the participation of lab specialists and officials responsible for GILO schools to activate use of technology	23%	35 (TDC)
The method of distribution of hardware inside schools to serve all staff involved in the educational process	23%	35 (TDC)
Can you list 2-3 examples of where government leaders (in your idara and muderiya level) have demonstrated support for the GILO IT program of IT M&S training and IT equipment? (top 2 reasons)		
The decision of non-transfer of trainees from GILO schools to other schools	38.4%	26 (TDC)
Coordination between departments, the directorate, and the school to obtain the training courses provided by GILO	30.8%	26 (TDC)