Using ICT to Achieve Sustainable Transformation in Educational Systems of Developing Countries

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Abstract

Information and communication technology (ICT) in developing countries is suggested as an effective way to improve the population's life and well-being. It has the potential to "bridge the knowledge gap" in terms of improving quality of education, increasing the quantity of quality educational opportunities, making knowledge building possible through borderless and boundless accessibility to resources and people, and reaching populations in remote areas to satisfy their basic right to education. As various ICTs become increasingly affordable, accessible, and interactive, their role at all levels of education is likely to be all the more significant in making educational outcomes relevant to the labour market, in revolutionizing educational content and delivery, and in fostering "information literacy." However, without improved efficiencies in their education systems, developing nations will not likely be able to provide the additional human capital required to achieve economic self-sufficiency in the context of a highly competitive global economy that is increasingly based on the electronic transfer and manipulation of information. This paper discusses the rationale for investing in ICT for education, and the issues concerning ICT for education in low- and middle-income countries.

Keywords: *ICT, education, knowledge, information, developing countries*

INTRODUCTION

ICTs are making dynamic changes in society. They are influencing all aspects of life. The influences are felt more and more at schools. This is because ICTs provide both students and teachers with more opportunities in adapting learning and teaching to individual needs, society is, forcing schools aptly respond to this technical innovation. Tinio (2002), states the potentials of ICTs in increasing access and improving relevance and quality of education in developing countries. Tinio further states the potentials of ICT as follows:
ICTs greatly facilitate the acquisition and absorption of knowledge, offering developing countries unprecedented opportunities to enhance educational systems, improve policy formulation and execution, and widen the range of opportunities for business and the poor. One of the greatest hardships endured by the poor, and by many others, who live in the poorest countries, in their sense of isolation, and ICTs can open access to knowledge in ways unimaginable not long ago.

In Watson's (2001) description, ICTs have revolutionized the way people work today and are now transforming education systems. As a result, if schools train children in yesterday's skills and technologies they may not be effective and fit in tomorrow's world. This is a sufficient reason for ICTs to win global recognition and attention. For instance, ICTs are dependable tools in facilitating the attainment of one of the Millennium Development Goals (MDGs), which is achievement of universal primary education by the year 2015. Kofi Anan, the former United Nations Secretary General, points out that in order to attain the goal of Universal Primary Education by the year 2015; we must ensure that information and communication technologies (ICTs) unlock the door of education systems. This indicates the growing demand and

increasingly important place that (ICTs) could receive in education. Since ICTs provide greater opportunity for students and teachers to adjust learning and teaching to individual needs, society is, forcing schools to give appropriate response to this technical innovation. Even though ICTs play significant roles in representing equalization strategy for developing countries, the reality of the digital divide- the gap between those who have access to, and control technology and those who do not, make a huge difference in the use of ICTs. This means, that the introduction and integration of ICTs at different levels and various types of education is the most challenging undertaking. Failure to meet the challenges would mean a further widening of the knowledge gap and deepening of existing economic and social inequalities among the developed and the developing countries. Thus, the purpose of this review article is to discuss the benefits of ICT use in education, in the enhancement of student learning and experiences of some countries in order to encourage policy makers, school administrators, and teachers pay the required attention to integrate this technology in their education systems. In so doing, it highlights the benefits of ICT in education, existing promises, and the limitations and challenges of integration to education systems.

Globalization and technological change—processes that have accelerated in tandem over the past fifteen years—have created a new global economy "powered by technology, fueled by information and driven by knowledge." The emergence of this new global economy has serious implications for the nature and purpose of educational institutions. As the half-life of information continues to shrink and access to information continues to grow exponentially, schools cannot remain mere venues for the transmission of a prescribed set of information from teacher to student over a fixed period of time. Rather, schools must promote "learning to learn,": i.e., the acquisition of knowledge and skills that make possible continuous learning over the lifetime. Concerns over educational relevance and quality coexist with the imperative of expanding educational opportunities to those made most vulnerable by globalization—developing countries in general; low-income groups, girls and women, and low-skilled workers in particular. Global changes also put pressure on all groups to constantly acquire and apply new skills. The International Labour Organization defines the requirements for education and training in the new global economy simply as "Basic Education for All","Core Work Skills for All"and "Lifelong Learning for All". (ILO, 2002)
Information and communication technologies (ICTs)—which include radio and television, as well as newer digital technologies such as computers and the Internet—have been touted as potentially powerful enabling tools for educational change and reform. When used appropriately, different ICTs are said to help expand access to education, strengthen the relevance of education to the increasingly digital workplace, and raise educational quality by, among others, helping make teaching and learning into an engaging, active process connected to real life. However, the experience of introducing different ICTs in the classroom and other educational settings all over the world over the past several decades suggests that the full realization of the potential educational benefits of ICTs is not automatic. The effective integration of ICTs into the educational system is a complex, multifaceted process that involves not just technology—indeed, given enough initial capital, getting the technology is the easiest part—but also curriculum and pedagogy, institutional readiness, teacher competencies, and long-term financing, among others.

Issues in the Use of ICTs in Education
There are four broad intertwined issues which must be addressed when considering the overall impact of the use of ICTs in education. They are Effectiveness, cost, equity, and sustainability.

i) Effectiveness - Does ICT-enhanced learning really work?
The educational effectiveness of ICTs depends on how they are used and for what purpose. And like any other educational tool or mode of educational delivery, ICTs do not work for everyone, everywhere in the same way.

***Enhancing access*:** It is difficult to quantify the degree to which ICTs have helped expand access to basic education since most of the interventions for this purpose have been small-scale and under-reported. In Asia and Africa, assessments of distance learning projects at the junior secondary level using a combination of print, taped, and broadcast technologies have been less conclusive, while at the primary level there is little evidence that ICT-based models have thrived. In higher education and adult training, there is some evidence

that educational opportunities are being opened to individuals and groups who are constrained from attending traditional universities.

***Raising quality*:** The impact of educational radio and television broadcasts on the quality of basic education remains an under-researched area, but what little research there is suggests that these interventions are as effective as traditional classroom instruction. Hannafin and Savenye (1993) said that of the many educational broadcast projects, the Interactive Radio Instruction project has been the most comprehensively analyzed. Findings provide strong evidence of the project's effectiveness in raising the quality of education as demonstrated by increased scores on standardized tests as well as improved attendance. In contrast, assessments of the use of computers, the Internet and related technologies for distance learning have been equivocal. Russell (1999), in his comprehensive review of research, claims that there is "no significant difference" between the test scores of learners taking ICT-based distance learning courses and those receiving face-to-face instruction. However, others claim that such generalizations are inconclusive, pointing out that the large number of articles on ICT-based distance learning does not include original experimental research or case studies. Other critics argue that dropout rates are much higher when instruction is delivered at a distance via ICTs.

There have also been many studies that seem to support the claim that the use of computers enhances and amplifies existing curricula, as measured through standardized testing. Specifically, research shows that the use of computers as tutors, for drill and practice, and for instructional delivery, combined with traditional instruction, results in increases in learning in the traditional curriculum and basic skills areas, as well as higher test scores in some subjects compared to traditional instruction alone. Students also learn more quickly, demonstrate greater retention, and are better motivated to learn when they work with computers. But there are those who claim that these represent modest gains and, in any case, much of the research on which these claims are based are methodologically flawed (Fouts, 2002).

ii) Cost- How much does it cost?

Broadly speaking, educational television broadcasts and computer-based and online learning are more expensive than radio broadcasts. There is disagreement, however, over whether television broadcasts are cheaper than computer-based and online learning. That said, categorical assessments of cost-effectiveness are difficult to make because of lack of data, differences in programs, problems of generalization, and problems of quantification of educational outcomes and opportunity costs. Speaking specifically of computers and the Internet, Blurton (2002) argues that "when considering whether ICT is "cost-effective" in educational settings, a definitive conclusion may not be possible for a variety of reasons. However, when considering the alternative of building more physical infrastructure, the cost savings to be realized from sharing resources, and the societal price of not providing access, ICT as a means of enabling teaching and learning appears to be an attractive and necessary alternative."

A common mistake in estimating the cost of a particular ICT educational application is to focus too much on initial fixed costs—purchase of equipment, construction or retrofitting of physical facilities, initial materials production, and the like. But studies of the use of computers in classrooms, for example, show that installation of hardware and retrofitting of physical facilities account for only between 40% to 60% of the full cost of using the computers over their lifetime, or its total cost of ownership. In fact, while at first glance it may seem that the initial purchase of hardware and software is the costliest part of the process, the bulk of the total cost of ownership is spread out over time, with annual maintenance and support costs (known as variable or recurrent costs) constituting between 30% to 50% of the total cost of hardware and software. The cost of professional development, another variable cost, also accumulates over time. For computer-based approaches the total cost of ownership therefore includes:

Fixed Costs

Retrofitting of physical facilities
Hardware and networking
Software

Upgrades and replacement (in about five years)

Variable or Recurrent Costs
Professional development
Connectivity, including Internet access and telephone time
Maintenance and support, including utilities and supplies

iii) Equity- Is there equity of access to ICTs in education?
Given the wide disparities in access to ICTs between rich and poor countries and between different groups within countries, there are serious concerns that the use of ICTs in education will widen existing divisions drawn along economic, social, cultural, geographic, and gender lines. Ideally, one wishes for equal opportunity to participate. But access for different actors—both as users and producers—is weighted by their resources. Hence, initial differences are often reproduced, reinforced, and even magnified….A formidable challenge, therefore, continues to face planners of international education: how to define the problem and provide assistance for development (Hernes, 2002).

The introduction of ICTs in education, when done without careful deliberation, can result in the further marginalization of those who are already underserved and/or disadvantaged. For example, women have less access to ICTs and fewer opportunities for ICT-related training compared to men because of illiteracy and lack of education, lack of time, lack of mobility, and poverty. Boys are more likely than girls to have access to computers in school and at home. Not surprisingly, boys tend to enjoy working with computers more than girls (Mark, 2002). In an evaluation of its programme in four African countries, Worldlinks an organization that promotes project-based, international telecollaboration activities among secondary school teachers and students from developing countries, it was found that despite efforts to make the programme gender neutral, gender inequalities in access persist in Uganda and Ghana (Haddad and Jurich, 2002). Providing access to ICTs is only one facet of efforts to address equity issues. Equal attention must be paid to ensuring that the technology is actually being used by the target learners and in ways that truly serve their needs. from uneven capacities to make purposeful, relevant and critical use of digital resources.

iv) Sustainability- Are ICT-enhanced educational projects sustainable?
One aspect of development programs that is often neglected is sustainability. The long history of development aid has shown that too many projects and programs start with a bang but all too soon fade out with a whimper, to be quickly forgotten. This is true for many ICT-based educational projects as well. In many instances, these projects are initiated by third party donors—such as international aid agencies or corporations—and not enough attention is paid to establishing a mechanism by which the educational institution or community involved can pursue the project on its own or in partnership with other stakeholders after the initiating donor exits. But cost and financing are not the only barriers to sustainability. According to Cisler (2002), the sustainability of ICT-enabled programs has four components: social, political, technological, and economic.

Economic sustainability refers to the ability of a school and community to finance an ICT-enabled programme over the long term. Cost-effectiveness is key, as technology investments typically run high and in many cases divert funds from other equally pressing needs. Planners should look to the total cost of ownership (see preceding discussion on cost) and build lucrative partnerships with the community to be able to defray all expenses over the long term. The need to develop multiple channels of financing through community participation ties economic sustainability closely to social and political sustainability.

Social sustainability is a function of community involvement. The school does not exist in a vacuum, and for an ICT-enabled project to succeed the buy-in of parents, political leaders, business leaders and other stakeholders is essential. Innovation can happen only when all those who will be affected by it, whether directly or indirectly, know exactly why such an innovation is being introduced, what the implications are on their lives, and what part they can play in ensuring its success. ICT-enabled programs must ultimately serve the needs of the community. Thus community-wide consultation and mobilization are processes critical to

sustainability. In short, a sense of ownership for the project must be developed among all stakeholders for sustainability to be achieved.

Political sustainability refers to issues of policy and leadership. One of the biggest threats to ICT-enabled projects is resistance to change. If, for instance, teachers refuse to use ICTs in their classrooms, then use of ICTs can hardly take off, much less be sustained over the long term. So because of the innovative nature of ICT-enabled projects, leaders must have a keen understanding of the innovation process, identify the corresponding requirements for successful adoption, and harmonize plans and actions accordingly.

Technological sustainability involves choosing technology that will be effective over the long term. In a rapidly changing technology environment, this becomes a particularly tricky issue as planners must contend with the threat of technological obsolescence. At the same time, there is the tendency to acquire only the latest technologies (which is understandable in part because these are the models which vendors are likely to push aggressively). Generally, however, planners should go with tried and tested systems; stability issues plague many of the latest technologies. Again, the rule of thumb is to let the learning objectives drive the technology choice and not vice versa—the latest technologies may not be the most appropriate tools for achieving the desired educational goals. When making technology decisions, planners should also factor in not just costs but also the availability of spare parts and technical support.

Investing in ICT for Education

ICT has the potential to "bridge the knowledge gap" in terms of improving quality of education, increasing the quantity of quality educational opportunities, making knowledge building possible through borderless and boundless accessibility to resources and people, and reaching populations in remote areas to satisfy their basic right to education. As various ICTs become increasingly affordable, accessible, and interactive, their role at all levels of education is likely to be all the more significant in making educational outcomes relevant to the labor market, in revolutionizing educational content and delivery, and in fostering "information literacy." Information literacy is the sustaining force of a knowledge society. Information literacy is recognized as "a basic human right in the digital world" as it empowers individuals "in all walks of life to seek, evaluate, use, and create information effectively to achieve their personal, social, occupational, and educational goals" (UNESCO 2008a). The digital divide is much more than a "technology access" divide; without the skills to use the technologies, an even greater divide emerges—the information literacy divide. This divide is not a "north–south, developed–developing" issue; it applies to all countries and is more a reflection of the extent to which education systems are—or are not—keeping up in the development of knowledge societies (UNESCO 2008a). It is increasingly clear that a principal factor in stimulating economic growth is improvement in cognitive competencies and skills (ADB 2008b). To date, many initiatives in ICT for education in developing countries have been limited to increasing information access for educational institutions in general and specifically for teacher training, aimed at using ICT-based resources and tools in the classroom. Evidence that the use of ICT leads to higher student achievement or other positive effects is limited to pilots that have yet to be implemented on a larger scale in developing countries. However, ICTs enable access to and use of information that may not be commonly available in certain contexts, thus providing teachers with content they would not have had otherwise to engage their students. In addition, teacher training in ICT for education parallels training in teaching methodology that supports student-centered learning. Hence, investments in ICT for education are likely to lead developing countries toward educational reforms that are necessary for fostering an information-literate citizenry, which is the key to competing in the global economy.

Investments in ICT for education at the basic and secondary levels support information literacy as a foundation for subsequent learning, as well as supporting teacher training in student-centered methodologies that foster critical and analytical thinking during the early years of the education cycle. ICTs have the potential to improve the teaching and learning process by enabling students to access information and engage in interactive learning experiences that would not otherwise be available to them. Such ICT-enhanced classroom experiences have the potential for encouraging student-centered learning, allowing students to be active learners who construct knowledge rather than passively receiving information. As a

further pedagogical development, ICT can support evolution from the student-centered approach and the use of interactive technology to team-centered pedagogy and the use of collaborative technology. In this context, the focus is evolving from ensuring appropriate learning styles to ensuring an appropriate learning environment. Investments in ICT for education at the higher educational level support the development of a skilled, "ICT-capable" labor force that may attract direct foreign investment, as well as research and development activities and university–private sector links that are important drivers of innovation and growth in advanced economies (ADB 2008b). ICT capability involves technical and cognitive proficiency to access, use, develop, create, and communicate information appropriately, using ICT tools. Along with having the potential to enhance teaching and learning in the classroom, ICTs in higher education have the potential to:

- encourage open communication between and among students, faculty, and others that supports active learning and knowledge construction;
- make available information and resources supporting academic research that would not be accessible otherwise; and
- foster development of learning materials, presentations, and lectures in an interactive manner that allows faculty to deliver them to and share them with students directly.

The flexibility and accessibility enabled by ICT have led to the emergence of open distance learning (ODL), wherein the teacher is removed in space and/or time from the student, and most communication is through an electronic medium (e.g., internet, radio, television) (UNESCO 2002). ODL has taken the form of open universities that have adopted a student-centered approach in higher education systems in a number of countries. Open universities have been established to meet the increasing demand for higher and/or tertiary education while providing opportunities to working adults and others who face constraints in accessing such education in its traditional form. Investments in ICT for education in the area of technical and vocational education and training (TVET) further support the demand for a skilled, "ICT-capable" labor force, which is the hallmark of a country transitioning to a knowledge economy. ODL holds promise for addressing critical problems facing TVET, namely, the lack of qualified instructors, the need to greatly increase the delivery of skills training on a wide scale, and the need to deliver training at much lower unit costs (UNESCO 2003). ODL can be used in TVET to empower disadvantaged populations, such as women and ethnic minorities, and to allow greater participation by working adults who cannot afford to take time off from their jobs and who are interested in improving various aspects of their work and/or their general professional knowledge (UNESCO 2003). Additionally, ICT in TVET has the potential to provide such persons with real-life learning experiences that are applicable to their immediate work situations (e.g., ICT-based simulations that model best practices). In a number of developing member countries (DMCs) of the Asian Development Bank (ADB), TVET students are often from the working class or are minority students having limited access to ICT. The integration of ICT in TVET would provide equality of opportunity for these students (UNESCO 2003). In alternative settings (e.g., programs for out-of-school youth, adult literacy, students in remote areas), ICTs have the potential to deliver education to those unable to participate in the mainstream education system.

Limitations of ICT use in Education

ICT as a modern technology that simplifies and facilitates human activities is not only advantageous in many respects, but also has many limitations. Many people from inside and outside the education system, think of ICT as "Panacea" or the most important solution to school problems and improvements. However, many conditions can be considered as limitations of ICT use in education. The limitations can be categorized as teacher related, student related, and technology related. All of them potentially limit the benefits of ICT to education. Teachers' attitude plays an important role in the teaching-learning process that utilizes computers and internet connections. Although teachers' attitude towards use of these technologies is vital, many observations reveal that teachers do not have clarity about how far technology can be beneficial for the facilitation and enhancement of learning. Of course, some teachers may have positive attitudes to the technology, but refrain from using it in teaching due to low self-efficacy, tendency to consider themselves not qualified to teach with technology. In this respect, Bandura (1986) describes self-efficacy as

"individual's opinion of capabilities to organize and perform courses of actions to achieve particular types of performances." Moreover, as identified by Brosnan (2001), attitude, motivation, computer anxiety, and computer self-efficacy are factors affecting teachers' use of computers in their lessons. Teacher resistance and lack of enthusiasm, to use ICT in education may also be another limitation. Furthermore, many teachers may not have the required IT skills and feel uncomfortable, nor do they have trainings needed to use the technology in their teaching. Unless teachers develop some basic skills and willingness to experiment with students, ICT use in education is in a disadvantage (Brosnan, 2001).

On the other hand, the limitation of ICT use in education is related to student behaviour. Appropriate use of computer and the internet by students have significant positive effects on students' attitude and their achievement. Nonetheless, it is very common to observe limitations related to student behaviour. Students tend to misuse the technology for leisure time activities and have less time to learn and study. Yousef and Dahmani (2008) described online gaming, use of face book, chat rooms, and other communication channels as perceived drawbacks of ICT use in education, because, students easily switch to these sites at the expense of their study. Internet access at home, for instance, may be a distraction because of chat rooms and online games, reducing the time spent in doing assignments and learning (Kulik, 1994). Therefore, the impact of availability of ICT on student learning strongly depends on its specific uses. If ICT is not properly used, the disadvantage will overweight the advantage. For example, while students use the internet, it may confuse them by the multiplicity of information to choose from. As a result, the teacher spends much time to control students from websites unrelated to the learning content. Then, for caution, it is important to identify the major limitations of ICT use in education as related to student behaviour. The various literature in the area, identify the following limitations of ICT use in education as related to student behaviour.
Computers limit students' imaginations,
Over-reliance on ICT limits students critical thinking and analytical skills,
·Students often have only a superficial understanding of the information they download,
Computer-based learning has negative physical side-effects such as vision problem,
Students may be easily distracted from their learning and may visit unwanted sites,
Students tend to neglect learning resources other than the computer and internet,
Students tend to focus on superficial presentations and copying from the internet,
Students may have less opportunity to use oral skills and hand writing,
Use of ICT may be difficult for weaker students, because they may have problems with working independently and may need more support from the teacher.

The other limitation of ICT use in education is technology related. The high cost of the technology and maintenance of the facilities, high cost of spare parts, virus attack of software and the computer, interruptions of internet connections, and poor supply of electric power are among the technology related limitations of ICT use in education.

The Key Challenges of ICTs Integration in Education

The integration of ICTs in education systems may face various challenges with respect to policy, planning, infrastructure, learning content and language, capacity building and financing. ICT-enhanced education requires clearly stated objectives, mobilization of resources and political commitment of the concerned bodies. Tinio (2002) discusses issues such as analysis of current practices and arrangements, identification of potential drives and barriers, curriculum and pedagogy, infrastructure and capacity building to be considered in the formulation of policy and planning. In addition, it is wise to specify educational goals at different education and training levels as well as the different modalities of ICT use that can facilitate in the pursuit of the goals. Policy makers then, need to know the potentials of ICTs in applying different contexts for different purposes. Other challenging points at the level of policy and planning are identification of stakeholders and harmonization of efforts across different interest groups, the piloting of the chosen ICT-based model, and specification of existing sources of financing and the development of strategies for generating financial resources to support ICT use over the long term. The infrastructure challenges that may exist are absence of appropriate buildings and rooms to house the technology, shortage of electric supply and telephone lines, and lack of the different types of ICTs. Because of this, one need to deal with infrastructure

related challenges before the planning of ICTs integration to education systems.

With respect to challenges of capacity building, we have to develop competencies of teachers and school administrators for the successful integration of ICT in the education system. In fact, one impeding factor of ICTs integration in education systems is the skill gap of people implementing it (Tinio, 2002). For instance, teachers need professional development to gain skills with particular applications of ICT, integration into existing curricula, curricular changes related to its use, changes in teacher role, and on underpinning educational theories such as constructivism/or student-centred learning. Because of this, any attempt of ICT integration in education should parallel with teachers professional development. The school leadership also plays a key role in the integration of ICT in education. Lack of support from the school administration is also a big challenge. Thus, for the effectiveness of ICT integration, administrators must be competent and have a broad understanding of the technical, curricular, administrative, financial, and social dimensions of ICT use in education.

Furthermore, learning content and language also challenge the integration of ICT in education. Content development is a critical area that educators overlook. In integrating ICT in education, we have to care for the relevance of the learning content to the target groups. With respect to language, English is the dominant language in many of educational software, while English language proficiency is not high in many of the developing countries, and this is one barrier in the integration of ICT to education. Another great challenge is the financing. ICTs in education programs require large capital investment and developing countries need to predict the benefit of ICT use to balance the cost relative to the existing alternatives. Potential sources of money and resources for ICT use programs suggested are grants, public subsidies, fund-raising events, in kind support from volunteers, community support, revenues earned from core business, and revenues earned from ancillary activities (Tinio, 2002). Overcoming the mentioned challenges may help education systems benefit the most from this technology.

Summary

Research has shown that the appropriate use of ICTs can catalyze the paradigmatic shift in both content and pedagogy that is at the heart of education reform in the 21st century. If designed and implemented properly, ICT-supported education can promote the acquisition of the knowledge and skills that will empower students for lifelong learning. When used appropriately, ICTs—especially computers and Internet technologies— enable new ways of teaching and learning rather than simply allow teachers and students to do what they have done before in a better way. They are promoting changes in working conditions, handling and exchanging of information, teaching-learning approaches and so on. ICT-enhanced learning environment facilitates active, collaborative, creative, integrative, and evaluative learning as an advantage over the traditional method. In other words, ICT is becoming more appropriate in the realization and implementation of the emerging pedagogy of constructivism that gives greater responsibility of learning for students. Several surveys are showing that ICT use in education systems of developed nations has comparatively advanced than ICT use in education systems of developing nations. In addition, the major promises of ICTs use in education systems of developing countries focus on training teachers in new skills and introducing innovative pedagogies into the classrooms, investing on ICT infrastructure for schools and creating networks among educational institutes, improving overall standard of education by reducing the gap in quality of education between schools in urban and rural areas, initiation of smart school with objectives to foster self-paced, self-assessed, and self-directed learning through the applications of ICTs, and developing ICT policy for education and training.

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