INNOVATIVE STRATEGIES FOR ACCELERATED HUMAN RESOURCE DEVELOPMENT IN SOUTH ASIA

INFORMATION AND COMMUNICATION TECHNOLOGY FOR EDUCATION

Special Focus on Bangladesh, Nepal, and Sri Lanka

ASIAN DEVELOPMENT BANK

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FOREWORD

Countries in South Asia have perceived information and communication technology (ICT) as an enabler for transforming their education systems, and have invested in several ICT in education initiatives and projects in collaboration with development partners, private sector, and international or regional organizations to enhance access to quality teaching and learning and promote lifelong learning opportunities. As part of a series of four reports about education in South Asia, this study on ICT in education complements and cuts across the other crucial themes in education and training today: teacher professional development, public–private partnership (PPP) in education, and assessment of student learning outcome.

For the potential of ICT to be leveraged in education, the capacity of teachers to use ICT for teaching and learning is pivotal; teacher professional development ensures that such capacity is built and sustained. Teacher professional development may also be mediated by ICT providing teachers in rural and remote areas with access to capacity building opportunities. ICT in education initiatives provide windows for PPPs to enhance school infrastructure, hardware and digital resources, and professional development programs. As the teaching and learning activities are transformed with the aid of ICT in schools, the mode of assessment of student learning outcomes also becomes an important dimension of ICT in education.

South Asia's huge opportunities arising from its demographic dividend could be harnessed fully only if it is able to skill a large number of new entrants to the labor market every year, and upskill the expanding labor force that is still undereducated and inadequately trained compared with their counterparts in other regions. South Asia must capitalize on innovations, knowledge, and skills by building a strong base for foundational skills in school education, reinforced by high-quality technical and vocational education and training and higher education. This can only be facilitated and made more effective by optimizing the benefits from effective and efficient mechanisms in the four aforementioned focus areas (teacher professional development, PPP in education, ICT in education, and assessment of student learning outcome). South Asian countries are poised to transition from low-skilled labor to higher productivity and globally competitive labor, and they are all ready to build up investments in human capital development.

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PREFACE

This report presents an analysis of the current practices and policies in information and communication technology (ICT) in education of three South Asian countries: Bangladesh, Nepal, and Sri Lanka, including existing gaps. It then recommends strategies to address these gaps by better leveraging upon the opportunities of ICT to improve equity and enhance quality and efficiency in the education sector for accelerated human resource development. Overall, ICT in education developments in Bangladesh, Nepal, and Sri Lanka are in the early stages of adoption. ICT in education efforts need to be better coordinated, and the scope and sequence of the initiatives must be prioritized when addressing equity, quality, and efficiency issues.

Cher Ping Lim prepared the regional synthesis report and national expert Abul Basher prepared the country report for Bangladesh, Rabi Karmacharya for Nepal, and Sunil Chandrasiri for Sri Lanka. As part of a series of four reports, this study on ICT in education complements and cuts across the other crucial themes in education and training today: teacher professional development, public–private partnership in education, and assessment of student learning outcome.

The country reports have been shared with government officials, particularly from education ministries, individual experts including practitioners, and researchers from academe and pertinent institutions in the three countries. They were also reviewed by colleagues from South Asia Human and Social Development Division and resident missions in focus countries. They benefited from the insights of: Karina Veal, senior education specialist, ADB; and Seok Yong Yoon, senior public management specialist, ADB; as well as from Hitendra Pillay, professor, Faculty of Education, Queensland University of Technology; and Prakash Man Shrestha, dean, Faculty of Education, Tribhuvan University. The regional synthesis as well as the country reports were also cross-referenced among the four national consultants in each country to ensure the complementarity of findings. Brajesh Panth, then lead education specialist from South Asia Human and Social Development Division, managed and coordinated the studies with support from Rhona Caoli-Rodriguez, the national program coordinator. Excellent administrative assistance was provided by Erwin Salaveria and Rosalia Baeza.

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ABBREVIATIONS

A/L	–	GCE advanced level
A2I	–	Access to Information Program
ADB	–	Asian Development Bank
CDC	–	Curriculum Development Council
DEO	–	district education office
DOE	–	Department of Education
EMIS	–	educational management information system
FOSS	–	Free/Open Source Software Nepal
GCI	–	Global Competitiveness Index
GCE	–	general certificate of education
GDP	–	gross domestic product
GEP	–	General Education Project
GIT	–	general information technology
HeNN	–	Help Nepal Network
ICT	–	information and communication technology
ICTA	–	Information and Communication Technology Agency
IT	–	information technology
ITE4	–	The Fourth Strategy on Information Technology in Education
ITES	–	information technology enabled services
ITS	–	intelligent tutoring system
MOE	–	Ministry of Education
MOOC	–	massive open online courses
NCED	–	National Centre for Educational Development
NEC	–	National Education Commission
NEP	–	National Education Policy
NGO	–	nongovernment organization
NIE	–	National Institute of Education
NPD	–	National Planning Department
O/L	–	GCE ordinary level
OECD	–	Organisation for Economic Co-operation and Development

OLE   – Open Learning Exchange
OLPC   – one laptop per child
PEDP   – Primary Education Development Program
PTA   – Parent–Teacher Association
SDG   – Sustainable Development Goal
SEMP   – Secondary Education Modernization Project
SMC   – School Management Committee
SMS   – short messaging service
UNESCO   – United Nations Educational, Scientific and Cultural Organization

EXECUTIVE SUMMARY

The last three decades have witnessed a global recognition of the potential of information and communication technology (ICT) in addressing the existing challenges of education equity, quality, and efficiency. ICT has brought new opportunities to achieve the Sustainable Development Goal (SDG) 4 of "inclusive and equitable quality education and promote lifelong learning opportunities for all" and its targets (United Nations, 2015). Just like governments around the world, the governments of South Asian countries have perceived ICT as an enabler for transforming their education systems, and have co-invested in several ICT in education initiatives and projects with aid agencies, private sector, and international and/or regional organizations. While these system-level efforts are vital for initiating ICT-enabled teaching and learning practices that have an impact on student learning engagement and outcomes, they may not be sufficient for widespread sustainable adoption of such practices within their countries. The stage of implementation and impact of investments also vary significantly from country to country in South Asia.

This paper first examines the existing state and gaps of ICT in education of three South Asian countries, Bangladesh, Nepal and Sri Lanka, and then suggests innovative strategies to address these gaps by better leveraging upon the opportunities of ICT to improve equity, and enhance quality and efficiency in the education sector for accelerated human resource development. Although this paper will examine how ICT could be leveraged to improve equity and enhance quality and efficiency, the main focus of the discussion in this paper will be on how ICT could be adopted at the system level to enhance student learning engagement and outcomes, including their capacity to learn for life. A holistic approach to ICT in education is adopted to assess the existing state of ICT in education within and across the three countries. Seven dimensions are considered in this comprehensive assessment: (i) national ICT in education vision, policies, and strategies; (ii) ICT infrastructure, (iii) professional development of teachers and education leaders; (iv) modernization of curriculum and teaching and learning resources, (v) improvements in learning environment; (vi) improvements in assessment and examination; and (vii) improvements in education management information system (EMIS). Based on the assessment of these dimensions, the three countries' ICT in education development are then evaluated by United Nations Educational, Scientific and Cultural Organization's four progressive stages of ICT in education adoption: emerging, applying, infusing, and transforming stage.

Overall, ICT in education developments in Bangladesh, Nepal, and Sri Lanka are in the early stages of adoption. Bangladesh and Nepal are at the emerging stage where there is an awareness of the potential of ICT in addressing education equity, quality, and efficiency at national and school levels. Sri Lanka has reached the applying stage as its schools have

better access to ICT infrastructure and resources (compared with the countries at the emerging stage). Based on the analysis of the state of ICT in education across the three countries, there is a significant gap between their development goals and the outcomes of their implementation of ICT in education. Much of the ICT in education initiatives have been developed and implemented without enough attention and efforts on building the ICT in education ecosystem.

The project-based and uncoordinated multiple agency approach of ICT in education initiatives in these countries also results in fragmented efforts with redundancies and a lack of sustainability and scalability of ICT in education efforts. Hence, these efforts have to be better coordinated, and the scope and sequence of the initiatives must be prioritized when addressing equity, quality, and efficiency issues of education with ICT. Based on the promising practices and lessons learned in Asia, especially among the more developed and advanced countries, this paper suggests six innovative strategies to address the abovementioned gap:

(i)   better coordination of ICT in education initiatives and efforts within the education sector and with other sectors;
(ii) better technical support for teachers as they use ICT for teaching and learning;
(iii) just-in-time and differentiated ICT in education professional learning for teachers in schools;
(iv) better pedagogical support for teachers using ICT for teaching and learning;
(v)   localized and customized intelligent tutoring system, video-recorded lessons, and ICT-mediated resources; and
(vi) monitoring and evaluation of ICT use in schools.

System-wide implementation of these strategies will address the disparate efforts in these three South Asian countries and leverage upon the opportunities of ICT to improve equity, and enhance quality and efficiency in the education sector, and ultimately accelerate human resource development in South Asia.

I. INTRODUCTION AND BACKGROUND: OPPORTUNITIES OF INFORMATION AND COMMUNICATION TECHNOLOGY FOR EDUCATION EQUITY, QUALITY, AND EFFICIENCY IN SOUTH ASIA

The overall aim and vision of national information and communication technology (ICT) in education policies and strategies in most countries are similar—to optimize the use of ICT to improve the accessibility to quality education and develop lifelong learning competencies of students, in all sectors, for the benefit of individuals and society. ICT is perceived as an enabler to achieve Sustainable Development Goal (SDG) 4 of "inclusive and equitable quality education and promote lifelong learning opportunities for all" and its targets.[1] This role of ICT in education is identified and explained in the Qingdao Declaration as harnessing the potentials of ICT to address the existing challenges in education and ensure equitable quality education and lifelong opportunities for all—a vision of Education 2030.[2]

This paper first examines the existing state and gaps of ICT in education in three South Asian countries—Bangladesh, Nepal, and Sri Lanka—based on country reports in Appendixes 1, 2, and 3. It then suggests innovative strategies to address these gaps by better leveraging upon the opportunities of ICT to improve equity and enhance quality and efficiency in the education sector for accelerated human resource development in these countries.

In this paper, equity pertains not only to access and participation, but also to educational survival, completion, transition, and achievement of the expected learning outcomes. Quality is the capacity of the education sector to meet the particular learning needs of particular students in particular settings to achieve the expected learning outcomes as defined in a particular curriculum. This is most relevant in South Asia, which has wide-ranging and diverse educational contexts within and across countries. Internal efficiency involves the optimization of inputs (teachers, administrators, facilities, instructional methods, teacher training) to support students to achieve the expected outcomes. External efficiency relates to the outcomes of an education system; in this case, the key outcome is the capacity to learn how to learn. In this paper, when efficiency is discussed, the focus is on external efficiency with respect to lifelong learning.

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[1] United Nations. 2015. Transforming our World: The 2030 Agenda for Sustainable Development. New York, USA.

[2] United Nations Educational, Scientific, and Cultural Organization (UNESCO). 2015. *Qingdao Declaration*. Qingdao, People's Republic of China.

Given the existing pace of economic and social development in some parts of South Asia, the equity target of SDG 4 may not be achieved by 2050. Although this paper will examine how ICT could be leveraged to improve equity and enhance quality and efficiency, the main focus of the discussion in this paper will be on how ICT could be adopted at the system level to enhance student learning engagement and outcomes, including their capacity to learn for life. For these enhancements to be realized, there must be a transformation of teaching and learning practices at the school and classroom levels—students have to be empowered to monitor and manage their own learning with the guidance and support of their teachers. Teachers have to move away from their traditional role of being the focal point of knowledge dissemination and construction in the classroom toward one that creates an enabling environment for students to learn at their own pace and co-construct knowledge as they work in groups on assessment tasks.

However, for such transformation of practices to be realized at the system level, policymakers and school leaders have to guide the change by addressing the complexities associated with the introduction of ICT into schools to enhance student learning engagement and outcomes. Fullan (2007) suggests that, to address the dynamic nature of change to take up the opportunities of ICT for education, policymakers and school leaders have to create and strategize the conditions within the system and school that support one another. A number of developed countries in Asia, such as Japan, the Republic of Korea, and Singapore, have already embarked on this journey about 2 decades ago; the other countries, including the three South Asian countries, could leapfrog some of the initial challenges associated with ICT in education by adopting the innovative strategies and lessons learned in the more developed countries to transform teaching and learning practices in schools.

Bangladesh, Nepal, and Sri Lanka face two major education roadblocks: (i) unequal access to quality education, and (ii) lack of capacity of their graduates to learn how to learn to contribute to their country's economic growth in an increasingly complex and globalized world. There is disparity in education quality across school types, locations, and population groups. In particular, students from schools in rural and remote or low socioeconomic areas (such as city slums) are severely disadvantaged in terms of the quality of education they receive. Although there has been significant quantitative improvement over the last decades in the focus countries' e-education systems, particularly in terms of access and delivery (such as an increased number of schools, teachers, and net enrollment rate), the teaching methodology is still based heavily on rote learning and memorization. Even in the city schools, many teachers teach didactically to the examinations. Students in these countries then have little opportunities to monitor and manage their own learning, leading to a lack of capacity to learn for life. These two roadblocks compromise the equity, quality, and efficiency of the education sector, and are major impediments to the quality enhancement of human capital for a sustainable and growing economy.

ICT offers the education sector the opportunities to improve its equity, and enhance its quality and efficiency. With respect to equity, ICT has the potential to broaden the access to quality education. Winthrop and Smith (2012) have shown how ICT, together with teacher capacity building, has provided quality learning for more students in disadvantaged communities and improved the completion rate of primary education in these communities. ICT in Asian schools may include radio, television, computers,

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Technology for Education Equity, Quality, and Efficiency in South Asia

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and the internet in classrooms, computer laboratories, and other locations, and learning environments that support mobile learning using smart phone and tablet devices.[3] However, ICT is not universally available across all schools in the three South Asian countries. The computer laboratory in the school seems to be the preferred venue for implementing ICT-enabled teaching and learning activities. Such a practice puts a strain on the use of the laboratory and limits student access to ICT; in many cases, the majority of students do not have access to these ICT facilities.

The 700 empirical studies reviewed by Schacter (1999) show that students with access to ICT in their schools are more engaged and more likely to achieve the expected learning outcomes compared with students who do not have access to ICT. These findings are consistent with those of the Organisation for Economic Co-operation and Development study that demonstrates the effects of ICT in education to enhance cognitive competencies, improve social values and lifestyles, and educational performance.[4] Dutta, Geiger, and Landvin (2015) observe that the potential of ICT in education investments to enhance student learning outcomes could be optimized through the development of teachers' professional capacity. Winthrop and Smith (2012) emphasize that different ICT-enabled strategies are needed to address the complex issues affecting quality learning for all children and youth in the developing world. ICT—from distance learning, to ICT teaching and learning resources, to information management and teacher support—has the potential to address some of these barriers. Understanding the educational landscape and sociocultural context could help identify the types of issues ICT could or could not address to ensure smart and strategic uses of ICT for enhancing the quality of education.

ICT also has a direct impact on building the capacity of teachers to enhance the quality of teaching and learning. With the pervasive use of mobile technologies with better access to the internet, massive open online courses (MOOCs) have the potential to transform teacher professional development by providing better access to quality professional learning opportunities for teachers in remote, rural, and urban areas. MOOCs are "*massive,* with theoretically no limit to enrollment; open, allowing anyone to participate, usually at no cost; *online,* with learning activities typically taking place over the web; and a *course,* structured around a set of learning goals in a defined area of study."[5] With more professional development opportunities, teachers are more likely to build their capacity to enhance the learning engagement and outcomes of their students.[6] As MOOCs are deliverable on learning platforms capable of capturing big data on participants, such data may be analyzed and used to inform design and delivery of MOOCs for the professional development of teachers.[7]

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[3] P. Wallet. 2014. Information and Communication Technology in Education in Asia: A Comparative Analysis of ICT Integration and E-readiness in Schools across Asia. Montreal, Quebec, Canada: UNESCO Institute of Statistics. http://www.uis.unesco.org/Communication/Documents/ICT-asia-en.pdf (accessed 28 January 2017).

[4] United Nations High Commissioner for Refugees (UNHCR). 2011. *Ensuring Access to Education Operational Guidance on Refugee Protection and Solutions in Urban Areas.* Geneva, Switzerland. http://www.unhcr.org/4ea9552f9.pdf (accessed 29 January 2017).

[5] Educause. 2013. Seven things you should know about MOOCs II. *Educause Learning Initiative.* http://net.educause.edu/ir/library/pdf/ELI7097.pdf (page 1).

[6] J. Daniel. 2012. Making sense of MOOCs: Musings in a maze of myth, paradox and possibility. *Journal of Interactive Media in Education.* 2012 (3). http://jime.open.ac.uk/articles/10.5334/2012-18/.

[7] V. Mayer-Schönberger and K. Cukier. 2014. *Learning with Big Data: The Future of Education.* Houghton Mifflin Harcourt.

ICT provides opportunities for students to monitor and manage their own learning and, hence, develop their lifelong learning competencies. This will enhance the external efficiency of the education sector by preparing students to live and work in the increasingly complex world. Digital portfolios have been shown to afford students the opportunity to reflect upon their learning experiences and outcomes, identify gaps in their learning with respect to the expected learning outcomes, and plan their own learning trajectory.[8] Personalized ICT-enabled platforms with social networking features also empower students to take control of their own learning. However, as students take control of their own learning, they need support from teachers to scaffold their reflections and support them to plan for their own learning; otherwise, they may lose task orientation and become disengaged.

The governments of all Bangladesh, Nepal, and Sri Lanka are aware of these opportunities of ICT to enhance education equity, quality, and efficiency and have co-invested (with aid agencies, private sector, and international and/or regional organizations) to take up these opportunities. In the World Economic Forum's Global Competitiveness Index, a measure attempts to quantify the impact of a number of key factors that contribute to create the conditions for competitiveness; technological readiness has been considered as an essential pillar (Schwab and Sala-i-Martín 2016). International and national efforts for improving access to ICT have been made, which stem from the desire to leverage ICTs to respond to social and economic changes and future prosperity. Among these efforts, improving access to the internet has been one of the key enablers of technological readiness. For example, a macro-level econometric analysis performed by the World Bank (2009) reports that a 10% increase in broadband penetration is associated to a 1.38% increase in gross domestic product (GDP) while a 10% increase in wire line internet penetration contributes to a 1.12% GDP growth.

In addition to the investments on infrastructure, hardware, and connectivity, a growing number of government leaders and policymakers in recent years have realized that technological readiness is more than the access to ICT but the ability to adopt ICT in a transformative fashion. Countries and regions have been investing in the application of ICTs to transform their education systems to develop the 21st century competencies of students and to align with emerging developments and promote new possibilities. For example, in Hong Kong, China, The Fourth Strategy on Information Technology in Education is implemented to strengthen students' self-directed learning, problem-solving, collaboration, and computational thinking competency; enhance their creativity, innovation, and entrepreneurship; and nurture students to become ethical users of ICTs for pursuing lifelong learning and whole-person development through leveraging technology and the capacity of ICTs (EDB 2014). Similarly, in Singapore, *The Fourth Masterplan for ICT in Education* is driving end-to-end integration of ICT into the curriculum, pedagogy, and assessment to empower students to manage their own learning (Government of Singapore 2015).

Although there have been promising practices that have significant positive impacts on equity, quality, and efficiency in the education sector, these practices were not widespread and, in some cases, not sustainable. Many of these practices were confined to a small

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[8]   M. Yang, M. Tai, and C. P. Lim. (2015). The role of e-portfolios in supporting productive learning. *British Journal of Educational Technology.* (DOI: 10.1111/bjet.12316).

number of schools or classrooms from selected regions within the country; some of these practices were only observed during the period of the project or initiative. Despite the investment of ICT in education of these countries, sustainability and scalability of promising practices are a challenge. Moreover, how ICT has been used and its impacts have varied significantly between and within schools, and between and within regions. To examine the existing state and gaps of ICT in education in the Bangladesh, Nepal, and Sri Lanka, a system perspective of ICT in education has to be adopted.

II. A SYSTEM PERSPECTIVE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN EDUCATION

Considerations of taking up the opportunities provided by information and communication technology (ICT) for equity, quality, and efficiency in the education sector are not simply based on the introduction of ICT per se, but rather, a consideration of macro-and micro-level dimensions in taking up these opportunities. In this paper, a system perspective of ICT in education at the national level includes adopting a holistic approach to ICT in education and assessing the approach based on the four stages of ICT in education (UNESCO 2005). Such a perspective helps us make sense of the disjointed ICT in education efforts in Bangladesh, Nepal, and Sri Lanka. More important, it allows us to examine the existing state of ICT in education of each of the three countries and across the three countries, identify and explain the facilitating factors and barriers to ICT in education, and make recommendations of how the opportunities of ICT could be better taken up.

A. A Holistic Approach to Information and Communication Technology in Education

Drawing upon the paper by Ra, Chin, and Lim (2016), a holistic approach to ICT in education consists of 10 dimensions at the micro and macro levels of the national education system driving and supporting ICT in education. These dimensions are:

(i)   national ICT in education vision,
(ii)   national ICT in education plans and policies,
(iii)   complementary national ICT and education policies,
(iv)   access to ICT infrastructure and resources,
(v)   professional development for teachers and education leaders,
(vi)   partnerships,
(vii)   ICT in the national curriculum,
(viii) teaching and learning pedagogies,
(ix)   assessment, and
(x)   evaluation and research.

Based on the country reports of the three South Asian countries, the 10 dimensions could be merged and condensed into 7 dimensions (Figure 1):

(i)   national ICT in education vision, policies, and strategies;
(ii)   ICT infrastructure (information technology [IT] backbone and connectivity);
(iii) professional development of teachers and education leaders;
(iv)   modernization of curriculum and teaching and learning resources;
(v)   improvements in learning environment;
(vi)   improvements in assessment and examination; and
(vii) improvements in education management information system (EMIS), including evaluation and research to inform evidence-based planning and resource allocation.

Figure 1: Dimensions of Information and Communication Technology in Education

EMIS = educational management information system, ICT = information and communication technology, IT = information technology.

Source: Adapted from S. Ra, B. Chin, and C. P. Lim. 2016. A Holistic Approach Towards Information and Communication Technology for Addressing Education Challenges in Asia and the Pacific. *Educational Media International.* 53 (2). pp. 69–84.
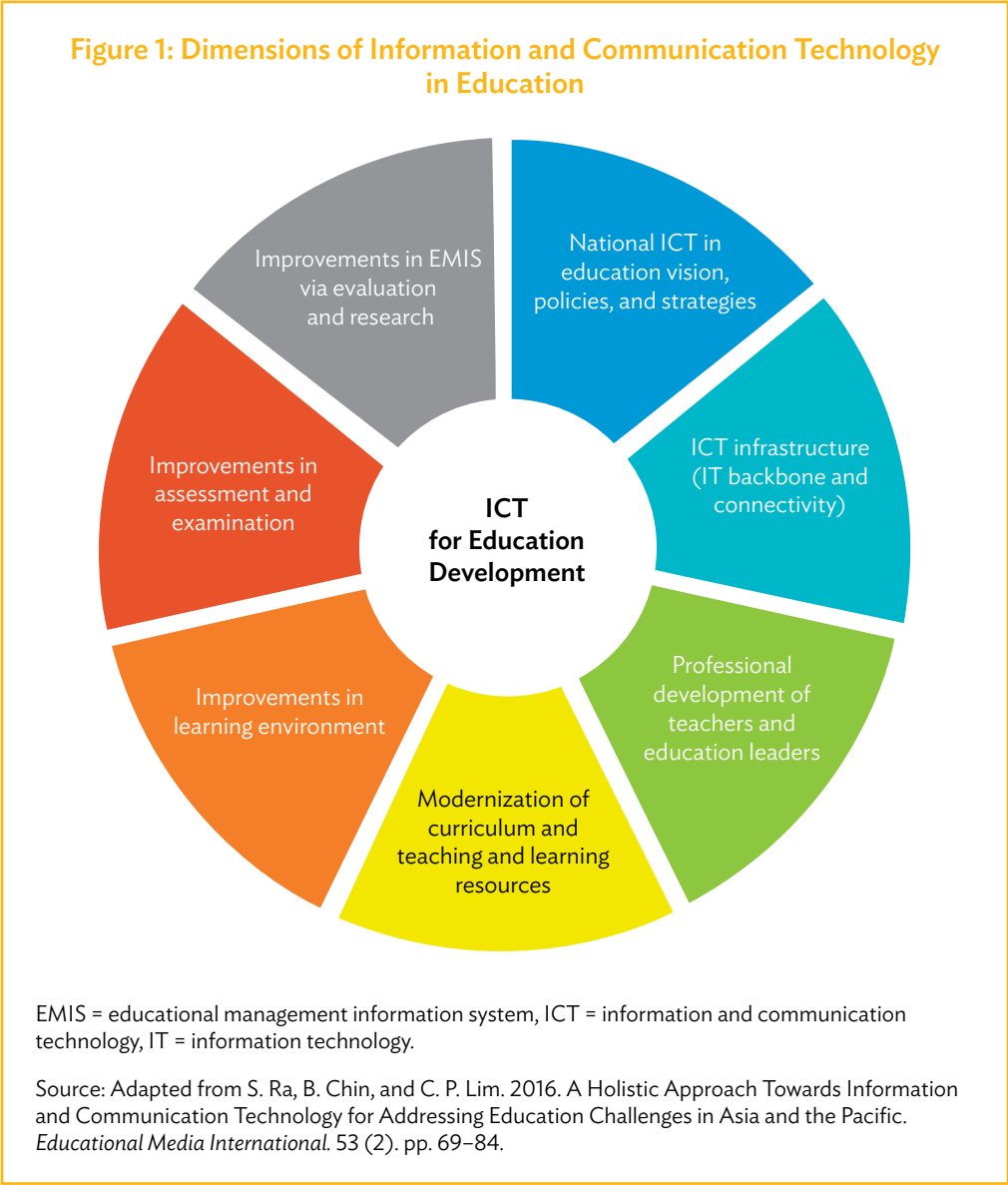
1. National Information and Communication Technology in Education Vision, Policies, and Strategies

A national ICT in education vision that is shared among all education stakeholders ensures that all ICT in education efforts and initiatives are well-aligned to this vision, improving the internal efficiency of the education system. A regularly updated national ICT in education plan can provide a framework to guide policy formulation and strategy implementation of ICT in education. As such, envisioning clear goals and translating them into appropriate implementation strategies is the key factor in achieving the systematic transformation of education through ICT. At the same time, for ICT in education initiatives to be sustainable and scalable, there must be synergies between the national ICT policies and education policies. This would create the necessary condition for successful ICT in education—access to ICT infrastructure and resources.

2. Information and Communication Technology Infrastructure (Information Technology Backbone and Connectivity)

Developing and providing access to ICT infrastructure as well as expending connectivity have been a universal concern in the education sector, whatever stage of ICT in education a country is at. Although the increasing penetration of home access and mobile technology is beginning to shift government attention away from the provision of personal hardware in schools (e.g., low pupil–computer ratios) and toward provision of ICT services for home-based learning in developed countries, the provision of school-based ICT infrastructure is still a priority in developing countries. The infrastructure includes wireless network, hardware, ICT-enabled learning environments, and, in many cases in the remote region, electricity. While more ICT infrastructure is being built, it is important to move away from overemphasis on hardware to developing content and emphasizing application. After all, sustainable and/or transformative uses of ICT in education do not depend on infrastructure alone; they also depend on the approaches of ICT use in specific educational contexts.

3. Professional Development for Teachers and Education Leaders

The successful use of ICT in education requires competent human resources at every level, from policy makers, curriculum and content designers, district supervisors, teacher educators, school leaders, and teachers. Professional development of these education personnel then is a key dimension of ICT in education. Professional development is "the sum total of formal and informal learning experiences throughout one's career from pre-service teacher education to retirement".[9] Of these education personnel, the literature on professional development has focused on teachers and education leaders. Teachers are pivotal in transforming teaching and learning practices and engaging students in ICT-enabled learning environments, while education leaders need strong managerial skills to motivate staff and students and to mobilize local support required for ICT-enabled teaching and learning programs to succeed. Strong leadership in the education sector is essential for the successful implementation and long-term sustainability of ICT in education.

4. Modernization of Curriculum and Teaching and Learning Resources

Today's knowledge economy requires curriculum cultivates 21st century competencies. ICT has the potential to be a valuable tool as well as a pedagogical agent in the curriculum

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[9]   M. Fullan and S. Stiegelbauer. 1991. *The new meaning of educational change.* 2nd ed. New York: Teachers College Press (page 326).

development if it can be embedded within the curriculum across subjects. ICT in the national curriculum takes three forms in most developing countries: (i) ICT skills as a distinct curriculum subject, (ii) ICT across the curriculum to transform the teaching and learning of all subjects, and (iii) digital literacy. A progressive shift toward the development of digital literacy, which focuses on the 21st century ICT-related competencies (e.g., the use of ICT to support problem solving, information analysis, and design) may serve as a key enabler to the modernization of curriculum. In addition, modernization of curriculum also means the need for reshaping teaching and learning resources. When curriculum is combined with engaging teaching and learning resources, teachers are enabled to have better understanding and have improved capacity to make informed instructional decision. As a result, they are able to make the subjects and disciplines more meaningful to students.

5. Improvements in the Learning Environment
There is no shortage in the number of articles and reports that improvements in the learning environment have been brought about by further cultivation of student-centered, inquiry-based, problem-based, personalized, and life-long learning. A closer look into these studies often shines light on a learning environment that supports constructivist theories of learning and constitute a shift from a teacher-centered pedagogy—in its worst form characterized by memorization and rote learning—to one that is learner-centered. In reality, more often than not, teachers' actual use of ICT in the classroom is reported as incremental, merely reinforcing traditional teacher-centered approaches using slides and drill-and-practice exercises. As a result, their use of ICT rarely creates authentic learning opportunities for students. Therefore, the goal of improvements in the learning environment is to utilize ICT to bring real life experiences into the classroom to engage students, and prepare them for further education, careers, and well-being in a way that traditional practices often fail to do.

6. Improvements in Assessment and Examination
Assessment and examination have to be aligned with the curriculum to ensure that students, as well as teachers, are provided with feedback if they have achieved the expected learning outcomes. Formal assessment and examination methods have to change to accommodate the new digital capabilities students will have and the more challenging forms of assessment and examination that ICT can offer. However, the reference to assessment and examination in most policies is to ensure that basic ICT competencies are assessed, which is different from assessing the ability to use ICT to learn and demonstrate what has been learned. Further, schools' assessment and examination policies in most countries are strongly determined by their national educational policies and the assessment and examination bodies, so ICT and assessment and examination reform remains a national policy issue.

7. Improvements in Education Management Information System, including Evaluation and Research to Inform Evidence-Based Planning and Resource Allocation
EMIS should inform the different actors and partners on the state of the sector, its internal and external efficiency, its pedagogical and institutional operation, its performance, shortcomings, and needs. If it is to be effective, information on EMIS should be based on a precise and exact diagnosis. In the context of ICT in education, while it is often noted that ICT can only have educational benefits in certain situations and under certain conditions,

evaluation and research is often not considered in the implementation of ICT in education of developing countries. Evaluation, both formative and summative, ensures that ICT in education strategies are effective and, more importantly, informs the revision and refinement of the strategies during the course of implementation. Research is necessary to ensure evidence-based policies and practices, and support system-wide scaling up of ICT-enabled teaching and learning practices.

As the state of ICT in education in Bangladesh, Nepal, and Sri Lanka is being examined, there is a need to consider all seven dimensions of the holistic approach. To identify the gaps of ICT in education in the three countries and to explain and compare their existing status of ICT in education, the model of stages of ICT in education by Anderson and van Weert (2002) and Majumdar (2005) is included in the system perspective.

B. Stages of Information and Communication Technology in Education

As countries introduce ICT into their education sector, they go through different stages of ICT in education. Anderson and van Weert (2002) and Majumdar (2005), in their work with UNESCO, identify four stages: emerging, applying, infusing, and transforming (Figure 2). These four stages are situated in the pedagogy–technology nexus where the pedagogy axis represents increasing changes of teaching practices (toward more learner-centered ones) due to ICT in education and the technology axis represents increasing ICT use and more variety of use in education. Although the figure may suggest that the stages of ICT in education are linear and sequential, it is possible for countries in the emerging stage to leapfrog to the infusing stage when innovative strategies are employed by policymakers.

The emerging stage is the beginning point of ICT in the education process. At this stage, with limited ICT tools and infrastructure in most schools, teachers are expected to master the basic ICT tools and available ICT-enabled resources and applications for their teaching, learning, and administrative tasks. ICT-enabled teaching practices are generally teacher-centered.

At the applying stage, with the support of the national ICT policies and a variety of ICT in education initiatives and strategies, there is better access to ICT infrastructure and resources (compared with the emerging stage) and teachers become more confident in the use of specific ICT tools to enhance the quality of their teaching. However, the enhancement in the quality of teaching is focused on teachers using the ICT tools rather than students using the ICT tools. Moreover, ICT is still often seen as a separate curriculum area for students to learn about ICT-related competencies.

At the infusing stage, teachers use ICT to enhance their own professional learning and the learning quality of their students. Teachers and students have good access to ICT infrastructure and resources. Teachers are competent in the use of ICT for enhancing the quality of student learning through more learner-centered environment and activities. Teachers are more likely to collaborate with other teachers to codevelop and share ICT-

Figure 2: Stages of Information and Communication Technology in Education

Sources: S. Majumdar, ed. 2005. *Regional Guidelines on Teacher Development for Pedagogy-Technology Integration.* Bangkok: UNESCO Regional Office for Education in Asia and the Pacific. http://unesdoc. unesco.org/images/0014/001405/140577e.pdf; and UNESCO. 2010. *ICT Transforming Education.* Bangkok.
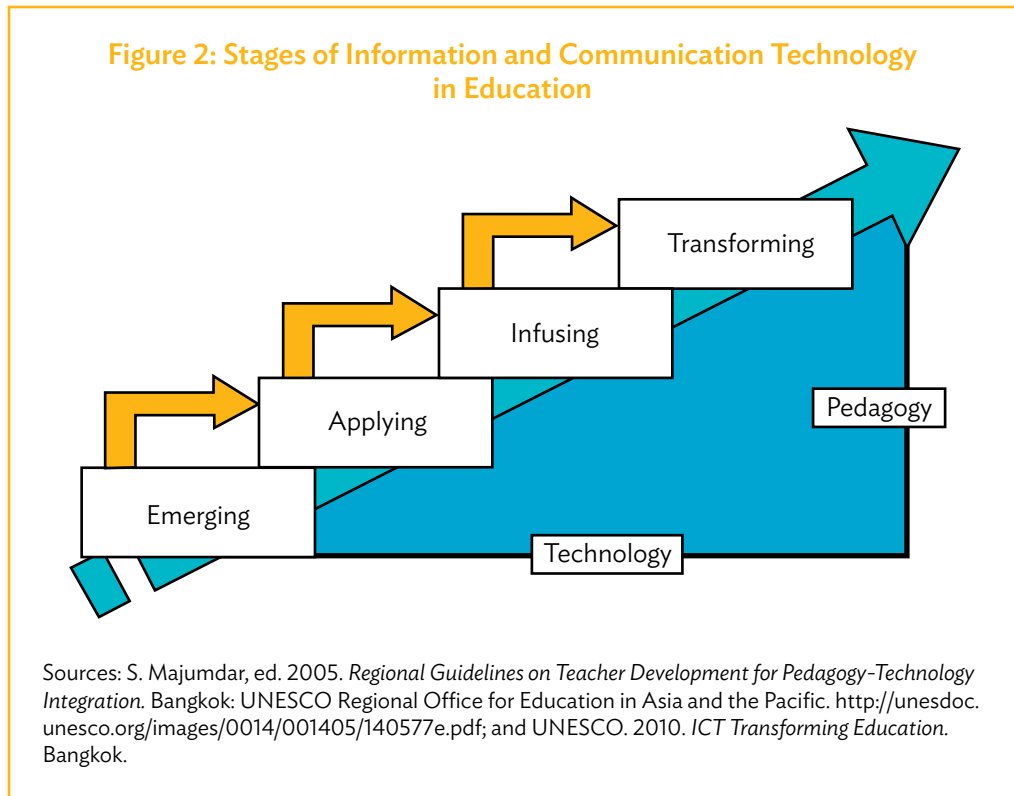
enabled teaching and learning resources and practices. However, ICT is still perceived as a tool to support the existing curriculum rather than a tool to transform the curriculum.

When it comes to the transformation stage, ICT is used by teachers for most of their personal and professional tasks and activities. At this stage, teachers use different types of ICT tools to enhance teacher–student and student–student interactions to create a learner-centered learning environment to engage students and enhance their learning outcomes. The national curriculum is designed and school ICT in education plans are developed to take up the opportunities of ICT for enhancing education equity, quality, and efficiency.

By drawing upon the holistic approach to ICT in education and the model of stages of ICT in education, the system perspective provides a framework to make sense of the state of ICT in education in Bangladesh, Nepal, and Sri Lanka.

III. MAKING SENSE OF THE STATE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN EDUCATION IN SOUTH ASIA: BANGLADESH, NEPAL, AND SRI LANKA

Bangladesh and Nepal are at the emerging stage of information and communication technology (ICT) in education process where there is an awareness of the potential of ICT in addressing education equity, quality, and efficiency at the national and school levels. Although there are various ICT in education initiatives that have been implemented by government and nongovernment agencies, and local and international organizations, these efforts are not coordinated at the national level. The level of ICT use for teaching, learning, and administration is low, and most teaching practices remain teacher-centered. Moreover, most teachers have a basic level of ICT in education competencies and most schools have limited ICT tools and infrastructure.

Sri Lanka is at the applying stage of the ICT in education process where schools have better access to ICT infrastructure and resources than schools at the emerging stage. There is an effort to coordinate the various ICT in education initiatives, and to ensure that national ICT and education policies drive and support the use of ICT for teaching, learning, and administration. Although teachers are using ICT to enhance the quality of teaching, the focus is on the teachers using ICT for their teaching rather than students using ICT for their learning. In most cases of students using ICT, they are within the context of ICT as a curricular subject to develop students' ICT competencies.

To better understand the existing status of ICT in education adoption in the three countries and their ICT in education trajectory, there is a need to examine each of the 10 dimensions of the holistic approach.

A. National Information and Communication Technology in Education Vision, Policies, and Strategies

Bangladesh
The Government of Bangladesh, with its National Education Policy (NEP) 2010 (Government of Bangladesh 2010), is contemplating to build an education system

that develops students as fit candidates to survive and thrive in the 21st century, and a framework of educational governance that ensures this. The main visions of the new education policy are:

  (i)   to ensure a productive 21st-century ready workforce;
  (ii) to reform curriculum, pedagogy, and teacher's capacity building to ensure education for all;
  (iii) to ensure transparency, efficiency, and effectiveness at all levels of educational administration; and
  (iv) to secure accountability and involve real stakeholders in policy making.[10]

Although ICT in education vision has not been explicitly stated, ICT is perceived as an enabler to realize these education visions.

In terms of policies and strategies, although there is no ICT in education master plan in Bangladesh, NEP 2010 emphasizes the use of ICT to improve the quality of education. The government has planned to make ICT a compulsory subject at the secondary level by 2013 and at the primary level by 2021. At the same time, NEP 2010 identifies the following ICT in education strategic priorities:

  (i)   promotion of ICT-enabled teaching and learning,
  (ii) promotion of professional development of teachers using ICT,
  (iii) promotion of ICT literacy for students,
  (iv) promotion of ICT-enabled education-related citizen services, and
  (v)   use of ICT in education administration.

These strategic priorities, when operationalized, could move Bangladesh from the emerging stage to the applying stage of ICT in education adoption.

The revised national ICT policy was formulated and accepted in 2009. This provides a road map for the development of ICT in the country. The vision of the National ICT Policy 2009 is to expand and diversify the use of ICT to establish a transparent, responsive, and accountable government; develop skilled human resources; enhance social equity; ensure cost-effective delivery of citizen services through public–private partnerships; and support the national goal of becoming a middle-income country by 2021 and joining the ranks of developed countries within 30 years.[11]

Given the growing digital divide across regions and income groups, the National ICT Policy 2009 also focused on striking the right balance between equity and growth in the implementation plan. Out of 306 action items of the National ICT Policy 2009, 53 focus on human resource development and education. The National Strategy for Accelerated Poverty Reduction also recognizes the need to improve the country's knowledge base using education, training, and research, and emphasizes the importance of ICT as an invaluable enabler toward achieving this objective.

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[10]   Government of Bangladesh. 2010. *National Education Policy 2010.* http://reliefweb.int/sites/reliefweb.int/files/resources/02.National-Education-Policy-2010-English.pdf.

[11]   Government of Bangladesh. 2009. *National ICT Policy 2009.* http://health.harinakundu.jhenaidah.gov.bd/sites/default/files/harinakundu.jhenaidah.gov.bd/en_382.pdf.

At the same time, the Access to Information program (A2I),[12] instituted within the Prime Minister's Office, is the central hub for facilitation and oversight of the implementation of ICT related-activities. The key strategic priorities identified for action by A2I (2011) are (i) enhance domestic and international connectivity, (ii) expand telecommunication services, (iii) enhance access to broadband, (iv) enhance last-mile connectivity, and (v) develop content and improve services.

Nepal

The vision of ICT in education for Nepal is to ensure quality education for all through the use of ICT in all aspects of education (Government of Nepal 2013). The goals include expanding equitable access to education, enhancing the quality of education, reducing the digital divide, expanding access to teaching and learning materials, and improving the service delivery system in education.

Nepal is the only country among the three South Asian countries to have an ICT in education master plan. The process of developing a master plan for ICT in education was initiated in 2010 and was completed in 2013. Before 2013, the use of ICT in education has been mentioned in various policy documents related to IT, e-governance, and education. However, most of these documents have mentioned the use of ICT in education on a superficial level without going much into strategies, action plans, and clear timetables. Few plans that have been prepared and implemented are related more to ICT literacy than the use of ICT in improving teaching and learning.

This Master Plan 2013–2017 (Government of Nepal 2013) has attempted to take into account the policy and strategy directions provided by the national plans, IT policies, and the School Sector Reform Plan to devise a consolidated plan for the use of ICT in the education sector. The master plan has set the vision to ensure quality education for all through the use of ICT in all aspects of education. The goals include expanding equitable access to education, enhancing the quality of education, reducing the digital divide, expanding access to teaching and learning materials, and improving the service delivery system in education. The master plan focuses on four key components of successful ICT in education program: (i) ICT infrastructure, (ii) human resource development, (iii) digital content development, and (iv) education system enhancement. With the master plan in place, Nepal is in a good position to move toward the applying stage of ICT in education adoption in the medium term.

Although the National IT Policy 2000 called for review and amendment every 2 years to keep up with rapid technological advances, the subsequent policy was not formulated until 2010. The new policy document set the vision of establishing Nepal on the global ICT map and transforming it into a knowledge-based society. The policy calls for the development of ICT to promote good governance, poverty alleviation, and socioeconomic growth. The specific objectives included making ICT a priority area, creating employment through establishment of knowledge-based industries, developing e-government programs as a way to provide effective services and timely information to the public, and establishing a centralized government data center to aid in ICT development.

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[12] A2I. http://a2i.pmo.gov.bd.

One of the key policy amendments mentioned was the integration of ICT policy with other development policies and giving high priority to programs to create employment. The policy also emphasized the use of ICT for e-governance, and agencies that deal with health, education, and businesses that can function better with ICT-related strategic plans, and help increase the domestic consumption. Among the plans prepared to fulfil the policy objectives, the following education-related ICT plans were implemented:

- **Computer education in schools.** The government has launched a Computer Education for All by 2010 campaign as the policy, but it has not resulted in any concrete steps toward meeting the vision.
- **Websites for all ministries and departments and district offices.** These have been established, but they lack relevant content and updated documents. Many sites have empty pages, and most district offices have nothing beyond the common templates that were prepared by their respective ministries.
- **Information and communication technology officers.** Officers have been placed in each ministry to provide assistance and support in computer use and the internal network, and to keep the website up and running.

The use of ICT in education has also been mentioned in various national plans and policies:

- Ninth, 10th, and interim national plans (1997–2010):
  - Introduce computer in schools.
  - Increase access to education.
  - Develop human resources in ICT.
  - Integrate ICT in education.

- ICT policies (2000 and 2010):
  - Use ICT to improve the quality of education.
  - Emphasize computer education in schools.
  - Gradually make computer knowledge mandatory for all newly recruited teachers.
  - Provide computer education to in-service teachers in phases.
  - Continually update and improve ICT education to prepare a capable workforce.
  - Provide facilities to universities to offer computer science and engineering subjects.
  - Provide free internet access to universities and public schools.
  - Provide scholarships to students from remote areas to pursue higher studies in ICT.
  - Introduce a distance learning system.
  - Encourage collaboration between the IT industry and academic institutions.

- e-Government Master Plan
  - Improve education administration with ICT.
  - Develop ICT literacy for human resource development.

- School Sector Reform Plan, 2009–2015
    – Enhance quality and improve student learning using ICT.
    – Use ICT to improve the classroom teaching and learning process.
    – Develop a separate ICT plan for education.
    – Seek new and cost-effective approaches to capacity development using ICT.
    – Develop human resources in the ICT sector.
    – Develop ICT infrastructure in education.
    – Use ICT to improve governance, management, and quality.
    – Transition the MOE into an e-governance system.
    – Improve education administration.
    – Improve transparency, accountability, timeliness, and quality of EMIS data.

Sri Lanka

The latest policy document, Unstoppable Sri Lanka 2020, states that the government`s vision is that future generations of citizens of Sri Lanka are equipped with competencies to meet the challenges of a changing, globalized, and knowledge-driven economy.[13] The knowledge path covers the entire education sector representing general education, skills education, and higher education. The first strategy is to create a child-friendly education system through physical and learning facilities improvement, teacher development, and capacity development. This involves providing Mahindodaya technological labs for 1,000 secondary schools. In these laboratories, a language lab, a mathematics lab, a distance education unit, and a computer lab are to be established. Facilities of about 5,000 primary schools in isolated or remote areas are to be improved. Although this is not the ICT in education vision, the pivotal role of ICT to realize this vision is clear; that students of Sri Lanka should be made children of the new millennium by providing them with modern technology applications in education such as the internet, multimedia technology, computer technology, distance education methods, and electronic media, including TV.[14]

The government has introduced several measures to promote ICT in education with support from the donor community. Subsequent to the Secondary Education Modernization Project I (SEMP I 2000–2006), there were eight major interventions to promote ICT in education. These initiatives have led to significant improvements in ICT infrastructure facilities and capacity building of teachers, principals, and administrators on the use of ICT in teaching, curriculum, and digital content development. In addition to government efforts, several private sector organizations, including multinational ICT firms, have also contributed by providing teacher capacity building, supplying relevant content and software, and improving internet connectivity.

However, Sri Lanka has yet to develop a master plan or overall program to ensure the full integration of ICT in education. Given the multi-institutional character of the education system in Sri Lanka, development of a master plan is vital to provide direction and promote the use of ICT as an enabler in improving access, quality, and relevance of education and student learning outcomes. The ICT master plan needs to be guided by a long-term

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[13] Government of Sri Lanka, National Planning Department. 2013. *Unstoppable Sri Lanka 2020: Mahinda Chintana, Vision for the Future.* https://www.adb.org/sites/default/files/linked-documents/cps-sri-2012-2016-oth-01.pdf.

[14] Government of Sri Lanka, Ministry of Education. 2014. *New Educational Policies and Proposals.* Battaramulla.

vision of reaching the infusing and transforming stages in the adoption and use of ICT in education.

In November 2002, the e-Sri Lanka Project was launched with the objective to develop a national ICT road map or action plan. The road map resulted in the formulation and implementation of the ICT Act No. 27 of 2003 that is now known as the Sri Lanka e-Policy, and establishment of the ICT Agency (ICTA). The e-Sri Lanka Development Initiative is an ICT development strategy implemented by ICTA. The primary objective of the project's first phase is to leverage ICT to develop the national economy, reduce poverty, and improve the quality of life. It consists of seven programs: (i) ICT policy; (ii) leadership and institutional development; (iii) information infrastructure; (iv) re-engineering government; (v) human resource development; (vi) ICT investment and private sector development; and (vii) e-society. The e-Society program promotes ICT in education through the Community Assistance Program and Partnership Assistance Program. The second phase of the project is to be implemented over 5–6 years, starting from the first quarter of 2014.

The policy documents of the National Planning Department (NPD) at the subsector level include the use of ICT in education. The policy emphasis of the government is to focus on the next century in developing the education system.[15] The government is aiming for an education system that will provide the competencies and technological skills required for rapid economic and social development. Thus, the education policy aims at creating a knowledge-based society, with educational institutions producing a workforce with the skills required to face emerging societal challenges. It recognizes the necessity of promoting equity and enhancing the quality and relevance of education, while improving governance in service delivery. The policy also aims at promoting values and attitudes needed by individuals to live in peace and harmony in a disciplined society (NPD 2010, p. 112).

The policy documents also state that the quality of basic and secondary education will be improved through diversifying the curriculum and improving student achievement in secondary schools in English, science, mathematics, ICT, and management (NPD 2010 p. 116). With respect to the use of ICT in improving information systems, it states that a dynamic online information center, which is intended to house a database system and function as resource center for ICT-based learning materials and sources, will be established in the Ministry of Education to provide the necessary information and material for students, teachers, parents, and school administrators. The latest and most reliable information in relation to schools and school-based assessments, postsecondary education planning, apprenticeship training, career planning, curriculum, teaching resources, exams, and health and safety measures will be disseminated to students, teachers, parents, and school administrators through this online information center (NPD 2010, p. 117).

A special education affairs advisory committee in Parliament presented new education policies and proposals to the cabinet and to Parliament (MoE 2014). Its policy recommendations on ICT include the use of modern ICT in education, equitable distribution of resources, human resources development, legal support systems, and self-financing. It states that students of Sri Lanka should be made children of the new

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[15] Government of Sri Lanka, Ministry of Finance and Planning, National Planning Department. 2010. *Wonder of Asia: Sri Lanka Development Policy Framework 2011–2020.* Colombo (page 71).

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millennium by providing them with modern ICT applications in education such as the internet, multimedia technology, computer technology, distance education methods, and electronic media including TV. Suitable cocurricular tools are also to be provided for the enhancement of education of the children. It also proposes to develop teachers, principals, and education administrators through training.

B. Information and Communication Technology Infrastructure (Information Technology Backbone and Connectivity)

Bangladesh

Unlike many other countries, Bangladesh is trying to promote the use of ICT in education before accomplishing a reasonable level of e-readiness, which is currently very poor, albeit improving gradually. Only about 5% of the total population use the internet. The country has the second-highest cost of internet in South Asia, next to the Maldives. On average, the monthly internet cost in Bangladesh is about five times higher than Sri Lanka, and three times higher than Nepal. Private internet providers seem to have a cartel to sustain the high price for their services. A notable digital divide exists in the country in terms of differential rate of use of internet by rural and urban, poor and rich households. This digital divide is increasing over time.

The Directorate of Primary Education has been implementing the Primary Education Development Program (PEDP) to promote the quality of primary education in the country. One of the main components of the third phase of this program (PEDP III) is promoting the use of ICT in primary education. Under this component, the government is providing two different types of ICT infrastructure at different primary schools. At least one multimedia classroom has been developed so far in 502 model primary schools, at least one selected from each *upazila* (subdistrict). A multimedia classroom is equipped with a computer, internet connection, projectors, and a sound system. About 15,000 primary schools have each received a laptop.

There are two main interrelated government initiatives to promote the use of ICT in education at post-primary level. One of them is the multimedia classroom—classrooms equipped with ICT-supportive infrastructure—and development of digital content by teachers. The government has already converted one classroom into a multimedia classroom in 20,500 secondary and higher secondary academic institutions. Out of them, 15,200 are secondary and higher secondary schools and 5,300 are madrassas—institutions fully dedicated to the teaching of religious education. The criteria used to select them include whether the institution (i) has electricity; (ii) is accredited to provide an academic certificate; (iii) is public or private; and (iv) if private, whether it is included in the monthly pay order of the government. Each selected school received one laptop, one projector with screen, one pair of speakers, and one internet modem with connection.

Complementing the provision of ICT infrastructure, the government has been training teachers on how to develop and use digital content in teaching. So far, about 12,000 teachers from different secondary and higher secondary schools and madrassas have been

trained on developing digital content. Half of them are identified as master trainers who are capable of training other teachers. The government also has developed an interactive and user-friendly web-based repository where teachers can share and store digital content they have created. The total number of items in this repository, named *ShikkhokBatayan*, has already exceeded 8,000.

Anyone can be a member of *ShikkhokBatayan* and upload digital content. As of now, there is no quality control mechanism in place. However, when new content is uploaded by a teacher, other users rate it according to its usefulness and merit. Three content developers are selected for recognition every week on the basis of these ratings. Thus, content uploaded in *ShikkhokBatayan* does undergo some level of peer review. The total number of active participants in *ShikkhokBatayan* has exceeded 13,000. One can choose digital content by using different drop-down bars: type of education (technical education, general education, or madrassa education), level (class) of education, and subject.[16]

The government has also developed another web-based platform, www.ebook.gov.bd, where the digital copy of all textbooks is made available. As of 2012, 300 textbooks and 100 auxiliary books were available in this portal. By using different drop-down bars, one can choose any chapter of the book. Currently, the books are stored in PDF format. Initiatives are underway to make them interactive so that, by double-clicking on a particular topic, one can get additional related information, images, and even videos.

The use of ICT has already resulted in some changes in the delivery of education-related citizen services in Bangladesh in recent years. A key milestone is the online publication of board examinations at all levels and all types of education since 2009. Simultaneously, they are also sent to people via short messaging service (SMS) and e-mailed to educational institutions. Similar to the board examinations, results of the teacher selection process have also started to be published on the web and distributed via SMS. Most of the higher secondary- and tertiary-level academic institutions have started an online admission process.

Nepal

Nepal's Ministry of Education (MOE) has provided computers to schools through various schemes over the past few years. The following summarizes the support provided to various schools:

(i)   In 2010, 3,038 schools received two computers and one printer each.
(ii) Under an annex program, six schools are running a 15-month computer lab program with internet connectivity.
(iii) Under an open education program, 85 secondary schools are receiving internet connectivity.
(iv) A total of 1,453 schools received NRs140,000 each from the MOE over the past 3 fiscal years: 356 schools in fiscal year (FY) 2010, 428 schools in FY2011, and 668 schools in FY2012. Schools are required to add NRs60,000 from local funds, and use the total of NRs200,000 toward the following:
      (a)   purchase and install five computers,

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[16]   Madrassa is a Muslim educational institution.

(b) purchase and install one printer,

(c) arrange for digital content and learning materials for grades 1–10,

(d) internet connection and continued operation,

(e) train at least one teacher on computer hardware and software, and

(f) arrange alternative energy source in schools without electricity.

The MOE's program to introduce computers in schools does specify the minimum basic configuration, but since schools receive the funding to buy the computers directly from local suppliers, most of them do not have the resources to make sure that the supplied computers meet the requirements. And with very little follow-up and monitoring from the district education office, little is known regarding the fate of machines that were procured as recently as last year. Moreover, the specifications provided by the MOE do not mention anything about operating system and other software, or about the power requirements. The budget allotted to each school toward the purchase of computers does not have any provision for operating system and software applications. As a result, most computers are loaded with pirated and unauthorized operating system and software applications. With a very low budget allocated per computer (NRs25,000), schools can only afford to buy locally assembled computers that are poor in quality and come with short warranty periods.

To address the issue of computer shortage, in 2008, a local nongovernment organization, Open Learning Exchange Nepal (OLE Nepal), partnered with the Department of Education (DOE) to launch a two-phase pilot project to introduce the one laptop per child (OLPC) approach. The project has deployed over 4,400 laptops in 65 schools spanning 15 districts, benefiting over 15,000 students. The project has introduced the OLPC shared-model approach in schools to reduce the financial and logistical burdens both from the implementation and the school .[17] In this shared model, schools are provided with a set of laptops, enough to cover the largest class size, and different grades take turns using laptops based on a schedule prepared by the teachers. Laptops are placed in a separate room where students go to use them as per the schedule, and for schools that do not have an extra room available, laptops can be carried to the classroom in portable racks. When any one grade is using the laptops, each student will have one-to-one interaction with a laptop and its digital content. This arrangement allows students to learn at their own pace and benefit from the learning-by-doing approach. Schools are encouraged to let students use laptops during free time and after school as well so that they can explore and engage in activities on their own. Although the OLPC shared model seems similar to the traditional computer lab model, it has a number of distinct advantages. Using laptops instead of desktop machines allows schools to run the classes even during power outages. Since laptops consume much less power than desktop computers, the recurring cost associated with electricity consumption is lower.

Unlike in other countries, Nepal's program went beyond distributing laptops to students and connecting schools to the internet. The project took a comprehensive approach to improving quality of and access to education through the integration of laptops in the classroom teaching and learning process. Hence, the distribution of laptops was accompanied by efforts in the following four key areas:

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[17] Government of Nepal, Department of Education. 2008. *Concept Paper on Using Digitalized Curriculum and OLPC in Nepal.* Kathmandu.

(i)   design and development of local digital content,
(ii)   teacher training and support,
(iii) network and power infrastructure, and
(iv)   capacity building.

Notable efforts include those of the Help Nepal Network (HeNN), a global network of volunteers with chapters in Nepal and abroad, which initiated the One District–One E-Library campaign in 2007 to set up computer facilities in all 75 districts of Nepal to benefit students and communities. Instead of installing traditional computer labs, HeNN partnered with the Free/Open Source Software (FOSS) Nepal volunteer community to deliver low-cost solutions based on the Linux Terminal Server Project that combines a powerful central computer with low-end cheap computers as clients. This approach shares the high processing power and storage capacity of a Linux server with the client computers, which would otherwise be useless without hard disks. HeNN has set up 15 e-libraries in 12 districts of the country.[18] Although HeNN's e-library project provides some books and content, it is not a full-fledged digital library, but a center where users can learn how to use computers and a few other applications.

Another initiative is the Nepal Wireless Project, which was launched in 1997 in the Myagdi district to connect village communities to the internet using long-range wireless devices and customized local antennae.[19] The project aimed to empower village communities by connecting them to the outside world and by providing opportunities in health, education, communication, and commerce. The project has carried out activities in distance education, telemedicine, and e-commerce in a few villages in Myagdi. Schools in villages have been provided access to digital learning materials, including the learning activities prepared by OLE Nepal. However, the attempt to promote distance education has not been successful due to technical and other reasons.

E-Paathis a collection of subject-specific and grade-specific digital learning materials designed and developed by OLE Nepal as an integral part of its ICT in education initiative with the DOE.[20] Conceptualized by educators and curriculum experts, these interactive educational software modules are closely aligned with the national curriculum and are designed to help teachers and students meet the learning objectives outlined in the curriculum. These activities employ various features of technology such as audio, images, animation, and text to help students better understand concepts in various subjects. Over 540 modules for grades 2–6 in English, mathematics, and science subjects and for grades 2–4 in Nepali subjects have already been developed and introduced in schools. Each activity module is accompanied by a teacher's note that explains how teachers can integrate the activity into classroom teaching, including the learning objective from the curriculum that the activity is designed to help meet, the learning areas that are addressed by the activity, the chapter of the book that the activity correlates to, and, most importantly, how the digital activity can be used alongside other learning tools inside and outside the classroom to teach various concepts.

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[18] Help Nepal Network. www.helpnepal.net.

[19] Nepal Wireless Project. http://www.nepalwireless.net.

[20] E-Paath. http://www.olenepal.org/e-paath/.

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Currently having a collection of 5,000 titles, e-*Pustakalaya* is an education-focused digital library containing full-text documents, books, images, videos, audio files, and interactive educational software that can be accessed through an intranet or on the internet.[21] Developed in 2008 by OLE Nepal, e-*Pustakalaya* aims to improve reading skills, to develop a reading culture in schools by giving them free and open access to age-appropriate reading materials, to enable students to do research projects, and to promote the habit of independent inquiry. Since the launch of e-*Pustakalaya* in 2009, teachers have benefited greatly from the rich teaching resources and educational materials that are available on the system. The use of the materials in e-*Pustakalaya* is governed by CC licenses. e-*Pustakalaya* can also be installed in low-power servers and deployed in schools and community libraries that either do not have internet connectivity or have a low-bandwidth connection. Such local instances of e-*Pustakalaya* will enable better user experience through fast access and quick downloads.

MiDas eCLASS is a product of MiDas Education designed to change the way teachers teach and students learn through innovative and meaningful use of technology.[22] The eCLASS combines state-of-the-art infrastructure complete with customized software, projection system, computers, and power backup system with curriculum-based digital content into a single package known as eduKit. This teaching aid allows teachers and students to have more lively and perhaps effective classes using multimedia, graphics, pictures, and diagrams. It also allows teachers to assess and evaluate the learning achieved by their students in class. Students can use the digital content to visualize the concept much better than static images or oral instruction, thus improving learning greatly. However, it has been criticized that, among the 215 schools that are using eduKit digital content, more than 90% are private schools in urban areas, with a majority in Kathmandu and surrounding districts. This might be because the content offered is in the English language and only private schools use English as the medium of instruction. Further, although the digital content is also available on CDs for those schools without sufficient infrastructure, the cost for user licenses per CD could be high.

Sri Lanka

Systematic provision of computers to schools started in 2003 under the Secondary Education Modernization Project (SEMP) I and continued in SEMP II and the Education for Knowledge Society Project. It included the establishment of 1,006 computer learning centers; 1,200 SchoolNet online connections; 30 multimedia centers; and 30 computer resource centers and computer development labs. Under SEMP I, the following were also carried out: training program on computer-assisted learning (239,600 trainees); 7-day e-Citizen Program trainings for teachers (1,398 trainees); and training teachers on multimedia centers (9,940 trainees). The main purpose of SEMP I (2000–2006) was to enhance computer literacy to narrow the digital divide, enabling rural youth to successfully cater to the future job market by acquiring computer literacy and sound technical knowledge.

Similarly, the main objective of the General Education Project 2 (GEP 2), 2003 was to improve the quality of general and ICT education in schools in Sri Lanka. It funded 400

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[21]   e-Pustakalaya. http://pustakalaya.org. Pustakalaya means library.

[22]   MiDas eCLASS. http://www.midaseducation.com.np/.

computer labs in eight provinces and the computer quota for each province was 50 labs with 10 computers. The National Institute of Education (NIE) conducted teacher training workshops for schoolteachers on ICT and use of ICT in teaching other subjects. SEMP II, 2004–2009 provided further support for ICT in education covering 1,200 schools. The ICT component provided by SEMP II included the establishment of 358 computer learning centers, provision of 105 multimedia rooms, and ICT training for 35,000 teachers.

Of the above, computer resource centers were initially established to provide training for the general certificate of education (GCE) ordinary level and advanced level students who are waiting for results. These computer resource centers have become tools to promote computer-assisted learning in schools, implement computer education courses, use ICT for professional training, and provide opportunities for external institutions to receive ICT training.

The ICT initiatives of SEMP II were continued with assistance from the Education for Knowledge Society Project. It is a wide-area network currently connecting more than 2,100 schools throughout Sri Lanka. It connects the schools' computer resource centers, provincial departments of education, zonal education offices, provincial ICT centers, National Colleges of Education, the NIE, and the MOE.

SEMP II established a wide-area network connecting most of the senior secondary schools and other related organizations via SchoolNet, which is the platform for the key institutions in school education (schools, computer resource centers, provincial ICT centers, National Colleges of Education, Ministry of Education, the NIE, SEMP project management offices). SchoolNet is an online educational system aimed at promoting efficiency and academic achievement in public schools. It is also expected to improve the quality and accessibility of online learning of mathematics, science, ICT, and other subjects. It has interactive educational content for students and teachers and provides an opportunity for students, teachers, school administrators, operators, and parents to get involved in the whole education process. To achieve this, Sri Lanka Telecom provides an Internet Protocol–Virtual Private Network (IP–VPN)-based network that includes multiple products such as voice, video, broadband internet, network services, and hosting services. SEMP II allows access to SchoolNet communities, promotes online access to educational software, and enhances teaching and learning. SchoolNet communities improvise development in audio, video, and computer-assisted programs along with the computer-mediated communications, thereby offering many possibilities for teachers to convert activities around interactive learning, watching videos, marking online assignments, and communicating through real time.

Besides donor-assisted projects, in early 2008, special cabinet approval was given to allocate SLRs40 million from the consolidated fund to provide ICT facilities. Through this grant, the MOE provided computer labs (10–20 computers per lab) to the national schools to maintain the basic ratio of 75 students per computer. Computers and other facilities were distributed considering the real need and present available resources of the school. Continuous teacher training activities were also provided as a part of this support system. In addition, provincial educational ministries have also provided computers, other infrastructure facilities, recruitment and training of ICT teachers, and in-service teacher

updating and other related activities (e.g., development of school websites, seminars) to promote ICT in school education.

The OLPC project was implemented as a pilot project in 2009 to introduce ICT to primary grades. With funding from the World Bank, this project involved 13 schools. Under the 1,000 secondary schools development program, it was planned to provide ICT labs with all the necessary equipment to every participating school. Action has already been taken to recruit 1,000 new graduates as ICT teachers and to train ICT teachers in the general education system with the assistance of the NIE.

As a non-English-speaking country, Sri Lanka needs custom-tailored digital content to promote the use of ICT in education. Teachers are being trained to develop instructional materials in the native language. It also maintains a web-based repository where any teacher can store instructional material, use others' materials, and comment on the usefulness of materials or how to make them more useful. These efforts need to be strengthened, streamlined, and better coordinated with a view to ensuring maximum benefits to students. The private sector service providers led by the Information and Communication Technology Agency have also been playing a key role in digital content development.

C. Professional Development for Teachers and Education Leaders

Bangladesh

In addition to building this infrastructural capacity, the MOE, with the help of Access to Information (A2I) program and the Bangladesh Computer Council, is also providing training to at least one teacher from each school that has the multimedia classroom. The country's 14 teacher training centers, its 4 higher secondary teacher training institutions, the Bangladesh Madrassa Teachers' Training Institute, and the National Academy for Education Management are imparting the training under the direct supervision of the MOE. To impart the training efficiently, 20 computer labs were established in each of the training institutes. Acknowledging that the teachers who would be using the multimedia classrooms can at best be characterized as migrants to the digital world, their training curriculum includes everything from physical operation of a laptop and projector to contextualization of lessons by relating them to real life. Trained teachers are instructed to teach their colleagues after going back to the school. About 12,000 teachers have benefitted from the training program. In addition to teacher training, the Government of Bangladesh is planning to conduct a 3-day course to train heads of academic institutions since their interest is one of the crucial determinants of the effective use of the multimedia classroom for education.

However, in an evaluation of professional development program, teachers who participated have reported that the program emphasized teaching about technology instead of teaching with technology. Preparing teaching materials to make teaching more attractive or interactive was left to the teacher as a topic of self-learning. The mainstream training provided by teacher training institutes does not include ICT in the curriculum. Another challenge in promoting the use of ICT in education in Bangladesh is the age and gender

composition of teachers who participated the professional development program. Teachers with fewer years of teaching experience seem to be more interested in using ICT in their teaching than those with more years of experience, probably due to these young teachers' previous exposure to computers. Additionally, few female teachers have used or tried to use ICT in their teaching. Hence, extra effort may be required to motivate change among older and female teachers, and to address the age and gender inequality issues.

Nepal

To ensure that newly recruited teachers have basic computer skills, the School Sector Reform Plan document by the MOE mentions giving priority to applicants with such skills during the hiring process. However, that has hardly been the practice, especially with numerous other issues that is hindering the hiring process.

The MOE's National Centre for Educational Development (NCED), the official body for training and capacity building of teachers, has recently developed a teacher training program for ICT curriculum, but it does not have a training program to build teachers' skill on integrating technology in classrooms. Since the NCED develops and delivers training packages to help train teachers to effectively teach the curriculum prepared by the Curriculum Development Council (CDC), the NCED will most likely not prepare ICT-based education training packages in the absence of clear curriculum guidelines from the CDC on the use of technology in classrooms.

Under the MOE's program to send funds to schools to set up computer labs, there is a mention of training at least one teacher from each recipient school on basic computer hardware and software. However, the training is not conducted by the NCED or any other body under the MOE system. Rather, schools are instructed to find a nearby computer-training institute and send one or more teachers for a general training. There is no detailed specification on what the training should include, nor any monitoring mechanism to verify whether teachers receive the training or how effective the training was toward the use of computers and other ICT in schools.

Other programs such as HeNN's e-library project and the Nepal Wireless Project have used volunteers from local universities to provide basic training to teachers in schools where they have gone to install the computers. These training programs are limited to providing basic knowledge about using computers, and they typically last about 1–2 days. OLE Nepal and the DOE's OLPC project was the first ICT in education project that has taken concrete steps to go beyond basic IT training and equip teachers with the skills and confidence to use digital learning activities in classroom teaching and learning. The training program trained teachers not only on using computers and software applications, but also on using a digital platform to teach subjects such as English, mathematics, science, and Nepali. The training package covered topics such as basic IT literacy, relation between digital content and curriculum learning objectives, managing students in IT-enabled classrooms, preparing lesson plans to integrate technology, and optimal seating arrangements. The training package was developed through discussions with training experts from the NCED, curriculum experts from the CDC, officials from the DOE and MOE, and other experts, with input and feedback from the OLPC program schoolteachers over the years. The overall training package is delivered over three stages: (i) initial residential training, (ii) in-school training, and (iii) refresher training.

The NCED prepared a manual of self-learning materials on ICT titled *Online Offline Professional Capacity Development Training in 2010* to help develop the capacity of the MOE officials.[23] The manual is a compilation of various resources to be used in the 3-month training program, which includes 12 days of workshop followed by 11 weeks of self-learning. The manual covers concepts and delivery methods of online and offline education, office productivity software, general internet use, email, web, and search engines, as well as devices such as LCD projectors and digital cameras. It also has chapters on using ICT in classroom teaching and in mobile learning. The manual takes a theoretical approach to the above topics, especially on using ICT in classrooms and e-learning.

Efforts in capacity building have to be accompanied by hands-on work. The DOE and OLE Nepal prepared 15 master trainers in 2009 to train teachers in OLPC program schools. They included trainers from the NCED and education training centers, experts from the CDC, and school supervisors from the district education offices (DEOs) of the program districts. These trainers were actively involved in delivering initial, in-school, and refresher training; monitoring the program; and preparing and revising the training program. Similarly, the project worked with subject experts from the CDC in the conceptualization and review of the digital learning activities. However, these efforts have not been able to get the institutional foothold to continue these capacity building programs.

Sri Lanka

Human resource development in ICT is being fulfilled by both public and private service providers. Within the public sector, universities, teacher colleges, and technical and vocational education and training (TVET) institutions conduct programs on computing at the certificate, diploma, and degree levels. Similarly, the private sector providers offer a wide range of ICT programs leading to certificate, diploma, and degree level qualifications. They also train individuals for professional examinations conducted by the United Kingdom National Computing Centre, the Australian Computer Society, and the British Computer Society. With these service providers, IT literacy levels have risen from 8% in 2002 to 38% in 2011.

Despite the improved public IT literacy rate, in education sectors, a survey on the skills profiles of teachers conducted by Fernando (2014) revealed that 52% of ICT teachers are with non-ICT teaching appointments. Only about 29% of ICT teachers have received less than 3 months of training to teach ICT for GCE ordinary level (O/L) and 42% have received more than 1 year of training. Another study showed that about 59% of principals in the country have only obtained basic training on computing (Senaka 2007). The same study also revealed that 59% of the teachers were not happy with ICT training (Senaka 2007). Among those training programs, admittedly, there is no detailed specification on what the training in the use of ICT in schools should include, nor any monitoring mechanism to verify if teachers received the training or how effective the training was.

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[23] Government of Nepal, Ministry of Education, National Center for Educational Development. 2010. Online Offline Professional Capacity Development Training in 2010. Sanothimi, Bhaktapur.

The education sector strategy matrix given in Unstoppable Sri Lanka 2020 spells out specific action programs for continuous professional development of teachers and it needs to be expanded to cover ICT applications in school education.[24] More specifically, the ICT training component needs to cover both technical and advanced training on digital resources development, technology planning and evaluation, action learning and research, and specialized ICT applications in humanities, mathematics, science, and languages. It also requires an action program on capacity building of training providers.

Therefore, the MOE made arrangements to train ICT teachers with assistance from multinational companies, including Intel and Microsoft. As one of the key activities carried out by the MOE, National Institute of Education, College of Teacher Training, the donor community, and private sector organizations over the past 14 years, this initiative also involved the development of digital content, software, and internet connectivity to widen the country's ICT skill base. Through this initiative, the number of teachers trained in ICT is around 4,000 and the number of teachers with basic ICT training is around 150,000. The number of teachers with International Computer Driving Licence training is around 100,000 or 45% of teachers.

D. Modernization of Curriculum and Teaching and Learning Resources

Bangladesh

The Bangladesh government's intention to build a computer literate nation is reflected in its different long-term development and planning documents. The role of ICT is emphasized in Vision 2021 to create an improved teaching and learning environment to empower and develop the proficiency of teachers and students.[25] A concerted effort to integrate ICT into the curriculum as a subject and as a means for learning has been made since 2010, following the adoption of the new National Education Policy 2010. One of the objectives of this education policy is to promote education in the area of "ICT and other related subjects (mathematics, science and English) to build a knowledge and technology based Bangladesh"[26] To achieve this objective, the government aspires to "make computer education mandatory from secondary level" and to "make the students acquainted with computer from primary level."[27]

Although the national development curriculum has emphasized ICT, most of the heads of educational institutions and management committees still fail to appreciate its importance. This is partly due to their lack of understanding about how ICT could change the country's education landscape. It may also be that the institutions need to ensure good results in the high-stake public examination, a summative assessment method that the national curriculum relies heavily on in Bangladesh. Therefore, the majority of the heads of

[24]   Government of Sri Lanka, Ministry of Finance and Planning, National Planning Department. 2013. *Unstoppable Sri Lanka 2020: Mahinda Chintana Vision for the Future.* Colombo.

[25]   Government of Bangladesh, Ministry of Planning, Planning Commission. 2010. *Perspective Plan of Bangladesh 2010–2021.* Dhaka.

[26]   Government of Bangladesh, Ministry of Education. 2010a. *National Education Policy.* Dhaka (page 2).

[27]   Government of Bangladesh, Ministry of Education. 2010. National Education Policy 2010. Dhaka (page 12).

educational institutions perceive the government's current endeavor to promote the use of ICT in education as just another public agenda that the government will forget about in no time.

Nepal

To familiarize students with computers and technology systems, the CDC has been developed. The main objective behind introducing computer-oriented subjects in school was to build students' knowledge, skills, and competency in computers and technology so that they can contribute to the country's development in the future. As a personal development, students can at the same time build self-confidence and gain the ability to apply technology-based knowledge toward meaningful employment.

However, the curriculum has not been updated since it was first designed in 2007, and much of the content is outdated and lacks the latest technologies that students are most likely to encounter in their daily lives. Although the assessment is supposed to be half on theoretical content and half on practical work, most of the schools lack computer facilities and infrastructure for students to engage in practical project work. Even schools that do have computer facilities simply do not have enough machines to give students ample time to work on projects. With the lack of qualified teachers, computer facilities, and updated curriculum, most students are limited to reading books about computers and programming, and memorizing the content of the books before the exam.

Sri Lanka

The national curriculum in Sri Lanka has been able to offer ICT courses to GCE O/L and advanced level (A/L) students and a general information technology (GIT) course to A/L students. As in other subjects, ICT is taught in three languages (Sinhala, Tamil, and English) and technical terms are in English.

The 8-unit[28] ICT courses, being offered in grades 10 and 11, have five objectives: (i) impart basic computer literacy and develop a base for further studies in ICT, (ii) develop understanding of the use of different types of ICT applications and the effects of their use, (iii) develop the concepts and principles related to ICT, (iv) improve the skills necessary for the development of ICT-based solutions for real-world problems, and (v) create an awareness of the benefits and problems of ICT use.

Introduced in 2004, GIT, on the other hand, is taught only in Grade 12 (first-year GCE A/L) to students following any stream of studies, for two periods per week. GIT emphasizes computer applications for day-to-day work, promotes appreciation of the role of ICT in

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[28] Government of Bangladesh, Ministry of Education. 2010a. *National Education Policy.* Dhaka (pages 12 and 31. Unit 1: Fundamentals of ICT (theory 10 hours and 3 hours practical), Unit 2: Data Representation and Internal Operation of the Computer (theory 11 hours and 2 hours practical), Unit 3: Generic Software (theory 8 hours and 44 hours practical), Unit 4: Information Systems (theory 26 hours and no practical), Unit 5: Programming Concepts (theory 17 hours and 35 hours practical), Unit 6: Website Development (theory 8 hours and 18 hours practical), Unit 7: ICT and Society (theory 13 hours and no practical), and Unit 8: Group Project (theory 13 hours and required practical hours).

development and the use of ICT tools with due respect to ethical and social norms. The GIT syllabus is designed to develop 10 competencies in ICT education.[29]

E. Improvements in Learning Environment: Bangladesh, Sri Lanka, and Nepal

The education sector in all three South Asian countries is still dominated by the conventional learning environments where students meet in structured classrooms at specified times, where teachers cover standard content by lecturing in front of a large class while students listen and take notes, work individually, and reproduce this knowledge on assessments. Although the governments of the three countries are planning or have already started programs to change the teaching and learning system of each of the three countries, there are hindering weaknesses that need to be addressed within a well-coordinated and continuing reform agenda. Below-average performance in subjects like mathematics and science, low competence in English, less exposure to ICT, unequal distribution of resources between the center and periphery, and poor maintenance of existing infrastructure are some of the major needs that should be addressed in a more coherent manner.

ICT has been introduced to schools in recent years to transform teaching and learning and for better educational attainment. The existing body of evidence on the impact of such initiatives reveals both negative and positive impacts, leading to mixed views on the impact and effectiveness of ICT in education. ICT was also not conceived for education nor was it demanded by the teaching community. It originated outside of the educational system and may be perceived to be imposed upon the school system. As a result, integration of ICT in education is a highly difficult process in all three countries.

F. Improvements in Assessment and Examination

Bangladesh
In 2009, the format of "Creative Questions" was introduced in board examinations to assess students' mastery of a subject in both junior and senior secondary education in Bangladesh (Hossain 2009). This initiative received strong opposition from parents and teachers. Currently, the assessment process in Bangladesh can still be characterized as "summative" as opposed to "formative," meaning the goal of assessment is to determine if the teaching of a particular subject increased scholastic gain compared with no teaching. Such a situation results in discouragement of using ICT among teachers: as ICT would

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[29] If they set the above objectives, the contents of the syllabus are as follows: Unit 1: Explores the computer and its potential to reap timely benefits (11 periods); Unit 2: Uses information and communication efficiently and effectively in day-to-day life (2 periods); Unit 3: Uses internet efficiently and effectively to accesses and communicate information (3 periods); Unit 4: Uses computers efficiently and effectively with awareness of operating system (4 periods); Unit 5: Word processing software to create various types of documents (4 periods); Unit 6: Makes electronic presentations to enhance attractiveness (4 periods); Unit 7: Uses spreadsheet software to solve simple statistical problems and present findings (4 periods); Unit 8: Uses database management systems software to manage information (6 periods); Unit 9: Uses selected high-level language effectively to solve simple problems (14 periods); and Unit 10: Uses ICT effectively and efficiently to be successful in life (6 periods).

not immediately improve the result of exams, teachers are often apathetic or often even disapprove of the use of ICT in teaching.

Nepal

Assessments in schools are very much summative in nature, and students are under the pressure to perform in public examinations. In recent years, there have been discussions about the need to improve student assessment. One discussion is how assessment systems and tools have to change to make them more relevant and to measure the right performance and achievement metrics. The current assessment system is a rote-learning approach to education, and it does not test student problem-solving skills and critical thinking competencies. The second discussion is on how ICT could be leveraged to assess students better and in a continuous manner. Integrating assessment into the student learning management system will allow teachers to track student performance formatively.

Sri Lanka

There is still a strong emphasis on the public examination—GCE "O" and GCE "A" levels—in Sri Lanka. Examination performance at GCE "A" Levels serves as the basis for admission to the public universities. Only about 34% who complete Grade 13 get access to tertiary level courses. Although there have been attempts to introduced school-based assessments in secondary schools, the high-stake examinations are still the key driver of teaching and learning practices in schools. The ministry is in the process of rethinking the mode of assessment and identifying the role of ICT in this mode of assessment.

G. Improvements in Education Management Information System, including Evaluation and Research to Inform Evidenced-Based Planning and Resource Allocation

Bangladesh

Although no new monitoring framework or mechanism has been developed to ensure that multimedia classrooms are being utilized to their full potential, the Government of Bangladesh uses the existing inspection structure for this purpose. The current inspection team mainly consists of the district education officer and the *upazila* secondary education officer. They have been trained to monitor the use of the multimedia classroom for teaching and learning. For all practical purposes, it is the *upazila* secondary education officer who is responsible for monitoring the activities of several schools—about 35 schools each, on average.

Nepal

For ICT in education master plan, a national fund would be established with contributions from government development partners and the private sector to aid research and development activities of ICT-enabled teaching and learning. However, there is no existing mechanism in place to evaluate the use and impacts of ICT in education.

Sri Lanka

The cost of project interventions on ICT education has been very high in Sri Lanka over the past 14 years, and its progress needs to be assessed in terms of sector-wide coverage, learner performance, and socioeconomic impacts. This requires a good database on investment of ICT in education, rate of resource utilization, and learning outcomes. At present, this function is not carried out systematically in spite of some observations by key policy making bodies. For example, in 2004, the National Education Commission (NEC) stated that no reasonable impact assessment has been done since the first computer was introduced into the education system. Inspection and progress monitoring at the school level is also unsatisfactory. The only census on computer literacy of school academic staff (Department of Census and Statistics 2006) needs to be repeated to measure the progress achieved from 2006 to 2014.

Besides evaluation of the cost-effectiveness, the entire system of supervision on the quality of ICT education in Sri Lanka is also unsatisfactory. Supervision of ICT subjects by district education officers and internal supervision at the school level is inadequate (Senaka 2007). As viewed by ICT teachers, inspection of ICT teaching by the principals or other officials has been taking place at the minimum level.

IV. LESSONS LEARNED AND PLANNING FOR INFORMATION AND COMMUNICATION TECHNOLOGY IN EDUCATION IN BANGLADESH, NEPAL, AND SRI LANKA

A close examination of dimensions of the holistic approach to information and communication technology (ICT) in education and the stages of ICT in education highlights the areas in which Bangladesh, Nepal, and Sri Lanka are progressing well, as well as the areas in which the development and implementation of policies can be improved. It also reveals that the challenges of ICT in education in these countries are associated with the unbalanced approach to ICT, as well as a lack of alignment and coordination between dimensions presented in Ra, Chin, and Lim's (2016) framework. To this end, the following recommendations are proposed:

A. Better Coordination of Information and Communication Technology in Education Initiatives and Efforts within the Education Sector and with Other Sectors

The use of ICT in education requires coordination of ICT in education efforts between multiple ministries and governmental bodies, which have proven to be difficult in all three countries. This coordination could be made possible by the development of the national ICT in education master plan that considers the 10 dimensions as discussed above. For example, partnerships could be better coordinated at the system level to ensure that they do not compete with or duplicate efforts to support ICT in education; these partnership efforts should complement one another. When partnership efforts are well-coordinated, small-scale but successful initiatives or projects could be scaled up nationwide.

However, having a national ICT in education master plan may not always address the coordination issues. Nepal has an ICT in education master plan, but could not align its current investment in ICT in education with the master plan developed by the Ministry of Education. For example, the budgets for ICT in education over the past few years have heavily favored procurement of computers, with very little going toward content development, training, and capacity development. This has not changed even though ICT in education master plan has emphasized the need for investment in these areas, an

implementation issue that is inherent among the three countries. Therefore, a national ICT in education master plan may be necessary for better coordination of the different ICT in education initiatives and efforts; a sufficient condition would be for the actual implementation to be well-aligned to the master plan.

B. Better Technical Support for Teachers as They Use Information and Communication Technology for Teaching and Learning

There is a lack of technical support available for teachers who face problems in using ICT in their teaching. Many teachers in Bangladesh reported that they were not sure where to go for help when something goes wrong with the computer or the projector they were using. Even though they have been trained to use these hardware, most teachers did not have the competencies to repair the hardware. They also did not know if they would be forced to replace hardware damaged while using them in the classroom. This lack of clarity was a major concern to them as a laptop or a projector on average would cost about two months of their salary. An assistant programmer is provided by the Bangladesh Computer Council to the schools that have a computer lab. However, this programmer is not under the administrative jurisdiction of the Ministry of Education, and hence is not accountable to the school heads. As a result, absentee rate among these ICT support staff is high. This lack of accountability of the ICT support staff to the schools may stem from the issue of coordination between different government bodies.

In Nepal, schools that are located away from the district centers and urban areas do not have technical support that could assist in installation and maintenance of the hardware. Since most schools do not have teachers with the technical competencies, they have to rely on outside help even for basic maintenance and support. The ministries of education for Bangladesh, Nepal, and Sri Lanka may consider providing each school or each cluster of schools with an ICT support staff. The installation and maintenance of the hardware could be carried in partnership with technical and vocational institutions, private sector or nongovernment organizations. Therefore, technical support has to be provided for teachers and schools as they use ICT to enhance the quality of teaching and learning.

C. Just-in-Time and Differentiated Information and Communication Technology in Education Professional Learning for Teachers in Schools

Although Bangladesh, Nepal, and Sri Lanka have invested in ICT in education professional learning of teachers in schools, many teachers could not apply what they have learned in their real-world experiences of using ICT for teaching and learning. This may be due to the time lapse between the professional learning and the use of ICT, the lack of relevance of the professional learning with respect to the context of ICT use in schools, and a one-size-fits-all professional learning program. Instead of just-in-case professional learning, teachers

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could be provided with professional learning support as they learn by doing when using ICT in their schools; when professional learning is just-in-time, teachers are more likely to find the professional learning experience meaningful as they could see the impact of their professional learning on their ICT-enabled teaching and learning practices. Besides just-in-time learning, there is a need for the professional learning program to meet the different professional learning needs of teachers and, hence, a differentiated professional learning program/pathway.

D. Better Pedagogical Support for Teachers Using Information and Communication Technology for Teaching and Learning

Professional development of teachers is an important ICT in education dimension. However, capacity takes time to be built and may be more appropriate as a medium- to long-term strategy for schools. A short-term strategy may be to provide the pedagogical support for teachers using ICT for teaching and learning. This pedagogical support may include scripted ICT-enabled teaching and learning activities (detailed lesson plans) where teachers will be guided to implement the ICT-enabled lessons or activities. They could be provided with more personalized support from an off-site helpdesk via SMS and mobile communication applications (e.g., WhatsApp). Although teachers may be following the script initially, their capacity for implementing ICT-enabled lessons will be developed from the middle to long term as they learn by doing.

E. Localized and Customized Intelligent Tutoring System, Video-Recorded Lessons, and Information and Communication Technology-Mediated Resources

Intelligent tutoring systems (ITSs) are ICT-based learning environments that make use of artificial intelligence to provide learners with finely tuned learning experiences that cater to individual needs (Woolf 2010). Built into intelligent tutors are a representation of expert knowledge of the domain of interest, a model of the student's knowledge that is updated with every student transaction, a pedagogical model that determines what teaching approach to use under different circumstances, and a user interface with which the learner interacts (Stern, Beck, and Woolf 1996; Woolf 2010). Ideally, when a student reaches an impasse, the system could provide students with alternative explanations, learning paths, and resource materials that will lead the student to the learning goal. Its pedagogical affordances aside, the use of ITSs has also been motivated by a desire to increase internal efficiency by addressing the problem of insufficient and insufficiently trained teachers, an issue that is common in all three countries. This issue is even more pertinent in rural, remote, and low socioeconomic schools within each of the country.

A recent meta analysis of research on the impact of ITSs deployed at the secondary and post-secondary levels on learning outcomes (Ma et al. 2014) suggests that the use of ITSs is more effective than teacher-led, large group instruction, non-ITS computer-assisted instruction, and the use of textbooks or workbooks, while just as effective as individualized or small-group instruction with a competent human teacher. ITSs could provide the access to quality education that students from disadvantaged schools would otherwise be denied of, quality of a set of pedagogically sound content. It could be used as a whole-class, small group or one-to-one approach with teachers from these disadvantaged schools as a guide and a facilitator. However, successful use of ITSs requires more careful attention to learning goals, design, and integration.

ITSs in the three countries could be developed in the following ways: (i) a mature ITS developed in and for a developed country is introduced and localized in the developing country, (ii) a homegrown ITS developed in and for a developing country targeted at local or national needs, and (iii) an ITS developed in a developed country for developing countries (Nye 2013). This ITSs development process is applicable for the video-recorded lessons and ICT-mediated resources.

F. Monitoring and Evaluation of Information and Communication Technology Use in Schools

Although the governments of Bangladesh, Nepal, and Sri Lanka have been equipping their schools with ICT infrastructure and hardware, interviews with education stakeholders (students, teachers, and parents) have highlighted the lack of use of these infrastructures and hardware and their lack of impact to teaching and learning in schools. During unscheduled visits to a number of schools in Bangladesh, it was found that unused laptops are stored in a cabinet, projectors have not been used, computer labs have been locked for months, and the assistant programmer provided by the Bangladesh Computer Council was absent. Under these circumstances, a national, provincial, or district arrangement for systematic monitoring and consultation becomes very important. Unfortunately, the current inspection and monitoring mechanism is inadequate and could not evaluate and identify the factors that facilitate and hinder the use of the existing ICT infrastructure, hardware, and ICT-mediated resources by teachers and students.

V. CONCLUSION AND RECOMMENDATIONS

Information and communication technology (ICT) offers the education sector the opportunities to enhance its equity, quality, and efficiency. To take up these opportunities, policy makers often thought that to simply equip schools with computers and train teachers in their use would prepare pupils for the demands of the 21st century. The reality, however, is that simply providing access to ICT is not going to enhance the reach and quality of teaching and learning. As such, this paper started with the notion that considerations of taking up opportunities offered by ICT are beyond the introduction of ICT per se. Utilizing Ra, Chin, and Lim's (2016) framework of holistic approach to ICT in education as the lens, this paper assesses the state of ICT in education of three countries in South Asia (Bangladesh, Nepal, and Sri Lanka) based on United Nations Educational, Scientific and Cultural Organization's four stages of ICT in education (UNESCO 2005).

The review findings show variances in the priority areas and development levels of ICT in education among Bangladesh, Nepal, and Sri Lanka, mainly due to their unique national contexts. The evaluation also suggests that many ICT initiatives in these countries are undertaken without paying adequate attention to the required ICT ecosystem in which they work. As an ICT ecosystem would require a good deal of resources and human capital, the scope and sequence of initiatives must be prioritized when addressing equity, quality, and efficiency issues of education with ICT. In addition, policy makers have to be aware of how ICT can be of best value in their own country's education system, and need to develop a supportive policy environment and framework at the national level for the integration of ICT into their education systems. As such, governments of these three countries should adopt a sequential approach with clear milestones to achieve in different years. A master plan with identified actions for short-term and medium- to long-term impacts on the use of ICT in education could be adopted as a driving force, although it may not always address the coordination issues. Moreover, as the implementation of the master plan and policies would require coordinated action in different areas of the education system, policy-dialogue needs to be taken between stakeholders for working together. To achieve this, this paper has provided six key recommendations for improving ICT in education in the three countries:

 (i) better coordination of ICT in education initiatives and efforts within the education sector and with other sectors;

 (ii) better technical support for teachers as they use ICT for teaching and learning;

 (iii) just-in-time and differentiated ICT in education professional learning for teachers in schools;

 (iv) better pedagogical support for teachers using ICT for teaching and learning;

    (v)   localized and customized intelligent tutoring system, video-recorded lessons, and ICT-mediated resources; and

    (vi) monitoring and evaluation of ICT use in schools.

A final and perhaps most important note is that, while learning others' experience for inspiration when making plans to implement ICT in education, no nation should simply "copy-and-paste," but create its own particular path for development. With continuous efforts, countries in South Asia will ultimately move toward an ICT-enabled teaching and learning environment that supports the existence and growth of a knowledge-based society.

APPENDIX 1: INFORMATION AND COMMUNICATION TECHNOLOGY IN EDUCATION IN BANGLADESH

A. Background

1. Current Situation of Information and Communication Technology in Bangladesh

Bangladesh has a countrywide telecommunications backbone network, both optical fiber and wireless. The mobile phone operators, Bangladesh Telecommunications, Bangladesh Railway, the public switched telephone network, and nationwide telecommunication transmission network operators are the key players in the telecom sector. According to the technical data available on the Bangladesh Telecommunications website, all districts, 478 *upazilas* (subdistricts), and 108 union *parishads* of the country are now connected through a fiber network.[1]

In addition to the mobile operators, two wireless broadband (WiMax) providers are also rolling out their backbone or shared network infrastructure from other operators. To avoid the unnecessary duplication of fiber backbone and other telecom infrastructure and to help create a cost-effective system, the Bangladesh Telecommunication Regulatory Commission has issued Infrastructure Sharing Guidelines, and the operators are now sharing their passive infrastructure and leasing out spare capacity to other operators. Bangladesh has already moved from internet protocol version 4 (IPv4) to IPv6.

In addition to the state-owned South East Asia–Middle East–Western Europe (SEA-ME-WE)-4 undersea cable, the installation of a second undersea cable, SEA-ME-WE-5, by the private sector is in the process. Although initially expected to be completed by 2014, the installation will be delayed by 1 year. The service providers of the consortium, mainly SingTel and China Telecom, are handling two cables, SEA-ME-WE-5 and Asia-Africa-Europe (AAE)-1, at the same time. This has caused the delay in the installation of the former.

In terms of e-readiness, Bangladesh is significantly lagging behind the global leader, albeit the situation has been improving over time according to United Nations e-Government Readiness Surveys.[2] In 2005, Bangladesh ranked 162th globally—last among the South Asian countries—in terms of e-readiness. In 2012, it ranked 150th globally and 4th among the seven South Asian countries.

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[1] Union parishads or union councils or rural councils are the smallest rural government units in Bangladesh. It is composed of a chairperson and and about 12 members.

[2] United Nations Department of Economic and Social Affairs. 2012. *United Nations E-government Survey 2012: E-Government for the People.* New York.

The population of people with land phones in Bangladesh doubled from 2000 to 2011, increasing from 0.5 million to about 1.0 million. During the same period, the number of mobile phone users has increased from 0.3 million to about 84.4 million. The number of people using wired internet services has increased from 0.06 million in 2000 to about 1.20 million in 2011. The percentage of the population using the internet, both wired and non-wired, has increased at a notably faster rate since 2006 (Figure A1.1). In 2011, 5% of the country's population used the internet. The share was only 0.07% in 2000.

Figure A1.1: Internet Users as Percentage of Total Population in Bangladesh, 2000–2011
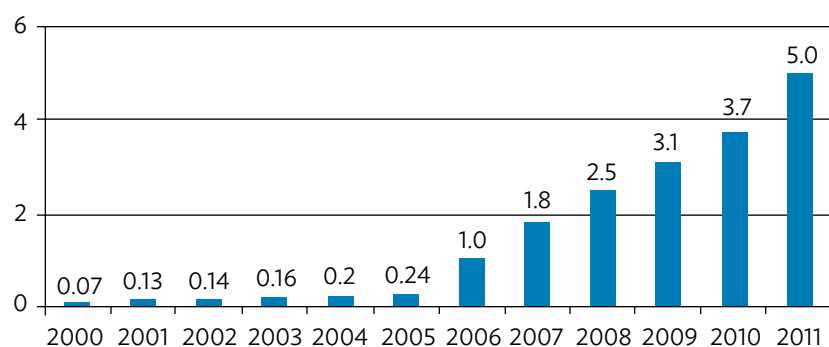
Source: World Telecommunication/ICT Indicators Database.

According to the latest information provided by the Bangladesh Telecommunication Regulatory Commission, the number of mobile subscribers has crossed the 100 million mark, reaching about 103 million in May 2013. The subscriber base was about 90 million in April 2012, when the mobile penetration was 61.8%. With the present subscriber base, mobile penetration has increased to 66.4%.[3]

Although internet penetration has been increasing rapidly in Bangladesh, a clear digital divide is observed in terms of access to information and communication technology (ICT) by different groups. Three distinct groups can be identified on the basis of access to ICT in Bangladesh:

(i)   ICT natives—urban students belonging to high-income groups;
(ii) ICT immigrants—academics, professionals, and university students; and
(iii) ICT-alienated groups—underserved children, especially those living in the rural areas with no knowledge about ICT.

The 2005 and 2010 Household Expenditure and Income Surveys, a nationally representative survey conducted by the Bangladesh Bureau of Statistics, indicate that access to the internet significantly varies across households, regions, and income groups. Use of landline phones slightly declined from 2005 and 2010, while use of mobile phones

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[3]   Bangladesh Telecommunication Regulatory Commission. www.btrc.gov.bd/index.php?option=com_conte ntandview=articleandid=738:mobile-phone-subscribers-in-bangladesh-january-2012andcatid=49:telco-newsandItemid=502 (accessed 10 July 2013).

significantly increased during the same period, from 11.3% of total households in 2005 to 63.7% in 2011.However, the rural–urban gap in use of phone and computers increased during the same period.

Figure A1.2 shows Lorenz-type curves for national, urban, and rural households with a computer. The vertical axis shows the cumulative percentage share of households with a computer, and the horizontal axis shows cumulative distribution of households by different income groups. About half of rural households with a computer have a monthly income of more than Tk12,500. However, half of urban households with a computer have a monthly income of more than Tk20,000.

Figure A1.2: Households with Computer, by Income

Source: Household Income and Expenditure Survey 2010, Bangladesh Bureau of Statistics.
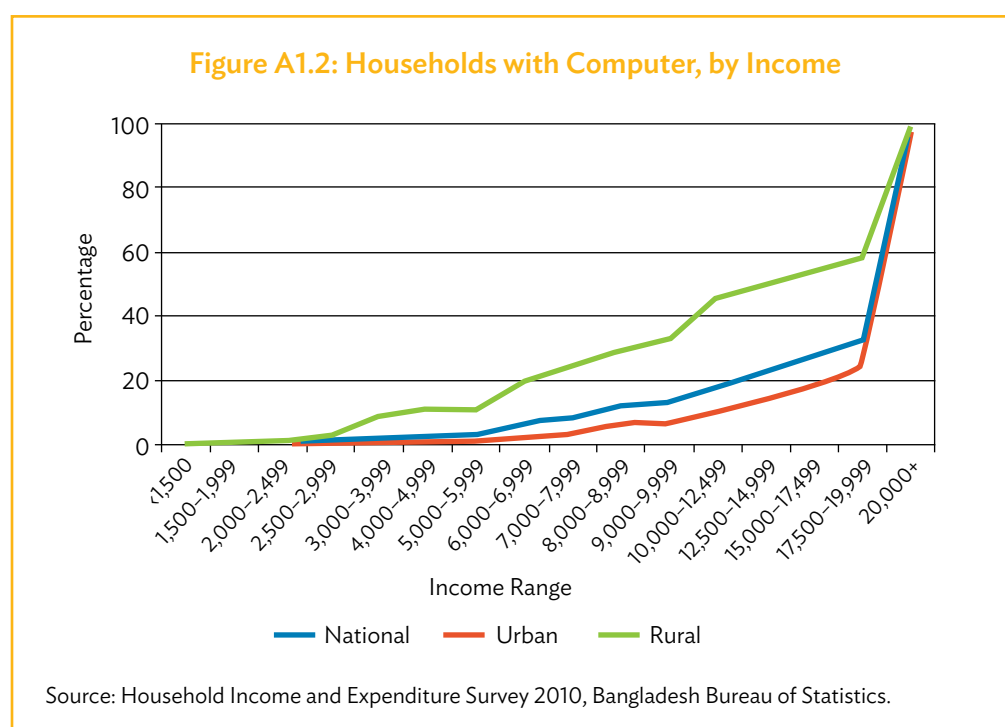
To avoid further increase of the digital divide, the Government of Bangladesh has established union information and service centers in 4,516 of the country's 4,545 union *parishads*. About 2,773 of these centers provide mobile banking service and 2,064 provide life insurance services. People from all strata of society have access to these centers and seek advice from fellow members, the number of which has already exceeded 13,500.[4] To provide different services in a timely, efficient, and cost-effective manner, the government has introduced an e-service center in each district office. The government has also introduced an electronic system so that people can collect digitized copies of land-related records and documents. To introduce a one-stop service center where one can get all services provided by public offices at different levels, the government has piloted a national e-service system in 240 public offices in Jessore, one of the 64 districts of the country.

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[4]   These are information centers where people can go online since not everyone can use the internet. People seek advice on a wide range of issues from those who use the internet.

When compared with the other South Asian countries, Bangladesh appears to have the second-highest cost of internet in the region. On average, the monthly internet cost in Bangladesh is about five times higher than Sri Lanka, and three times higher than Nepal. The only South Asian country where internet costs more than Bangladesh is the Maldives. Although a number of private providers are operating in Bangladesh, competition among them has so far failed to reduce the cost of internet service, probably indicating the existence of a cartel among them.

2. Information and Communication Technology Policies and Plans in Bangladesh

Bangladesh is striving to create an environment to ensure access to ICT by people from all strata of society. In its National Strategy for Accelerated Poverty Reduction 2009, ICT was given due importance as a key development enabler and poverty alleviator. With the Digital Bangladesh platform of the current government, the country has reinvigorated its ICT-related activities. Historically, the government has supported initiatives like the National ICT Task Force headed by the Prime Minister. There are also institutional structures and support for ICT development, including the Ministry of Science and ICT, the Bangladesh Computer Council, and industry associations such as the Bangladesh Association of Software and Information Services and Bangladesh Computer Samity.

A revised national ICT policy was formulated and accepted in 2009. This provides a road map for the development of ICT in the country. Moreover, a set of "ICT for development" targets developed by the World Summit on the Information Society for building an inclusive information society was endorsed by Bangladesh. The National ICT Policy 2009 is structured as a hierarchical pyramid with a single vision, 10 broad objectives, 56 strategic themes, and 306 action themes. The vision and objectives are aligned with the general national goals, while the strategic themes are areas within the broad objectives that can promote the use of ICT.

The vision of the National ICT Policy 2009 is to expand and diversify the use of ICT to establish a transparent, responsive, and accountable government; develop skilled human resources; enhance social equity; ensure cost-effective delivery of citizen services through public–private partnerships; and support the national goal of becoming a middle-income country by 2021 and joining the ranks of developed countries within 30 years. Given the growing digital divide across regions and income groups, the ICT Policy 2009 also focused on striking the right balance between equity and growth in the implementation plan.

The country's Sixth Five-Year plan incorporated some specific targets to implement the digital road map of the country, including:

- establishment of a high-technology park, information technology (IT) and biotechnology incubator, IT village and software park, and community e-center in suitable locations of the country;
- establishment of unique educational and recreational facilities, such as a tilted dome planetarium and digital pavilion for making people conscious of science and ICT;
- strengthening regional and subregional cooperation with South Asian Association for Regional Cooperation countries and with other science and ICT organizations for better cooperation and bilateral relations;

- training of scientists, technologists, and ICT personnel in selected fields at postgraduate levels in centers of excellence at home and abroad on a massive scale; and
- linking the remuneration packages for scientists, technologists, and ICT experts to their individual productivity and potential.[5]

3. Policy Focus on the Use of Information and Communication Technology in Education

a. Education Policy 2010

The government, with its newly formulated Education Policy 2010, is contemplating building an education system that develops students as fit candidates to survive and thrive in the 21st century and a framework of educational governance that ensures this. The main visions of the new education policy are:

(i)   to ensure a productive 21st-century ready workforce;
(ii) to reform curriculum, pedagogy, and teacher's capacity building to ensure education for all;
(iii) to ensure transparency, efficiency, and effectiveness at all levels of educational administration; and
(iv) to secure accountability and involve real stakeholders in policy making.

The National Education Policy 2010 emphasizes the use of ICT to improve the quality of education. The government plans to make ICT a compulsory subject at the secondary level by 2013 and at the primary level by 2021. Out of 306 action items of ICT Policy 2009, 53 focus on human resource development. The National Strategy for Accelerated Poverty Reduction also recognizes the need to improve the country's knowledge base using education, training, and research, and emphasizes the importance of ICT as an invaluable enabler toward achieving this objective.

To accomplish the envisioned goal in the National Education Policy 2010, the government chalked out a plan identifying the following strategic priorities:

(i)   promotion of ICT-enabled teaching and learning,
(ii) promotion of professional development of teachers using ICT,
(iii) promotion of ICT literacy for students,
(iv) promotion of ICT-enabled education-related citizen services, and
(v)   use of ICT in education administration.

b. Access to Information Program

The Access to Information program (A2I), instituted within the Prime Minister's Office, is the central hub for facilitation and oversight of the implementation of ICT related-activities. The key strategic priorities identified for action by A2I (2010) are:

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[5]   Government of Bangladesh, Ministry of Planning, Planning Commission. 2011. *The Sixth Five Year Plan 2011-2015.* Dhaka.

(i)   Enhance domestic and international connectivity.
  (a) The government will expedite the process of having the second and even a third submarine cable connection to ensure redundancy and reliability in nationwide internet connectivity.
  (b) The government will take the initiative to reduce the price of bandwidth, which will increase the number of internet users, enhance demand for local content and applications, and give an additional boost toward the development of a connected Bangladesh.
  (c) The Rural Telecommunications Network Development and Utilization Guideline 2010, drafted by the Domestic Network Coordination Committee with Bangladesh Telecommunication Regulatory Commission secretariat, will be implemented soon to make sure that the existing network infrastructures have been optimally utilized for commercial communication and key social services (e.g., education, health care, and e-governance).

(ii) Expand telecommunication services.
  (a) The government will revisit taxation policy for the mobile telecommunication industry to create incentives for reaching out to the poor rural population.
  (b) The government will accelerate the process of introducing new technology (e.g., 3G, 4G, long-term evolution) in the mobile telecom segment through a transparent licensing system.

(iii) Enhance access to broadband.
  (a) A national information infrastructure plan will be developed.
  (b) The government will initiate programs for resource mobilization so that every citizen will have effective access to information and services through various channels.
  (c) The government will develop appropriate incentives for service providers using mobile telecommunications and internet through regulatory arrangement and other mechanisms, geared toward finding innovative solutions and protecting the providers' investments.
  (d) The government will promote public–private partnership for launching various e-services, particularly those targeting rural and marginalized populations in the areas of health, education, employment creation, and human rights.

(iv) Enhance last-mile connectivity.
  (a) The government will invite the private sector and not-for-profit organizations to roll out broadband connectivity in rural areas. This could take the form of a partnership between the government, nongovernment organizations (NGOs), and private sector organizations for reaching the very last mile, where there is already a vibrant NGO presence. Here, local entrepreneurs will be encouraged to provide last-mile internet service to the community.

(v) Develop content and services.
  (a) Synergistic opportunities will be explored between diverse communication media (e.g., FM radio, satellite TV, cellular phone services) to disseminate

valuable information to the maximum number of people in the shortest possible time.

(b)   The government will provide support to the initiators of community radio for content. Community radio can emerge as another channel of last mile connectivity for the population.[6]

B. Analysis of Information and Communication Technology in Education in Bangladesh

This section reviews the ongoing initiatives—both private and public—and critically assesses the suitability of different elements of the education system to promote the use of ICT in teaching and learning,

Even though Bangladesh has decided to go global in almost all aspects of the economy, its education sector is still dominated by the traditional system where students meet in structured classrooms at specified times; teachers cover the standard content by lecturing in front of a large class, while students listen and take notes, work individually, and reproduce this knowledge on assessments. Very recently, the Government of Bangladesh started working to change the teaching and learning system of the country to achieve the world standard in terms of content and quality of education. According to Dwyer, Rinstaff, and Sandholtz (1991), there are five stages in the process of incorporating ICT in teaching and learning:

(i)   **Entry stage.** This is where the physical environment of learning starts to change with the introduction of ICT, yet the learning activities and supporting tools used remain relatively traditional (e.g., pen, paper, and books).

(ii)   **Adoption stage.** This is where various types of ICT are used, but for traditional learning activities (i.e., using new tools for old practices).

(iii) **Adaptation stage.** This is where ICT is used with increasing depth and breadth, and integrated into specific learning scenarios.

(iv)   **Appropriation stage.** This is where ICT is routinely used to transform pedagogical practices in a broader context (e.g., more extensive and frequent application of technology-enhanced collaborative learning).

(v)   **Invention stage.** This is where both physical environment and teachers' mind-sets about learning have been transformed and teachers are actively exploring and experimenting with new tools and activities to enhance learning effectiveness.

Currently, Bangladesh belongs to the entry stage as far as the use of ICT in education is concerned. But different public and private initiatives are underway at different levels of the education system to change the current situation. Different ongoing initiatives are described below.

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6   Government of Bangladesh, Prime Minister Office, A21. 2010. *Strategic Priorities of Digital Bangladesh,* 2010. Dhaka.

1. Government Initiatives at the Primary Level

Primary education in Bangladesh is managed by the Ministry of Primary and Mass Education. The Directorate of Primary Education has been implementing the Primary Education Development Program (PEDP) to promote the quality of primary education in the country. The third phase of this program (PEDP III) is currently ongoing. One of the main components of this project is promoting the use of ICT in primary education. Under this component, the government is providing two different types of ICT infrastructure at different primary schools. At least one multimedia classroom has been developed so far in 502 model primary schools, at least one selected from each *upazila*. A multimedia classroom is equipped with a computer, internet connection, projectors, and a sound system. About 15,000 primary schools have each received a laptop.

In addition to building this new infrastructure, teachers from these schools are trained on the use of ICT in teaching and learning. The primary teacher training institute provides the training logistics and venue, and the Prime Minister's Office, through A2I program, provides the trainers. There are 55 primary teacher training institutes in Bangladesh and each of them has at least three master trainers to train the primary school teachers on the effective use of multimedia in the classroom.

2. Government Initiatives at Postprimary Levels

As mentioned earlier, both government and NGOs work to promote the use of ICT in postprimary education. In the case of government initiatives, the Prime Minister's Office, the Ministry of Education, and the Bangladesh Computer Council are working together in partnership.

The A2I program under the Prime Minister's Office is responsible for developing and piloting new ideas to promote the use of ICT in education without resulting in any digital divide. Once a new idea is fully operationalized through piloting, the Ministry of Education can implement it in other schools by scaling up the operation to cover the whole country. The Bangladesh Computer Council provides the infrastructural and logistic support both to A2I and the Ministry of Education.

Government initiatives promote the use of ICT in education in postprimary level with the use of two newly developed interrelated endeavors. One of them is the multimedia classroom—classrooms equipped with ICT-supportive infrastructure—and development of digital content by teachers. The government has already converted one classroom into a multimedia classroom in 20,500 secondary and higher secondary academic institutions. Out of them, 15,200 are secondary and higher secondary schools and 5,300 are madrassas—institutions fully dedicated to the teaching of religious education. The criteria used to select them include whether the institution (i) has electricity, (ii) is accredited to provide an academic certificate, (iii) is public or private, and (iv) if private, whether it is included in the monthly pay order of the government. Each selected school received one laptop, one projector with screen, one pair of speakers, and one internet modem with connection.

Bangladesh has about 30,000 secondary and higher secondary academic institutions, out of which about 23,500 have an electricity connection. As a second phase of the ongoing initiatives, the government is now working to develop five multimedia classrooms in these 23,500 academic institutions. Although the Bangladesh Computer Council has already

developed a full-fledged computer lab in 3,214 schools on an experimental basis, the government aims to develop one computer lab in each school in the third phase.

In addition to building this infrastructural capacity, the Ministry of Education, with the help of A2I and the Bangladesh Computer Council, is also providing training to at least one teacher from each school that has the multimedia classroom. The country's 14 teacher training centers, its 4 higher secondary teacher training institutions, the Bangladesh Madrassa Teachers' Training Institute, and the National Academy for Education Management are imparting the training under the direct supervision of the Ministry of Education. To impart the training efficiently, 20 computer labs were established in each of the training institutes.

Acknowledging the fact that the teachers who would be using the multimedia classrooms can at best be characterized as migrants to the digital world. Their training curriculum includes everything from physical operation of a laptop and projector to contextualization of lessons by relating them to real life. Trained teachers are instructed to teach their colleagues after going back to school. The government is planning to impart a 3-day course to train the head of the academic institutions since their interest is one of the crucial determinants of the effective use of the multimedia classroom for education.

Although no new monitoring framework or mechanism has been developed to ensure that multimedia classrooms are being utilized to their full potential, the government uses the existing inspection structure for this purpose. The current inspection team mainly consists of the district education officer and the *upazila* secondary education officer. They have been trained to monitor the use of the multimedia classroom for teaching and learning. For all practical purposes, it is the upazila secondary education officer who is responsible for monitoring the activities of several schools—about 35 schools each, on average.

Complementing the provision of ICT infrastructure, the government has been training the teachers on how to develop and use digital content in teaching. So far, about 12,000 teachers from different secondary and higher secondary schools and madrassas have been trained on developing digital content. Half of them are identified as master trainers who are capable of training other teachers. The government also has developed an interactive and user-friendly web-based repository where teachers can share and store digital content they have created. The total number of items in this repository, named *Shikkhok Batayon,* has already exceeded 8,000.[7]

Anyone can be a member of *Shikkhok Batayan* and upload digital content. As of now, there is no quality control mechanism in place. However, when new content is uploaded by a teacher, other users rate it according to its usefulness and merit. Three content developers are selected for recognition every week on the basis of these ratings. Thus, the content uploaded in *Shikkhok Batayan* undergoes some level of peer review. The total number of active participants in *Shikkhok Batayan* has exceeded 13,000. One can choose digital content by using different drop-down bars. The first drop-down bar provides the option to choose by type of education: technical education, general education, or madrassa

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[7] *Shikkhok Batayan* or teachers' portal is a national portal for educational materials. It a common platform for all teachers in Bangladesh that enables them to develop and share the content they develop.

education. The second bar allows filtering by level (class) of education. The final drop-down bar provides the option to choose by subject.

The government has also developed another web-based platform, www.ebook.gov.bd, where the digital copy of all textbooks is made available. As of 2012, 300 textbooks and 100 auxiliary books were available in this portal. By using different drop-down bars, one can choose any chapter of the book. Currently, the books are stored in PDF format. Initiatives are underway to make them interactive so that, by double-clicking on a particular topic, one can get additional related information, images, and even videos.

The use of ICT has already resulted in some changes in the delivery of education-related citizen services in Bangladesh in recent years. A key milestone is the online publication of board examinations at all levels and all types of education since 2009. Simultaneously, they are also sent to people via short messaging service (SMS) and e-mailed to educational institutions. Similar to the board examinations, results of the teacher selection process have also started to be published on the web and distributed via SMS. Most of the higher secondary and tertiary level academic institutions have started an online admission process.

3. Nongovernment Initiatives

A number of nongovernment initiatives are currently underway to promote the use of ICT in education in Bangladesh. Different projects, programs, and initiatives undertaken by development partners, NGOs, and other organizations to promote the use of ICT in education in Bangladesh are listed in Table A1.1.

Table A1.1: Information and Communication Technology in Education Programs and Projects in Bangladesh

Project or Program	Target Outcome	Relevance to Use of ICT in Education	Main Strategies	What is Missing?	What Should Be Done?
Promoting Education for the Underprivileged in Bangladesh, Agami Foundation	Provide Khan Academy-based education to underprivileged students in Bangladesh.	Directly implement the much-acclaimed approach of the Khan Academy model, translated and customized to match the curriculum and teaching environment of Bangladesh.	Work directly at the school level by providing Khan Academy's video content translated into Bangla.	It is an ad hoc intervention without any active participation of other stakeholders.	This approach needs to be implemented in the mainstream education system to draw lessons for scaling up.
Secondary Education Investment, ADB	Improve inclusive participation in secondary education.	The proposed reform and ICT-oriented investment will play a significant catalytic role to promote the use of ICT in education.	Phased implementation of reform to modernize curriculum, examinations, and teacher development. Extensive investment in ICT-based teaching facilities.	There is no clear alignment between ICT-based teaching and proposed modernization of curriculum and student evaluation method.	The proposed reform should be aligned with the requirement to create an enabling environment to promote ICT in education.

Table A1.1 *continued*

Project or Program	Target Outcome	Relevance to Use of ICT in Education	Main Strategies	What is Missing?	What Should Be Done?
Preparing Rural ICT Connectivity, ADB	Make accessible, affordable, inclusive, sustainable, and useful ICT connectivity available in rural areas of Bangladesh.	The proposed provision of reliable high-speed internet coverage to rural schools will help promote the use of ICT in education.	Study and analyze the overall cross-operators' network countrywide, and identify the suitable design for ADB financing.	Use of ICT in education is a specific development objective of this project.	Particular attention should be given to academic institutions' needs.
Leveraging ICT for governance, growth, and employment, World Bank	Catalyze the growth of Bangladesh's ITES industry and establish basic e-government foundations.	The proposed training on IT and ITES are expected to eventually indirectly incentivize relevant stakeholders to use ICT in education.	Provide top-up training to science graduates for IT service segments, foundational training for ITES segment, and middle management training. Provide critical e-governance technological foundations for country's governance agenda for the years ahead.	No direct focus on modernization of education sector to yield graduates suitable for the promotion of IT/ITES industry in Bangladesh.	Use of ICT in education should be included as a component of this project at school level.
Computer-aided learning, BRAC	Make teaching and learning interesting, increase student involvement and peer learning through group work, provide computer literacy to teachers and students.	This project uses computer-aided teaching techniques involving CDs containing teaching materials aligned with national curriculum.	Computer-aided learning materials include content in science, mathematics, and English. At least 10 teachers from each school, including three teachers in each core subject and the head teacher, are trained to effectively use technology-aided pedagogy in classrooms.	This is not based on a holistic approach. It is more of a replacement of blackboards with computers and multimedia projectors.	The project should be modified to make teachers transition from knowledge providers to knowledge facilitators.
Computer Literacy Program, Dnet	Promote the knowledge and usage of computers among underprivileged students in rural Bangladesh and minimize the digital divide that exists between people from different classes and social contexts in rural and urban areas.	Teach mathematics, English, and geography, by using computer and digital content.	Establish computer learning centers in different rural schools. Provide each center with some basic ICT infrastructure and 1 year of free internet. Teachers are trained on ICT and given a teacher's manual.	Under this intervention, teachers remain the main providers of knowledge; only the instrument of teaching changed. While this makes their teaching more interesting to students, they are yet to graduate from provider to facilitator.	This piece-by-piece approach needs to be replaced by a holistic approach.

Table A1.1 *continued*

Project or Program	Target Outcome	Relevance to Use of ICT in Education	Main Strategies	What is Missing?	What Should Be Done?
Learning from E-Learning: Testing Intelligent Learning Systems in South Asian Countries, ADB	Introduce new strategies and technological innovations that lead to improved learning outcomes.	This pilot introduces ICT-based math learning in selected schools.	Provide customized and translated Khan Academy video tutorials on math to selected schools and train teachers on their use. Introduce web-based e-learning in math by using MathCloud.	While the project provides the software, its use is constrained by lack of appropriate ICT infrastructure.	This initiative should be preceded by provision of required ICT infrastructure.

ADB = Asian Development Bank, BRAC = Building Resources Across Communities, CD = compact disc, ICT = information and communication technology, IT = information technology, ITES = IT/Information Technology Enabled Services.

Source: Asian Development Bank.

4. Factors Affecting the Promotion of Use of Information and Communication Technology in Education

a. Stakeholders' Outlook on ICT in Education

Past experiences suggest that introduction of any new technology in Bangladesh is received in three different phases. The first phase is characterized by fear and suspicion. In the second phase it is accepted passively, and in the third phase it is appreciated and used widely. Currently, Bangladesh is in the first phase in regard to the use of ICT in education, where many teachers are afraid of it and parents are suspicious.

Peggy Ertmer (1999) classified barriers that teacher face in using ICT in the classroom into two categories: (i) extrinsic barriers, which are first-order barriers that result from inadequate and/or inappropriate configuration of ICT infrastructure, including access, time, support, resources, and training; and (ii) intrinsic barriers, which are second-order barriers related to teachers' personal experience and awareness, including attitudes, beliefs, practices, and resistance. While different public and private initiatives reduce the extrinsic barriers to a limited extent, the intrinsic barriers continue to affect the use of ICT in education.

A focus group discussion with teachers from different schools and interviews with some others revealed that most of them do not use ICT in their teaching. In many cases, the laptops and computers are just kept on the shelf. Most of the teachers acknowledged that the use of ICT as a medium of teaching and learning has the potential to be highly rewarding. But, at the same time, they felt that the use of ICT would require too much time to prepare the teaching materials and that school management is not appreciative of such efforts. In addition to their allocated teaching load, teachers also carry out a number of curriculum-related and other administrative responsibilities. In such an environment, teachers are not very enthusiastic about using ICT in teaching and learning.

b. Current Curriculum

The current curriculum in Bangladesh is evaluated on three dimensions: intended, implemented, and achieved. Intended curriculum refers to the curriculum described in terms of achievement targets. Implemented curriculum refers to the educational processes happening in the system to create learning opportunities for students. Finally, achieved curriculum refers to student outcomes. They are evaluated from the viewpoint of three concentric levels: macro (community), meso (school), and micro (classroom). These levels are mutually interacting and the boundaries between them are not distinct (Kozma 1999).

Macro context. The government's intention to build a computer literate nation is reflected in its different long-term development and planning documents. The role of ICT is emphasized in Vision 2021[8] to create an improved teaching and learning environment to empower and develop the proficiency of teachers and students. A concerted effort to integrate ICT into the curriculum as a subject and as a means for learning has been made since 2010, following the adoption of the new National Education Policy 2010.

The main stakeholders who lay out the vision for education and translate it into action at the macro level in Bangladesh are guided by what is called the "transmission view of learning" in the literature. This teaching philosophy perceives education as a process where students will learn facts and concepts and gain understanding by absorbing the content of their teacher's explanations from a text and answering related questions. When asked for their views about the transformation of teachers from knowledge providers to learning facilitators, many parents and headmasters opined that knowledge should be acquired by students through guided and repetitive practice, in a systematic and highly prescribed fashion conducted by the teacher in the classroom. Given this attitude by the clientele whom the teachers serve, there is no adequate incentive for any teacher to walk the extra mile to use ICT in teaching. This is a big challenge in promoting the use of ICT in education in Bangladesh.

Meso context. The main stakeholders at the meso level are the heads of institutions and management committees. While these stakeholders are very concerned about the academic performance of their institutions, when it comes to the use of ICT in teaching, they are simply the passive recipients of public resources and lack enthusiasm to make the best out of it. A number of factors have emerged as reasons for their lack of enthusiasm.

The main concern of the heads of the academic institutions and management committees is to ensure good results in the public examination. The country's education system currently relies on summative assessment, where the goal is to provide information about the end product of learning: Did the student meet the required standard? The goal of the assessment is not to improve the learning environment; rather, it is to determine whether the learning environment increased scholastic gains compared with no instruction. Given the nature of the assessment, the use of ICT in teaching is not perceived to contribute to good results in any public examination.

Almost all public and private educational institutions in the country either are at breakeven or suffer from a lack of human resources. Allegedly, most teachers are already

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8   Government of Bangladesh. Planning Commission, Ministry of Planning. 2009. *Perspective Plan of Bangladesh 2010–2021*. Dhaka.

overburdened and find the current teaching load too much for them. The use of ICT as an educational aid or its introduction as a subject would mean diversion of teachers' already-limited time from teaching students. This perceived high opportunity cost is mentioned by many of the heads of the educational institutions and managing committees as the main reason for their lack of enthusiasm to facilitate ICT either as a course or a means of education.

Most educational institutions, especially those located outside big cities, seriously lack the needed physical capacity. They suffer from a shortage of classrooms and essential laboratories for mandatory science classes. It is very difficult to manage a physical space to house a computer lab without affecting some other services.

Although the national development vision has emphasized ICT, most of the heads of educational institutions and management committees still fail to appreciate its importance. This is partly due to their myopia and partly due to their lack of understanding about how ICT can change the whole landscape of the country's education system in the near future. About 75% of the heads of educational institutions perceive the government's current endeavor to promote the use of ICT in education as just another public agenda that the government will forget about in no time.

For the purpose of this study, a group of parents and guardians of students from different schools were consulted to assess their views and support for the use of ICT in classrooms currently being attended by their children. The findings were not very encouraging. Most of them disapprove of the use of ICT in classrooms as they were not very clear what can be achieved through it. Some expressed apprehension that ICT in classrooms would enable teachers to reduce their efforts in important areas. Some are even afraid that exposure to ICT would dilute students' attention to textbooks. Such lack of support undermines the morale of teachers with genuine enthusiasm and interest in using ICT. However, parents and guardians with postsecondary education seem to have a favorable view of using ICT in education.

Micro context. Integration of ICT at the micro (classroom) level depends on the availability of infrastructure and pedagogical support (Venezky and Davis 2002, Nicholson 1995, and Pelgrum and Anderson 1999). Nicholson (1995) identified two kinds of curriculum models in relation to ICT at the micro level: the techno-centric and the humanistic. In the techno-centric curriculum, the emphasis is on equipping the learners with the necessary skills that will be important for their vocational future. In many cases, there is little attempt to integrate knowledge of computers into the mainstream curriculum, and computers remain a technology to be studied in an abstract way. The fundamental tenet of humanistic computing is that the computer should be like a pencil, not as an isolated class but as a tool that empowers children with knowledge, thinking skills, and problem-solving alternatives. It emerged from the consultation with a group of teachers that the performance of Bangladesh is very poor in the case of both models.

Most of the educational institutions up to the secondary level suffer from complete or partial lack of ICT infrastructure. Second, only about 20% of teachers who have ICT infrastructure in their institutions use or have at least tried once to use them in class. The rest mentioned their heavy workloads as a reason for not using them. In addition to their

teaching load, different administrative tasks are also mentioned for not getting time to design and develop digital content to incorporate ICT into their teaching.

About 60% of teachers that were consulted mentioned they would require time to learn how to use hardware and software, and incorporate technology into the classroom. Some teachers are unable to make appropriate use of ICT in their classes, while many others are unwilling to try because of technophobia, lack of appreciation by the head of the institution and parents, and lack of motivation of students. The situation is little different in the case of technical and vocational education. Shamim, Aktaruzzaman, and Clement (2011) report that the majority of the technical and vocational education teachers found ICT time-saving, a student motivational tool, and economical. Yet its use is constrained by lack of training, modern ICT tools, and awareness.

c. Teacher Qualifications

Current initiatives to promote the use of ICT in education in Bangladesh are undertaken without changing the existing classroom teaching and learning activities, or the technical expertise and qualification of teachers. An effort to train teachers is underway, but it focuses mostly on the technical know-how of running a multimedia classroom.

The literature identifies two types of shortcomings of teachers that can potentially affect use of ICT in education: non-manipulative and manipulative. Non-manipulative factors include those that cannot be directly changed or modified such as age, teaching experience, and preservice computer experience. Manipulative factors refer to the factors that can be changed such as attitudes toward teaching and ICT, and knowledge and skills on ICT. Quite logically, the government focuses on the manipulative factors. About 12,000 teachers have been trained so far on how to use ICT in classrooms and develop digital content.

However, the interview with several teachers who received ICT training revealed that the training programs emphasized teaching about technology instead of teaching with technology. How to prepare teaching materials to make teaching more attractive or interactive is left to the teacher as a topic of self-learning. The mainstream training provided by teacher training institutes does not include ICT in the curriculum.

Another interesting finding of that interview is that teachers with fewer years of experience are more interested in using ICT in their teaching than those with more years of experience. More specifically, the teachers who used or tried to use the available ICT in teaching have 5 years or less of teaching experience. One explanation is that these young teachers were exposed to computers as students themselves. None of the female teachers used or tried to use ICT in their teaching. Hence, with the current age and gender composition of the teaching staff, there is a big challenge in promoting the use of ICT in education in Bangladesh. Extra effort may be required to motivate change among older and female teachers.

d. Digital Content

One of the key components of effective ICT-enhanced education is the digital content. Introduction of ICT in classrooms creates the opportunity to make a qualitative change in teaching and learning. To what extent this qualitative change will be accomplished depends on the techniques and materials used. Whether teaching and learning would continue to be guided by a "transmission" philosophy despite the use of ICT or begin to be guided by

a "constructivist" philosophy depends on the use and quality of digital content. According to the transmission philosophy, teaching and learning is predominantly based on teachers' explanations or reading from a textbook and students' absorption of the information, while the constructivist view emphasizes prolonged student engagement with new ideas and explanations that are relevant to students' experience and socioeconomic context.

Use of ICT in education in Bangladesh is analyzed from the perspective of strengths, weaknesses, opportunities, and threats (Table A1.2).

Table A1.2: Strengths, Weaknesses, Opportunities, and Threats Analysis

Strengths	Weaknesses
• ICT in education has high-level policy focus; responsibility lies with the Prime Minister's Office. • Policy focus has been consistent. Attention to it did not slack with the change of government. • A concerted and well-coordinated effort involving the Prime Minister's Office (piloting of new modalities), the Ministry of Education (scaling up), and the Bangladesh Computer Council (building ICT infrastructure) is underway. • Two innovative models—the multimedia classroom and the interactive digital repository—are being implemented. • A good number of educational services are now provided through ICT, and management information systems in education are increasingly becoming ICT-centric.	• No incentive mechanism exists to recognize a teacher's hard work to use ICT in education. • There is no strong monitoring to evaluate and identify the factors that hinder the use of already provided ICT infrastructure. The current education administration is too centralized for effective monitoring and evaluation. • Teachers in secondary schools often do not have the appropriate background to teach a particular subject. • Teacher professional development, including refresher training, is inadequate or absent. • Communication and leadership between national, institution, and classroom levels in education are lacking. • Inadequate support and practical help for first-time users of ICT and computer labs. The assistant programmer provided by the Bangladesh Computer Council is not accountable to the Ministry of Education, and hence remains absent most of the time.
Opportunities	**Threats**
• Despite being non-users of ICT, most teachers recognize its huge potential in teaching and learning. • The vision of building a "Digital Bangladesh" has adequately sensitized the citizen of the country to provide a favorable ground to promote the use of ICT in education. • Rather than being mere users, teachers are the developers of digital content, and their active participation is encouraged by awarding a high-end-laptop to the 10 best developers every year. • Increased and more widespread use of ICT in other spheres of society creates a "demonstration effect" that motivates teachers and students to use it in education.	• Despite strong political will and enthusiasm, the ownership by the school heads and management committees to the ongoing endeavors to increase use of ICT in education is yet to develop. • The use of summative assessment to provide information about the end product of learning is a disincentive to the use of ICT in teaching and learning. • Teachers have heavy teaching and other workloads. • Frequent power outages hamper the use of multimedia classrooms.

ICT = information and communication technology.

Source: Author.

While dependence on these sources saves time and resources, it has at least two limitations: linguistic and cultural irrelevance (incompatibility in some cases). Therefore, the local development of digital content is crucial as it enhances relevance and cultural conformity. Even if the digital resources are collected from external sources, they need to be custom-tailored to fit with the country requirements. Localization of digital content also involves creating materials that are appropriate for the local context, as well as placing information on the web in local languages so that others can use or build on them, avoiding much duplication of effort.

e. Inspection and Monitoring
The government has just finished the first phase of developing ICT infrastructure in selected schools. However, it emerged from the interview with a number of stakeholders, including students, parents, teachers, and relevant government officials, that in most cases the ICT infrastructure is not being used in teaching, let alone making any visible impact. During unscheduled visits in a number of schools, it was found that unused laptops are stored on a shelf, projectors have not been used, computer labs have been locked for months, and the assistant programmer provided by the Bangladesh Computer Council was absent.

As mentioned before, there is no adequate perceived benefit for teachers and school management committees to pursue the use of ICT in education. Under these circumstances, an institutional arrangement for systematic monitoring and consultation becomes very important. Unfortunately, the current inspection and monitoring mechanism is inadequate and not meant for promotion of ICT in education.

f. Current System of Assessment of Students
In 2009, "creative questions" were introduced in board examinations to assess students' mastery of a subject in secondary and higher secondary levels in Bangladesh, with strong opposition from parents and teachers. Despite this initiative, the assessment process in Bangladesh can still be characterized as "summative" as opposed to "formative." The goal of the summative assessment is to determine if the teaching of a particular subject increased scholastic gain compared with no teaching, while the goal of the formative assessment is to inform the learning process. Summative assessment evaluates the end product of teaching regardless of the teaching process. Since the main stakeholders at the school level are yet to be convinced that ICT would improve the end product of teaching, they are apathetic or often even disapprove of the use of ICT in teaching. This eventually discourages teachers from using ICT.

g. Current Support Logistics
There is no support available to help teachers who face problems in using ICT in their teaching. Many teachers reported that they were not sure where to go for help if something goes wrong in the computer or the projector. Even though they are trained on the use of this equipment, many teachers lack the confidence to repair any damage. They also did not know if they would be forced to replace equipment damaged while using it in the classroom. This lack of clarity is a major concern to them, as a laptop or a projector on average costs about 2 months' salary of a high school teacher. An assistant programmer is provided by the Bangladesh Computer Council to the schools that have a computer lab. However, this programmer is not under the administrative jurisdiction of the Ministry of Education, and hence is not accountable to the school heads. Allegedly, the programmer is absent most of the time as a result.

C. Conceptual Frameworks for Information and Communication Technology in Education in Bangladesh

1. From Mass Production to Massive Knowledge Paradigm

Transformation of Bangladesh's education system would require a holistic approach with the active participation of different bodies and effective reforms in a number of areas. Technology-enhanced learning is founded on the modification of the teaching and learning process in ways that could not be accomplished without the use of ICT.

Based on the analysis of the factors that affect the integration of ICT in education in countries like Australia (Baskin and Williams 2006, and Hayes 2007), Belgium (Tondeur, Valcke, and van Braak 2008), the Netherlands (Mooji and Smeets 2001), Israel (Nachmias et al. 2004, and Tubin et al. 2003), Malaysia (Cloke and Sharif 2001), the United Kingdom (Kirkman 2000; Tearle 2003, 2004), and Singapore (Lim 2002, and Lim and Hang 2003), Rodriguez et al. (2012) identified three main settings where inputs are processed: (i) classroom where teaching and/or learning occurs, even though it might not happen within a classroom (e.g., computer lab); (ii) school which is the specific educational institution in which ICT-enhanced teaching and/or learning takes place; and (iii) external setting which considers those processes that are outside of schools (e.g., public policies, monitoring, and assessment). These settings are shown in Table A1.3.

A universal introduction of ICT-enhanced teaching and learning in all schools will help to reduce the digital divide. However, it may not be possible to provide effective and adequate ICT support to all schools at the same time in Bangladesh. In such a situation, the government can sequence the introduction of ICT in different branches of education

Table A1.3: Different Aspects of Uses of Information and Communication Technology in Education According to the Setting

Setting		Aspects Involved in ICT Integration in Schools	
Inside school	Classroom	• Concrete improvement goals both in the immediate short term and in the longer term for stakeholders and beneficiaries • Support in learning theories and models for teaching • Materials and resources • Configuration in which students learn (e.g., individual/group, face-to-face/online/blended)	• Change in existing practices • Role of teachers, students, and other actors inside and outside school • Costing parameters • Processes that led to the outcomes • Monitoring and evaluation scheme to measure the differences between design and implementation • Total cost of ownership
	School	• Teacher professional development • Educational context where factors helped or hindered its impact • Sustainability • Shift in reform ownership	
External		Scaling up	

ICT = information and communication technology.

Source: Author.

depending on the availability of funds. Even a sequencing to cover different institutions within the same branches of education may be required due to resource constraints.

Any sequencing should be done on the basis of some clearly defined transparent criteria. Alternatively, rather than waiting to mobilize adequate resources to provide a full-fledged computer lab, the government can start with the provision of the bare minimum in all schools. As more resources become available, the amount of ICT support will be enhanced and made adequate, which is what Bangladesh is doing.

2. Architecture of the Road Map for Information and Communication Technology in Education

The architecture of the road map involves three different processes, as indicated by Rodriguez et al. (2012): (i) implementation, (ii) intervention, and (iii) transference.

Implementation. Implementation of an ICT-enabled pedagogical model involves a set of methodological strategies whose adoption would change and/or broaden the existing practices. Given the purpose of the use of ICT in education defined in line with national development goals, the government should first identify the target schools. The government targets all public secondary and higher secondary schools and madrassas, along with private schools that are included in monthly pay orders of the government, provided they have an electricity connection. This targeting approach automatically excludes schools located in backward areas that do not have electricity. Rather than minimizing the digital divide, the current policy will increase it. Therefore, the government should include the schools located in the backward areas by using solar power.

Intervention. While teachers and students develop the necessary autonomy for the sustainable use of an ICT-enabled pedagogical model, an external team carries out the professional development activities (e.g., teacher training, content development) according to a work plan. The outcomes of such an intervention are the skills and capacity needed by teachers, which are specific to the proposed pedagogic model, to achieve the learning objectives set out in the plan. Usually, the intervention includes five elements:

(i) **Work plan.** This identifies the course of action and the time required to complete tasks by taking account of the educational and professional profiles of teachers and personnel involved.

(ii) **Monitoring and evaluation scheme.** This scheme aims to measure the dependability of the implementation, evaluate the outcomes, and deliver information for decision making during the intervention to take remedial actions.

(iii) **Intervention materials and resources.** These include different core and supporting materials like documentation, software, hardware, observation guidelines, and training manuals.

(iv) **External team.** The team is composed of different actors directly and indirectly involved with their respective roles in the intervention process.

(v) **Intervention outcome.** This refers to the augmented skills and capacity of school team to implement the pedagogical model.

Transference. Transference is the professional development and training of the external team so that intervention can be made efficiently and accurately carried out on a massive scale. Training is adapted to the context of the school. It specifies the role of each member of the intervention team, and the educational background and skills required to perform them.

Figure A1.3: Proposed Architecture for Road Map of Information and Communication Technology in Education

ICT in education

Outcomes:
(i) Improved student outcomes
(ii) Equitable access to quality education

Central program management

Learning results

Implementation
Curriculum, Pedagogy, Assessment, Implementation resources

Classroom

Intervention
Workplan, Intervention resources (tools, hardware, connectivity) external team, M&E

School | External

Transference
Teacher and administration competency, Professional development and training

Skills and practices   Skills and practices

| Public-private partnership | Community participation | Corporate social responsibility | Third party outsourcing | External community |

Four key pillars of delivery for ICT in education

| **Infrastructure** | **Human capital** | **Digital content** | **Budget** |

ICT = information and communication technology, M&E = monitoring and evaluation.
Source: Author.

3. Financing Challenges and the Role of Public–Private Partnership

As a merit good, education is highly subsidized in Bangladesh at all levels. The initiatives to integrate ICT in education will also be financed by public money, at least in the initial phase. However, for their sustainability, these initiatives need to be financially viable. The policymakers must have a clear idea of the total cost of ownership of these initiatives and a plan to make them financially self-reliant at some point. The main components of total cost of ownership are:

- investment costs (e.g., hardware, classroom refurbishment, rewiring, furniture provision);
- replacement costs (e.g., replacing hardware);
- recurrent costs (e.g., consumables, power, internet connection, maintenance, servicing); and
- associated costs (e.g., teacher training, possible additional human resources, software development and provision).

Although the government is expected to bear the investment and associated costs, schools are expected to eventually bear the replacement and recurrent costs with support from private individuals. However, it may not be easy to mobilize private funds as people are not very familiar with the use of ICT in education in Bangladesh. Schools and academic institutions should resort to their alumni to collect donations to meet these costs.

D. Current Road Map to Implement Information and Communication Technology in Education in Bangladesh

This chapter discusses the core elements of the vision of Digital Bangladesh, reviews whether the currently implemented road map encapsulates those elements, describes what should be the guiding principle of the road map, and finally provides an operational framework of the proposed road map.

1. Current Vision and Efforts

Considering the importance of ICT to promote quality and equitable education in the country, the Government of Bangladesh launched several initiatives to facilitate the use of ICT in education (Section A). These initiatives are also considered as requirements for building the Digital Bangladesh envisioned in Vision 2021.

The idea of Digital Bangladesh is anchored on the idea that "the vision for an inclusive society is that all citizens are able to participate in creation of wealth and its equitable distribution, where information and reliable and affordable communication technology channels are available for accessing information for making informed decisions and accessing services at their doorsteps. Such an inclusive society also creates digital

opportunities for common citizens to participate in governance."[9] It is considered as the Charter for Change and composed of four interconnected pillars:

(i) **Human resource development.** This makes the best use of new technologies to build world-class skills in all areas of study, especially mathematics, science, and English.

(ii) **Connecting citizens.** This pillar focuses on reducing the digital divide by strengthening ICT awareness and capacity of communities, ensuring an innovative way of providing communication channels for citizens, and providing local language and locally relevant digital content. It also aims to establish two-way communication channels with grassroots organizations to promote their participation in policy intermediations.

(iii) **Digital government.** This pillar promotes e-governance to provide citizens with efficient, effective, and convenient access to services. The main target of this pillar is to deliver e-services, which is intended to ensure services anytime, anywhere, and to anyone at an affordable price. It also includes e-administration, which involves strengthening the government's planning, implementation, and monitoring of the government, including field administration, through the use of decision support systems. These systems would entail the easy sharing of data and information across various agencies and across geographic boundaries.

(iv) **Private sector.** This pillar is for ICT-related businesses, deals with three broad issues: access to markets, business productivity, and developing an ICT industry for local and export markets.

In addition to these four pillars, Digital Bangladesh also conceives five "enablers" that will also move forward the national development agenda: (i) providing an appropriate institutional framework, (ii) ensuring an adequate policy and legal framework, (iii) developing infrastructure for banking and financial transactions, (iv) providing appropriate delivery channels for taking services to citizens' doorsteps, and (v) identifying modalities where the private and public sectors can work together to enrich government services.

One of the key strategic priorities identified by the government to build Digital Bangladesh is to ensure 21st century education by (i) reforming curriculum, pedagogy, and teachers' capacity building to ensure quality education for all; and (ii) introducing ICT in education. Despite this strategic operational alignment, the ongoing endeavors lack horizontal alignment—the congruence with other policies within the education system relating to pedagogy, assessment, and others.

2. Missing Elements in the Current Road Map

The current initiatives are undertaken without paying adequate attention to the required ICT ecosystem in which they work. An ICT ecosystem encompasses the policies, strategies, processes, information, technologies, applications, and stakeholders that work together to build a technology-enabled environment that supports the existence and growth of a knowledge-based society. A technology-enabled environment is characterized by the existence of a reliable and robust ICT infrastructure and a conducive "info-structure"

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[9]   A2I (2010), Strategic Priorities of Digital Bangladesh, Prime Minister Office, Government of Bangladesh 2010 (p. 16).

system that ensures the effective flow of information, making ICT and information accessible and usable within the society (Zainab et al. 2002).

Kozma (2008) identified five key operational components for any effective policy to promote the use of ICT in education. They are (i) infrastructure development, (ii) teacher training, (iii) technical support, (iv) pedagogical and curricular change, and (v) content development. The current initiatives of Bangladesh are evaluated in light of these ingredients to derive the imperatives for the road map to increase use of ICT in education.

(i) **Infrastructure development.** The government has already developed one multimedia classroom in 20,500 secondary and higher secondary schools and madrassas that have electricity. The target is to develop more multimedia classrooms and, eventually, set up a computer lab in all secondary and higher secondary schools. While this is a welcome step as the overall ICT infrastructure and access to computers is very poor in Bangladesh, the current policy has some limitations. Since schools are selected for multimedia classrooms on the basis of availability of electricity, students from remote areas with no electricity will automatically be excluded from the benefit of the current endeavor. Also, in providing ICT infrastructure to schools, the size of the school and number of students should be taken into account. In this case, Malaysia can be an example, where the goal is to supply computers to schools at the ratio of 1 for every 10 students by 2005 and 1 computer for every 5 students by 2010. Given the resource constraints, Bangladesh cannot afford to be as generous as Malaysia, but the same modus operandi should be followed.

(ii) **Teacher training.** The ongoing endeavor to promote the use of ICT in education in Bangladesh includes teacher training, but it is not adequate in terms of either scale or focus. One teacher from each school that has received the multimedia classrooms is currently considered for training. The focus of the training is on the technical aspects of using the multimedia classroom. This approach needs to be rectified. Singapore can be an example for Bangladesh to follow. Singapore starts by providing teachers with 24 hours of workshops on basic ICT skills, such as text applications, spreadsheets, and interactive digital resources, but then offers advanced training and resources for teachers in the areas of digital resource development; technology planning and evaluation; action learning and research; and specialized ICT applications in humanities, mathematics, science, and languages.

(iii) **Technical support.** Support is a very important operational component, especially during the initial phase of ICT use in education. It is required to help the teachers when they face a technical problem. Unfortunately, this kind of technical support is not included in the ongoing endeavor to promote ICT in education in Bangladesh.

(iv) **Pedagogical and curricular change.** One of the most important components of operational policies to promote the use of ICT in education is the reform of curriculum, pedagogical practices, and assessment. This has been considered as a prime condition for success. For example, as an integral part of its endeavor to promote ICT in education, Singapore created a balance in the curriculum

between the acquisition of factual knowledge and the mastery and applications of concepts, and the development of individual curiosity, creativity, and enterprise. The curriculum was extended to include information skills, thinking skills and creativity, communication skills, knowledge application skills, and self-management skills. The assessment procedure has also been revised to measure students' skills in analyzing and applying information, thinking, and communicating. Bangladesh's current endeavor does not include any change in the existing pedagogy and curriculum, nor has any change in the current summative assessment been planned so far.

(v) **Content development.** As a non-English-speaking country, and also because of its cultural uniqueness, Bangladesh needs custom-tailored digital content to promote the use of ICT in education. Use of culturally insensitive content can create a public uproar and cause the main objective of using ICT in education to be misunderstood. This is why the development of digital content is so important. The country is currently training teachers to develop instructional materials in the native language. It also maintains a web-based repository where teachers can store their own instructional materials, use others' materials, comment on the usefulness of materials, and suggest ways to make them more useful. But the government's efforts need to be strengthened, streamlined, and well-coordinated.

The limitations of the current initiatives to promote ICT in education provide the ground to formulate a pragmatic road map to accomplish this objective. However, in crafting this road map, the distinction between different types of policy that involve the domain of ICT and education needs to be recognized. The "ICT in education policy" has to be clearly separated from "ICT policy for education" or "education policy for ICT." While these different policies may be interrelated, the "ICT in education policy" is the most important one in order to govern, direct, and promote the use of ICT as an enabler in improving education and student outcomes, in line with the national goal of producing a workforce that can thrive in the 21st century.

In contrast, the "ICT policy for education" will be too narrowly focused on enforcing certain rules, regulations, and operating procedures on the use of ICT in the classroom or computer lab. This will not be a holistic policy to enable ICT to improve education. Similarly, the "education policy for ICT" will also have a narrow scope of focus where it only defines the education syllabus or curriculum that should be covered in an IT or computer course. While these two policies are important, they will serve different objectives and will not play any role in promoting the use of ICT in education. It is important, therefore, to clearly define the principles that underpin the policy and road map of ICT in education in the context of Bangladesh (Figure A1.4).[10]

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[10] Policy on Education in Malaysia. http://www.mscmalaysia.my/sites/default/files/pdf/publications_references/ Policy%20on%20ICT%20in%20Education%20Malaysia%202010.pdf.

Figure A1.4: Distinction between Education Policy for ICT, ICT Policy for Education, and Policy on ICT in Education

✕   **Education policy for ICT**

- Covers education syllabus or curriculum under an IT or computer course
- No longer sufficient to optimize the potential of ICT in education
- Newer and intelligent use of ICT is required

✕   **ICT policy for education**

- Covers procedures on usage of ICT hardware and software applications
- ICT is deemed as a separate department from education
- ICT is limited to an ad hoc education tool
- ICT is not the all-encompassing role of an enabler to improve education

✓   **Policy on ICT in education**

- Most appropriate policy in order to govern, direct, and promote ICT as an enabler
- In line with the national goal outlined in Vision 2021, education should be lifted to the next level with ICT as an enabler
- Knowledge should be integrated with ICT to cut across all disciplines, subjects, and learning styles
- ICT to be incorporated as a subject and enabler of education

ICT = information and communication technology.

Source: Policy on Education in Malaysia.

3. Guiding Principle of the Road Map of Information and Communication Technology in Education for Bangladesh

The proposed road map is founded on a number of principles.

It is assumed that in a developing country like Bangladesh, market forces alone cannot guarantee the use of ICT in education to prepare the nation's workforce for the 21st century. Therefore, the government must play the pivotal role and its involvement must be predictable, developmental, transparent, efficient, and in agreement with other policies and actions. However, this is not to ignore the important role and responsibilities of the private sector, the community, NGOs, and development partners in promoting the use of ICT in Bangladesh.

The road map is guided by the twin objectives of (i) strengthening the integration of digital technologies and content to ensure the provision of quality education needed by the current and future generations of students, and (ii) increasing the efficiency of the delivery of education and training in Bangladesh. The road map aims at leveraging the use of ICT

as an enabler to create, promote, and sustain an educational environment that can help teachers transition from their traditional role as the ultimate source of knowledge to that of a facilitator of student learning.

The broad goal of the road map to promote use of ICT in Bangladesh can be further elaborated in terms of three inputs (instruments):

(i) **Infrastructure.** Improve and update ICT infrastructure for education and training, including connectivity.

(ii) **Content.** Upscale the creation, use, re-use, and sharing of quality and contextual digital content.

(iii) **Teaching and learning environments.** Modernize learning, teaching, and assessment practices and increase equity. In terms of outcomes, the road map aims to eventually produce knowledgeable, innovative, and creative graduates, who can be identified in terms of

(a) increased number of schools that meaningfully use ICT in teaching and learning,

(b) ICT-enabled and enhanced quality education that leads to the development of first-world talent,

(c) introduction of formative assessments in the education sector,

(d) favorable motivational and attitudinal change among the heads of educational institutions and management committees toward the use of ICT in education,

(e) formation of IT-savvy generation of students and teachers, and

(f) narrowing of the digital divide as currently observed.

4. Proposed Operational Framework of the Road Map

The infrastructural and human capital deficits that cripple Bangladesh's education sector, as well as international experiences, imply that the effectiveness of the implementation of the road map to promote ICT in education hinges upon four major pillars in Figure A1.3: (i) infrastructure, (ii) human capital (technical support and pedagogical and curricular change), (iii) digital content, and (iv) budget.

Infrastructural readiness is the foundation of ICT in education, and the country's lackluster ICT infrastructure requires significant improvements. Human capital readiness is vital to ensure that initiatives to promote ICT in education are implemented by the right people using the right methods at the right time with the right cost. Digital content is at the heart of the effort to allow ICT to be used as a critical enabler of student learning, creativity, innovation, and problem-solving and analytical skills. Finally, budgets must be focused right from the planning stage

**Table A1.4: Short- and Long-Term Actions
to Implement the Proposed Road Map**

Component	Actions for Immediate Benefit (1–2 Years)	Medium- and Long-Term Action (5 years and beyond)
Infrastructure	• Collaborate with the Bangladesh Telecommunication Regulatory Commission to ensure functional connectivity for schools that have been provided with ICT infrastructure by the Access to Information (A2I) program. • Instead of targeting all subjects, choose one or two science subjects to be taught by using ICT initially. • Establish a regional help desk for troubleshooting.	• Provide more ICT infrastructure to develop a computer lab and more multimedia classrooms. • Provide solar power for ICT infrastructure in schools with no electricity. • Develop a local area network or intranet in the computer lab.
Human capital	• Train the teachers who will teach the selected subjects and the head of the institute on use of ICT and web-based materials. • Change the curriculum and assessment of selected subjects.	• Train all teachers on use of ICT and web-based materials. • Change the curriculum and assessment method. • Include computer literacy as a requirement for hiring secondary-level teachers and/or include computer training in orientation programs for newly recruited teachers. • Strengthen the teacher training infrastructure to impart training on ICT. • Replace the current system of ad hoc monitoring with systematic and regular monitoring.
Digital content	• Immediately form a small committee to develop digital content for selected subjects by using materials from different open educational resources. • Streamline different ongoing efforts to develop digital content.	• Set up a wing or separate entity within the National Curriculum and Textbook Board to develop and appraise digital content for all subjects.
Budget	• The government should use its own development budget. Support from different development partners can also be sought.	• The government should make regular budgetary allocations every year. • Scope should be created for philanthropists, alumni, and different corporations to contribute.

ICT = information and communication technology.

Source: Author.

E. Summary, Conclusion, and Recommendations

In its Digital Bangladesh by 2021 vision, the government set a target of mainstreaming ICT as a pro-poor tool to eradicate poverty, establish good governance, and ensure social equity through quality education. The enhanced use of ICT in education has been identified as one of the strategic priorities to build Digital Bangladesh. The government envisioned ensuring a productive workforce ready for the 21st century through needed reforms of curriculum, pedagogy, and teacher capacity. It has laid the foundation for an enabling environment where ICT can play an important role in promoting quality education for all by adopting an actionable ICT Policy 2009 and a visionary Education Policy 2010. Out of 306 action items in the ICT Policy 2009, 53 focus on human resource development. The Sixth Five-Year plan incorporated some specific targets to implement the country's digital road map. However, Bangladesh's low overall e-readiness and the current lackluster condition of the education sector imply huge challenges in promoting use of ICT in education.

1. Summary and Conclusion

The government has just finished the first phase of developing ICT infrastructure in selected schools. However, interviews with a number of stakeholders, including students, parents, teachers, and relevant government officials, revealed that, in most cases, the ICT infrastructure is not yet being used in teaching, let alone making any visible impact.

Although current programs are yet to result in any impact on learning, their design is such that their impacts, when they do happen, are expected to be equitable. One of the main reasons for this is the more or less universal coverage of multimedia classrooms. Out of about 23,000 secondary and higher secondary schools and madrassas with an electricity connection, 20,500 of them have multimedia classrooms. The rest will be covered soon. The government will use solar power for multimedia classrooms in schools with no electricity. This kind of universal coverage eliminates disparities in the impact of ICT based on geographic region or socioeconomic group.

A second reason is that the government, in providing training on the use of ICT and digital curriculum, makes a conscious effort to maintain the balance between urban and rural schools. Conscious effort is also being made to include female teachers in training. In fact, it was found that in *Shikkhok Batayan*—an interactive web portal where teachers upload digital content they have created and comment on one another's content—female teachers are more active than the male teachers.

Bangladesh is in the first stage of the five-stage process of integrating the use of ICT in education. This stage is characterized by fear and suspicion of teachers. With the provision of ICT infrastructure, the physical learning environment in some schools has slowly started changing, but the learning activities and supporting tools remain traditional. The pace of progress of the enhanced use of ICT in education is hindered by a number of extrinsic and intrinsic problems.

In most cases, the heads of educational institutions and the management committees do not appreciate the use of ICT in education. Almost all public and private educational institutions of the country are either at breakeven or suffer from lack of human resources. In such an environment, introduction of ICT as an educational aid or its introduction

as a subject would mean diversion of teachers' already limited time away from teaching students. This perceived high opportunity cost was mentioned by many heads of the educational institutions and managing committees as the main reason for their lack of enthusiasm about using ICT in education. As a result of the lack of enthusiasm of the head of the institute, teachers are not very enthusiastic either about using ICT in teaching and learning, which many of them termed as a "thankless" job.

About 60% of teachers consulted for this study mentioned they would require time to learn how to use hardware and software and incorporate technology into the classroom. Some teachers are unable to make appropriate use of ICT in their classes, while many others are unwilling to even try because of technophobia, lack of appreciation by the head of the institution and the parents, and lack of motivation of students.

Young male teachers are comparatively more inclined to try the use of ICT in their teaching largely because they have been exposed to computers as students. Therefore, it is a big challenge in promoting and institutionalizing ICT in education, and innovative extra efforts to motivate older and female teachers to use ICT in teaching-learning activities are important.

Many parents and guardians of students disapprove of the use of ICT in the classroom because they do not understand what can be achieved through it. At the same time, some of them are apprehensive that ICT would enable teachers to slacken their effort. Some are even afraid that exposure to ICT would dilute students' attention to textbooks. Such lack of support undermines the morale of those teachers with genuine enthusiasm and interest in using ICT. However, parents and guardians of postsecondary students seem to have a favorable view of the use of ICT in education.

The lack of maintenance support and/or a helpdesk, where a teacher could get assistance when something goes wrong with the computer or the projector, is another problem. Even though teachers are trained on the use of this equipment, many of them lack the confidence to repair any damage. At the same time, teachers were not sure if they would be forced to replace equipment damaged while being used in the classroom. This lack of clarity is a major concern to many of them, as a laptop or a projector on average costs about 2 months' salary of a high school teacher.

2. Recommendations

a. Infrastructure

(i)   Improve the current lackluster situation in connectivity and reduce the cost. Expedite the process of awarding the license for the second submarine cable.
(ii)   While some improvements in overall electricity generation have taken place in recent years, and some more are foreseen, it will still take time for the country to ensure universal electricity coverage. Therefore, to ensure the equitable use of ICT in education, schools with no electricity connection should be supported by solar power. The government should adopt a policy of "no school left behind."
(iii)   The current level of ICT in schools is one laptop, one multimedia projector with a screen, and a pair of speakers. While this can provide the students and teachers

with exposure to ICT in education, the provision of ICT infrastructure has to be scaled up to have some tangible impact.

(iv) A computer technician should be employed in each *upazila* to help teachers with repairs and maintenance.

(v) The currently provided assistant computer programmers are employed under the jurisdiction of the Bangladesh Computer Council. As they are not accountable to the school heads or principals, they are allegedly absent most of the time. Therefore, the maintenance and support staff should be placed under the jurisdiction of the Ministry of Education, and under the direct control of the head of the school.

(vi) Alternatively, a help desk can be opened in every *upazila,* which will be managed by full-time and dedicated professionals who can provide prompt response and follow-up services to schools that need help. This job can be outsourced to the private sector and a feedback channel should be established so that users can give their opinions about the quality and timeliness of the services of the help desk. The renewal of the help desk contract can be made contingent upon a certain level of user satisfaction.

(vii) The level of ICT infrastructure to be provided to a school should be determined by the size of the school, the number of students, and the requirements of the users.

(viii) A reliable high-speed internet connection should be provided along with the laptop. A minimum level of connectivity speed should be provided to all schools, as well as basic infrastructure to ensure and support that speed and network connectivity.

(ix) All ICT in education initiatives should be implemented in a secure cyber environment protected by the necessary security measures. Freeware (free and open source software) applications will be preferred and tested to be free of spyware and malware.

b. Human Capital

(i) The current curriculum needs to be aligned with ICT-enabled teaching. From a constructivist perspective, Dede (2010) outlined some key ingredients for ICT-compatible curriculum that are also relevant for Bangladesh:
   (a) The curriculum should be centered on real-world problems.
   (b) Students should be involved in virtual communities of practice.
   (c) Include projects that will require interactive and reflective inquiry.
   (d) Include modeling and visualization as powerful means of bridging experience and abstraction.
   (e) Materials should be included and designed to enhance students' collaborative construction of knowledge.

(ii) The process of modifying the current assessment process needs to be expedited. The introduction of creative questioning can be considered as the first step to improving the assessment process. Training the teachers who are struggling to cope with this new system will help eliminate stumbling blocks.

(iii) To convert the heads of the educational institutions who are currently opposing the use of ICT in education into proponents, their ongoing training needs to

be scaled up and put first in the sequencing of different ICT-related activities in schools. At the same time, their training curriculum should be expanded to explain why ICT in education is needed for the country to thrive in a competitive global market, as well as its other potential benefits.

(iv)   A concerted national campaign is needed to raise community interest and awareness about the use of ICT in education. The media, different cultural organizations, respected personalities, and educationists should be involved. Events like annual fairs on the use of ICT in education can be arranged where high-level state dignitaries will participate to draw public attention to the issue; people will take serious interest in it.

(v)   The monitoring and evaluation mechanism needs to be strengthened. The Ministry of Education should collect periodic updates from field officers on problems faced by teachers so it can take necessary measures.

c. Digital Content

The government should form a high-powered national committee that would remain continuously engaged in the development of digital content. The committee would assess the total need for digital content, adapt some from different open educational resources, encourage domestic experts to develop the rest, and ensure coordination among different developers to avoid much duplication of efforts. To increase the quality and relevance of the digital content, a life cycle approach should be followed.

d. Budget

(i)   The procurement of ICT infrastructure, hardware and software, and other accessories must be conducted upholding the principle of transparency. Vendors should be selected using a multi-vendor approach.

(ii)   In procuring ICT infrastructure, contributions from different sources, such as private philanthropists, corporate social responsibility programs, and alumni, should be facilitated and encouraged.

(iii) Efforts should be made for cost recovery by allowing after-school commercial use of ICT facilities, wherever possible.

Promotion of the use of ICT in education would require coordinated action in different areas of the education system. Such an activity would not only require a good deal of resources to meet the cost, but also human capital to successfully pursue it. Therefore, the government should adopt a sequential approach with clear milestones and targets. A 5-year plan with identified actions for short-, medium-, and long-term impacts on the use of ICT in education should be adopted.

APPENDIX 2: INFORMATION AND COMMUNICATION TECHNOLOGY IN EDUCATION IN NEPAL

A. Background

1. Current Situation of Information and Communication Technology in Nepal

Nepal introduced the use of a computer (an IBM 1401) in 1971 for the census, an early start compared with other countries. But in the 1980s and 1990s, Nepal slowed its momentum in advancing the information and communication technology (ICT) industry. It was not until the turn of the millennium that the country felt the urgency to introduce national plans and policies in ICT, with the goals of joining the rapidly growing knowledge-based global economy and of using ICT to promote economic growth, governance, better service, and development in various sectors. Beginning in 2000, the Government of Nepal introduced a number of key policies and established a number of institutions to implement the policies. Market liberalization that started in the 1990s also helped private sector growth in the technology sector over the last 2 decades. There has been notable progress in the development of infrastructure, leading to increased access to information and communication links in the last decade. Figure A2.1 shows the growth of access to communication links in Nepal.

Figure A2.1: Access to Communication Services in Nepal
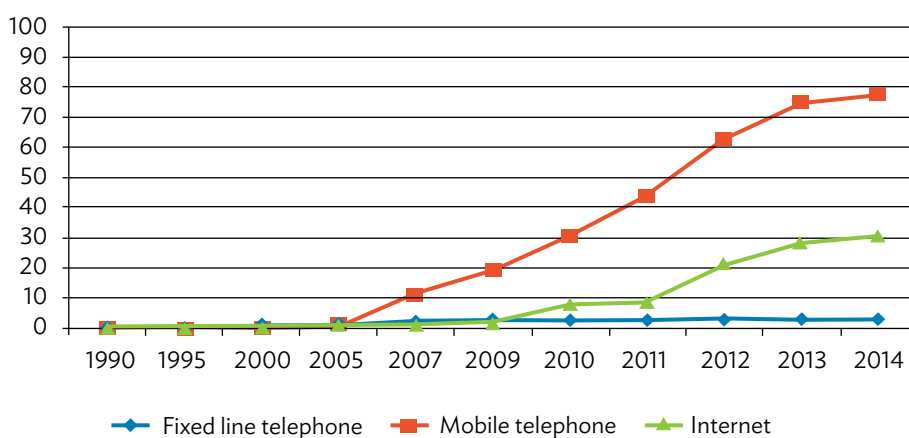
Source: Nepal Telecommunications Authority. Management Information System Report. Issue 56, Vol. 104. 15 June – 15 July, 2013. http://www.nta.gov.np/en/2012-06-01-11-33-01/mis-archives/mis-reports/nta-mis-76-pdf/download.

The latest release from Nepal Telecommunications Authority in May 2014 shows 30.99% internet penetration and 77.92% mobile telephone penetration.[1]

The high internet penetration is largely due to the increased cellular coverage in recent years. However, very few people with mobile phones access the internet using 3G and GPRS owing to high bandwidth cost and basic mobile phone sets. When this is factored in, the actual internet penetration is less than 10%.[2] The actual mobile penetration is also much lower once account is given to the fact that many people own two or more phone numbers from different service providers and different service types (GSM, CDMA) from the same provider.

2. Policies and Plans

Information Technology Policy 2000. The first information technology (IT) policy was prepared in 2000, as per the Ninth National Plan (1997–2002). The policy document recognized the potential of technology to enable rapid development in education, health, agriculture, tourism, and trade, as well as in raising living standards and in poverty alleviation. IT has also been viewed as a means to overcome geoterrestrial challenges impeding development in the country. The IT Policy 2000 planned to make IT accessible to the general public, and to increase employment opportunities in the country by building knowledge-based industries. The strategy called for rapid development and extension of IT in a fair and competitive manner, with the government playing the roles of promoter, facilitator, and regulator.

The document listed a number of policy steps needed to meet the objectives, including declaring IT as a priority sector, preparing the legal framework to facilitate IT, creating an investment-friendly environment, using IT in all types of governmental work, computerizing records, creating websites for government agencies, and providing internet facilities to all village development committees.[3] The human resources needed in IT would be developed with the help of educational institutions, and computer education would be included in school curricula. A national fund was to be established with contributions from the government, development partners, and the private sector to aid research and development activities, while venture capital funds were to be established with a public–private partnership.

Information Technology Policy 2010. Although the IT Policy 2000 called for review and amendment every 2 years to keep up with rapid technological advances, the next policy was not formulated until 2010. The new policy document set the vision of establishing Nepal on the global IT map and transforming it into a knowledge-based society. The policy calls for the development of IT to promote good governance, poverty alleviation, and socioeconomic growth. The specific objectives included making IT a priority area,

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[1] Nepal Telecommunications Authority. 2014. *Management Information System Report.* 67 (112). June. http://www.nta.gov.np/en/mis-reports-en (NTA-MIS-84).

[2] World Stats. Usage and Population Statistics. Nepal. http://www.internetworldstats.com/asia/np.htm.

[3] Village development committees are the lower administrative part of the Ministry of Local Development. Each of Nepal's 75 districts has several such committees, similar to municipalities, but with greater public–government interaction and administration. The purpose of the village development committee is to organize village people structurally at a local level and to create a partnership between the community and the public sector for improved service delivery. A village development committee is an autonomous institution with the authority to interact with the more centralized institutions of governance.

creating employment through establishment of knowledge-based industries, developing e-government programs as a way to provide effective services and timely information to the public, and establishing a centralized government data center to aid in IT development.

One of the key policy amendments mentioned was the integration of IT policy with other development policies and giving high priority to programs to create employment. The Ministry of Science and Technology sought an IT revolution through policies that can lead to socioeconomic growth and development. The revised policies emphasized the establishment of IT services outsourcing businesses to create jobs, and hoped to emulate the success of neighboring India. Outsourcing services could be in IT-enabled services, business outsourcing, or remote maintenance.

The policy also emphasized the use of IT for e-governance, and agencies that deal with health, education, and businesses that can function better with IT-related strategic plans, and help increase the domestic consumption.

e-Government Master Plan. The Government of Nepal, with the support of Korea IT Industry Promotion Agency (KIPA), prepared its e-Government Master Plan in November 2006 with the following objectives: (i) establish the vision, strategy, and framework for Nepal's e-governance; (ii) suggest major e-governance projects and draw the road map; and (iii) define the direction of the executing organization and restructure the legal framework.

The concept of e-government was introduced to use ICT to promote better governance and accountability by making government operations more transparent and reducing corruption. ICT-based services can help promote uniform service since it is not biased against any race, gender, or ethnic group. An e-government system breaks the barrier of geographic diversity and makes government services handy for all citizens, even those in villages who are not connected by roads, and opens up many opportunities—provided internet connectivity is available.

The master plan had four outputs: (i) rural e-community, (ii) government network, (iii) e-government applications, and (iv) human resources development for e-governance.

3. Information and Communication Technology in Education Plans and Policies

a. Information and Communication Technology in Education in National Plans and Policies

The use of ICT in education has been mentioned in various policy documents related to IT, e-governance, and education. The use of ICT in education has been recognized as the main medium of preparing the human capacity required in the use of ICT in development, and in building the country into a knowledge-based society.

Most of these documents mention the use of ICT in education on a superficial level without going much into strategies, action plans, and clear timetables. Few plans that have been prepared and implemented are related more to ICT literacy than the use of ICT in improving teaching and learning. This is evident in the introduction of computer science in high school curricula and the government's recent allocation of funds for schools to buy

computers. The government has launched a Computer Education for all by 2010 campaign as per IT Policy 2000, but that has not resulted in any concrete steps toward meeting the vision.

Table A2.1 details how the use of ICT in education has been mentioned in various national plans and policies.

Table A2.1: Information and Communication Technology in Education in National Plans and Policies in Nepal

Plans and Policies	Goals and Contents
Ninth, Tenth, and Interim National Plans (1997–2010):	• Introduce computer in schools. • Increase access to education. • Develop human resources in ICT. • Integrate ICT in education.
IT Policies (2000 and 2010):	• Use IT to improve the quality of education. • Emphasize computer education in schools. • Gradually make computer knowledge mandatory for all newly recruited teachers. • Provide computer education to in-service teachers in phases. • Continually update and improve IT education to prepare a capable workforce. • Provide facilities to universities to offer computer science and engineering subjects. • Provide free internet access to universities and public schools. • Provide scholarships to students from remote areas to pursue higher studies in IT. • Introduce a distance learning system. • Encourage collaboration between the IT industry and academic institutions.
e-Government Master Plan	• Improve education administration with ICT. • Develop ICT literacy for human resource development.
School Sector Reform Plan, 2009–2015	• Enhance quality and improve student learning using ICT. • Use ICT to improve the classroom teaching and learning process. • Develop a separate ICT plan for education. • Seek new and cost-effective approaches to capacity development using IT. • Develop human resources in the IT sector. • Develop IT infrastructure in education. • Use ICT to improve governance, management, and quality. • Transition the MOE into an e-governance system. • Improve education administration. • Improve transparency, accountability, timeliness, and quality of education management information system (EMIS) data.

ICT = information and communication technology, IT = information technology, MOE = Ministry of Education.
Source: Author.

b. Information and Communication Technology in Education Master Plan
The process of developing a master plan for ICT in education was initiated in 2010 and was completed in 2013. The master plan has attempted to take into account the policy and strategy directions provided by national plans, IT policies, and the School Sector Reform Plan to devise a consolidated plan for the use of ICT in the education sector. The master plan has set the vision to ensure quality education for all through the use of ICT in all aspects of education. The goals include expanding equitable access to education, enhancing the quality of education, reducing the digital divide, expanding access to teaching and learning materials, and improving the service delivery system in education. The master plan focuses on four key components of successful ICT in education program.

ICT infrastructure. Infrastructure development is one of the key requirements for the use of ICT in education. This includes equipment and internet connectivity at schools, resource centers, and training centers to enable access to resources, better teaching and learning practices, sharing of educational materials, and training of teachers in remote areas. An education network has also been proposed to initially connect the Ministry of Education (MOE) with other agencies and public institutions for higher education, and later connect schools, resource centers, and training centers.

Further, the master plan proposes the use of a central digital resource library that students and teachers can access from all over the country to access and download educational materials related to the curriculum. A multimedia resource center is being proposed to help develop multimedia content from primary to secondary levels that can be integrated in teaching and learning

Human resource development. To develop qualified and skilled human resources required to use ICT in education effectively, the master plan proposes the development of teachers, trainers, decision makers, and managers both in ICT and in using ICT to improve performance in their respective jobs. Teachers will be trained on basic computer maintenance in addition to using ICT to teach their subjects, and training centers will have at least one ICT master trainer who can train teachers on ICT curriculum and basic maintenance while also maintaining the computers and systems at the centers. Similarly, personnel at the MOE, Department of Education (DOE), Curriculum Development Centre (CDC), and the National Centre for Educational Development (NCED) will be provided the skills needed to manage and monitor the effective use of ICT in education.

The strategies for teacher preparation include integrating ICT skills in in-service and preservice teacher training curricula based on national ICT skill standards as well as in teacher performance evaluation. Teachers will be provided continuous learning through open and distance education modes.

Digital content development. Nepal's national curriculum framework for school education has stated the use of ICT as subject as well as a pedagogical tool to improve teaching and learning. Curricula will be developed for ICT to be used as a subject, and will include office productivity suites, use of internet, and e-mail, with the goal to develop soft skills in IT. There will also be elective courses in ICT for the vocational track.

To use ICT as a pedagogical tool, interactive digital content based on school curriculum needs to be developed. Such activities will make teaching and learning of concepts in

various subjects fun and easy. The strategies include building the capacity of the CDC to develop, manage, and disseminate digital content, and to encourage the private sector to develop open source digital content. But only content approved by the MOE can be used at schools. The master plan also calls for the creation and exchange of digital content by teachers and learners.

Education system enhancement. Recognizing the potential of ICT to improve education delivery and management, the master plan discusses reviewing and revising policy and regulatory provisions, developing new policies, and reflecting policy directives in national prioritized plans and programs for effective and efficient use of ICT in education. Further strategies are discussed in using ICT to strengthen the education management information system (EMIS), office automation system, examination management system, and monitoring and evaluation to ensure better planning and decision making and more effective service delivery.

Directive on the use of ICT in education. The DOE published a directive on the use of ICT in education in 2012. The directive calls for the formation of a steering committee and a working committee similar to the one in the master plan, and lists the roles and responsibilities of the committees. It has directed the formation of an ICT committee in each district under the chief district education officer. The directive cites the provisions in the School Sector Reform Plan to connect schools to the internet, and to use ICT to improve the quality of school education, while reducing the disparity in education quality and access between urban and rural areas as well as between public and private schools.

The steering committee is responsible for formulating policies to promote the use of ICT in education, facilitate coordination with other ministries, and provide guidance to various committees. The bulk of the responsibilities come under the working committee headed by the secretary of the MOE. The directive has provided clear guidelines on working with government and nongovernment actors to provide the needed ICT infrastructure in schools, establishing ICT units in training centers and lead resource centers, providing alternate methods of providing educational materials to schools that do not have internet connectivity, and working with private service providers to connect schools to the internet.

The directive has also given the working committee responsibility for aligning ICT training with in-service training for teachers and developing digital content in partnership with nongovernment and private institutions. It further mentions the creation of a central digital library at the MOE by integrating existing digital libraries and connecting schools, community learning centers, and training centers to the digital library network.

B. Analysis of Information and Communication Technology in Education in Nepal

1. Adoption of ICT in Education
The adoption of ICT in education has been quite slow in Nepal. It was only in 2000 that the national IT policy first introduced the concept of using computers in schools. With the catchphrase Computer Education for All by 2010, the policy called for the inclusion of

computer education in the school curriculum, to be taught as an optional subject at the beginning and made compulsory in the future. The policy also mentioned (i) the use of IT to improve the quality of education and (ii) making computer knowledge mandatory for newly recruited teachers while providing computer education to all in-service teachers through distance education.

While ICT education has been addressed to some extent over the past decade, hardly any progress has been made toward the application of ICT to improve education quality and access in public schools. The proposed free internet facilities at universities and schools have not come to fruition, nor has anything concrete been done toward the development of IT skills of teachers.

Computer education has been introduced as an optional subject in the high school curriculum, but many schools have not been able to offer it to their students due to the lack of infrastructure. Many schools also lack qualified teachers to teach the subject. Schools that do offer the course conduct mostly theoretical classes based on textbooks, and students have very limited time in front of computers. The curriculum itself is outdated because the CDC has not been updating it to keep up with the rapidly changing technologies. We cannot expect such outdated and impractical course content to lead to the desired result of equipping students with the skills necessary in today's knowledge economy. In reality, such curriculum can have the opposite effect and potentially alienate students from technical subjects, especially those who are not technically inclined to begin with.

Some private schools, especially in urban areas, have been offering computer courses using books from India. These schools also face the problem of outdated curriculum, as well as the challenges of long power outages and an insufficient number of computers. Many private schools advertise their IT facilities as a way to attract prospective students and parents, but in most cases, they also lack the skills to use computers to improve education quality. A handful of affluent schools have invested in technology and content; however, many teachers struggle with the complex hardware and software systems, and often have to seek help from the IT personnel to resolve technical problems.

On the tertiary level, there has been a sharp increase in the number of private colleges offering courses and degrees related to IT and computer science over the past decade with affiliations with Tribhuvan University, Kathmandu University, Pokhara University, and Purbanchal University.

The slow rate of adoption of technology is not limited to the education sector—it is the same in other services provided by the government. Many action plans outlined in the e-Government Master Plan and strategies formulated by the IT policy documents are far from being implemented. While part of the reason could be the political instability in the country that existed until the peace accord was signed in 2006, there seems to be a general apathy in government offices toward transforming the way business is done by employing technology. Until government officials become technology savvy, the task of using technology to improve efficiency and quality will always remain an uphill battle.

2. Current and Past Projects

The last decade has seen many efforts to introduce ICT in schools under separate initiatives from the government, nongovernment organizations (NGOs), the private sector, and, in many cases, individuals and schools themselves. These initiatives were driven by the common belief that computer skills should be taught to children so that they can compete in the emerging knowledge-based societies, and that computers can help improve the quality of education in our schools. However, most of the efforts did not go beyond putting a few computers in schools and, in some cases, connecting them to the internet. Further, due to the large class sizes and relatively low number of computers, students do not get enough time to use the resources productively. Schools often try to manage usage time by breaking classes into groups to allow students to use the computers, but this is still inadequate. To add to their woes, schools have to manage the time around long power outages in most parts of the country. Under the national curriculum, computer education is offered as an optional subject at the secondary level. However, because of resource constraints only a few public schools have been able to offer this course. The demand from the public for ICT education in schools is high despite their recognition that the present school curriculum is overloaded with subjects and content.

a. School Implementations

Computer labs. Setting up computer labs in schools has been the most common method of implementing ICT in school education. Schools designate a separate room for computers where students go during class periods or in free time to use the facilities on a shared basis. The MOE has provided computers to schools through various schemes over the past few years. They are:

- A total of 3,038 schools received two computers and one printer each in 2010.
- Under an annex program, six schools are running a 15-month computer lab program with internet connectivity.
- A total of 85 secondary schools are receiving internet connectivity under an open education program.
- A total of 1,453 schools received NRs140,000 each from the MOE over the past 3 fiscal years.[4]

The MOE's program to introduce computers in schools does specify the minimum basic configuration, but since schools receive the funding to buy computers directly from local suppliers, most of them do not have the resources to make sure that the supplied computers meet the requirements. And with very little follow-up and monitoring from the district education office, little is known regarding the fate of the machines that were procured. Moreover, the specifications provided by the MOE do not mention anything about operating system and other software, nor about the power requirements. The budget allotted to each school toward the purchase of computers does not have any provision for operating system and software applications. As a result, most computers are loaded with pirated and unauthorized operating system and software applications. With a very

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[4] The Government of Nepal has allocated NRs1 billion in the current fiscal year (2013–2014) to put computers in all secondary schools in the country under the same scheme.

low budget allocated per computer (NRs25,000), schools can only afford to buy locally assembled computers that are poor in quality and come with short warranty period.

One laptop per child. The one laptop per child (OLPC) program drew worldwide attention when it was announced in 2005. The program aimed to provide new opportunities to learning to children around the world through the distribution of specially designed laptops that were both affordable and durable. In Nepal, a local NGO, Open Learning Exchange Nepal (OLE Nepal) partnered with the DOE to launch a two-phase pilot project in 2008 to introduce the OLPC approach.[5] Unlike in other countries, Nepal's program went beyond distributing laptops to students and connecting schools to the internet. The project took a comprehensive approach to improving quality of and access to education through the integration of laptops in the classroom teaching and learning process. Hence, the distribution of laptops was accompanied by efforts in the following four key areas: (i) design and development of local digital content, (ii) teacher training and support, (iii) network and power infrastructure, and (iv) capacity building.

The pilot project was implemented in two test schools in the first phase with the goal of learning the challenges of using ICT in rural schools, including training and support needed for teachers, types of digital educational content, technical maintenance, and community involvement. Based on the lessons learned from the first phase, the project was expanded to 26 schools in six districts. In contrast to implementation of other ICT projects that were focused on the secondary grades, this project introduced technology in the primary grades, with the goal of improving teaching and learning by integrating technology in the classrooms.

The project has deployed over 4,400 laptops in 65 schools spanning 15 districts, benefiting over 15,000 students. The project has introduced the OLPC shared-model approach in schools to reduce the financial and logistical burdens both from the implementation and the school sides. In the shared model, schools are provided with a set of laptops, enough to cover the largest class size, and different grades take turns using laptops based on a schedule prepared by the teachers. Laptops are placed in a separate room where students go to use them as per the schedule, and for schools that do not have extra room available, the laptops can be carried to the classroom in portable racks. When any one grade is using the laptops, each student will have one-to-one interaction with a laptop and its digital content. This arrangement allows students to learn at their own pace and benefit from the learning-by-doing approach. Schools are encouraged to let students use laptops during free time and after school as well so that they can explore and engage in activities on their own.

Although the OLPC shared model seems similar to the traditional computer lab model, it has a number of distinct advantages. Using laptops instead of desktop machines allows schools to run the classes even during power outages. Since laptops consume much less power than desktop computers, the recurring cost associated with electricity consumption is lower.

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[5]   The OLPC project was also included in the national budget for 3 years (2009–2011).

e-Library. The Help Nepal Network (HeNN), a global network of volunteers with chapters in Nepal and abroad, initiated the One District–One E-Library campaign in 2007 to set up computer facilities in all 75 districts of Nepal to benefit students and communities. Instead of installing traditional computer labs, HeNN partnered with the Free/Open Source Software (FOSS) Nepal[6] volunteer community to deliver low-cost solutions based on the Linux Terminal Server Project that combines a powerful central computer with low-end cheap computers as clients. This approach shares the high processing power and storage capacity of a Linux server with client computers, which would otherwise be useless without hard disks.

HeNN has set up 15 e-libraries in 12 districts of the country.[7] Although HeNN's e-library project provides some books and content, it is not a full-fledged digital library, but a center where users can learn how to use computers and a few other applications.

Nepal Wireless Project. The Nepal Wireless Project was launched in 1997 in the Myagdi district to connect village communities to the internet using long-range wireless devices and customized local antennae. The project aimed to empower village communities by connecting them to the outside world and by providing opportunities in health, education, communication, and commerce. The project has carried out activities in distance education, telemedicine, and e-commerce in a few villages in Myagdi. Schools in villages have been provided access to digital learning materials, including the learning activities prepared by OLE Nepal. However, the attempt to promote distance education has not been successful due to technical and other reasons.

b. Educational Content and Curriculum

Learning Activities: E-Paath. E-Paath is a collection of subject-specific and grade-specific digital learning materials designed and developed by OLE Nepal as an integral part of its ICT in education initiative with the DOE. Conceptualized by educators and curriculum experts, these interactive educational software modules are closely aligned with the national curriculum and are designed to help teachers and students meet the learning objectives outlined in the curriculum. These activities employ various features of technology such as audio, images, animation, and text to help students better understand concepts in various subjects.

A total of over 540 modules for grades 2–6 in English, mathematics, science subjects and for grades 2–4 in Nepali subjects have already been developed and introduced in schools. Each activity module is accompanied by a teacher's note that explains how teachers can integrate the activity into classroom teaching, including the learning objective from the curriculum that the activity is designed to help meet, the learning areas that are addressed by the activity, the chapter of the book that the activity correlates to, and, most importantly, how the digital activity can be used alongside other learning tools inside and outside the classroom to teach various concepts.

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[6]   FOSS Nepal is a community of volunteers who actively promote the use of free and open source software in Nepal, and also participate in the development of such software. http://wiki.fossnepal.org.

[7]   Help Nepal Network. www.helpnepal.net.

Subject experts from the CDC have been involved in the conceptualization and design process, and the CDC has formally approved the activities as supplementary educational materials aligned with the national curriculum. OLE Nepal and the DOE plan to develop similar activities for more grades and subjects. These activities can be accessed, downloaded, and used free of charge. [8]

The Digital Library Project: e-*Pustakalaya.* e-*Pustakalaya* is an education-focused digital library containing full-text documents, books, images, videos, audio files, and interactive educational software that can be accessed through an intranet or on the internet.[9] OLE Nepal started the development of e-*Pustakalaya* in 2008 to improve reading skills, to develop a reading culture in schools by giving them free and open access to age-appropriate reading materials, to enable students to do research projects, and to promote the habit of independent inquiry. Since e-*Pustakalaya* went live in 2009, teachers as well as other adults have also benefited widely from various teaching resources and educational materials in agriculture, health, environment, and local technologies.

Users of e-*Pustakalaya* can browse through sections looking for items they like, or they can search for specific items based on full or partial author name, title, publisher, and/or keywords. Users can also link to similar items based on author, publisher, or keywords through a single click. Users can read books and documents, view videos, listen to audio clips, play educational games directly from e-*Pustakalaya*, and, in the case of books and documents, download and store for later viewing.

e-*Pustakalaya* currently has a collection of 5,000 titles, and the number continues to grow every day. OLE Nepal has sought and received permission from authors, publishers, and organizations to add the materials that are found in e-*Pustakalaya*. The use of the materials in e-*Pustakalaya* is governed by Creative Commons 3.0 Attribution–NonCommercial–Share Alike copyright licenses.

e-*Pustakalaya* is accessible on the internet at www.pustakalaya.org and can also be installed in low-power servers and deployed in schools and community libraries that either do not have internet connectivity or have a low-bandwidth connection. Such local instances of e-*Pustakalaya* will enable better user experience through fast access and quick downloads.

MiDas eCLASS. MiDas eCLASS is a product of MiDas Education designed to change the way teachers teach and students learn through innovative and meaningful use of technology. [10] The eCLASS combines state-of-the-art infrastructure complete with customized software, projection system, computers, and power backup system with curriculum-based digital content into a single package known as eduKit. This teaching aid allows teachers to run lively and effective classes using multimedia, graphics, pictures, and diagrams. It also allows teachers to assess and evaluate the learning achieved by their students in class. Students can use the digital content to visualize the concept much better than static images or oral instruction, thus improving learning greatly.

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[8] Can be accessed through EPaath. http://pustakalaya.org/external-content/static/epaath/epaath-en and downloaded through OLE Nepal. Download EPaath. www.olenepal.org/download-e-paath.

[9] Pustakalaya means library.

[10] MiDas eCLASS. www.midaseducation.com.np.

The eduKit offered by MiDas has digital learning content for preschool all the way to high school. This digital content is also sold in the local market on compact discs (CDs). The MiDas eCLASS program offers to enhance teaching skills of teachers so that they are able to use the content as effective teaching tools. Schools can also opt to use MiDas for constant monitoring and supervision. The eduKit contains audio and visual content, interactive drills and quizzes, educational games, summaries of chapters, sample questions, and other relevant content outside of the curriculum.

Among the 215 schools that are using eduKit digital content,[11] more than 90% are private schools in urban areas, with a majority in Kathmandu and surrounding districts. With all the materials offered in the English language, the target schools are private schools where classroom teaching is done in English. Most public schools do not have the resources to conduct classes in English. Further, due to the cost of installation and the limited number of user licenses per CD, affordability can be another reason why this digital content has not been used as widely in the public school system.

Curriculum on computer education. To familiarize students with computers and technology systems, the CDC has developed a computer education curriculum for grades 6–10. The computer education curricula for grades 6–8 cover the following general areas, with added complexity in each area as students move up the grades: computer fundamentals and basic skills, operating systems, computer graphics, and computer programming.

The main objective behind introducing computer-oriented subjects in school was to build students' knowledge, skills, and competency in computers and technology so that they can contribute to the country's development in the future. Students can gain familiarity with technologies, build self-confidence, learn to appreciate innovations in technology and development around the world, and gain the ability to apply them toward meaningful employment in the future.

However, the curriculum has not been updated since it was first designed in 2007, and much of the content is outdated, and lacks the latest technologies that students are most likely to encounter in their daily lives. Although the assessment is supposed to be half on theoretical content and half on practical work, most schools lack computer facilities and infrastructure for students to engage in practical project work. Even schools that do have computer facilities simply do not have enough machines to give students ample time to work on projects. With the lack of qualified teachers, computer facilities, and updated curriculum, most students are limited to reading books about computers and programming, and memorizing the content of the books before the exam.

c. Teacher Preparation

Teacher preparation is one of the most important parts of ICT in education, yet most programs in the country have either neglected it or have carried out perfunctory training programs by young college volunteers or local computer training institutes that attempt to teach teachers about the basics of hardware and software. Most of these training programs

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[11]   www.midaseducation.com.np (accessed 28 May 2013).

target computer teachers who teach computer subjects in schools. Teachers who teach other subjects do not get much training on how technology can be used to enhance lesson delivery.

To ensure that newly recruited teachers have basic computer skills, the School Sector Reform Plan document mentions giving priority to applicants with such skills during the hiring process. However, that has hardly been the practice, especially with numerous other issues that is hindering the hiring process.

The MOE's NCED, the official body for training and capacity building of teachers, has recently developed a teacher training program for ICT curriculum, but it does not have a training program to build teachers' skill on integrating technology in classrooms. Since the NCED develops and delivers training packages to help train teachers to effectively teach the curriculum prepared by the CDC, the NCED will most likely not prepare ICT-based education training packages in the absence of clear curriculum guidelines from the CDC on the use of technology in classrooms.

Under the MOE's program to send funds to schools to set up computer labs, there is a mention of training at least one teacher from each recipient school on basic computer hardware and software. However, training is not conducted by the NCED or any other body under the MOE system. Rather, schools are instructed to find a nearby computer-training institute and send one or more teachers for a general training. There is no detailed specification on what the training should include, nor any monitoring mechanism to verify whether teachers receive the training or how effective the training was toward the use of computers and other ICT in schools.

Other programs such as HeNN's e-library project and the Nepal Wireless Project have used volunteers from local universities to provide basic training to teachers in schools where they have gone to install the computers. These training programs are limited to providing basic knowledge about using computers, and they typically last about 1–2 days.

OLE Nepal and the DOE's OLPC program was the first ICT in education project that has taken concrete steps to go beyond basic IT training and equip teachers with the skills and confidence to use digital learning activities in classroom teaching and learning. The training program trained teachers not only on using computers and software applications, but also on using a digital platform to teach subjects such as English, mathematics, science, and Nepali. The training package covered topics such as basic IT literacy, relation between digital content and curriculum learning objectives, managing students in IT-enabled classrooms, preparing lesson plans to integrate technology, and optimal seating arrangements. The training package was developed through discussions with training experts from the NCED, curriculum experts from the CDC, officials from the DoE and MOE, and other experts, with input and feedback from the OLPC program schoolteachers over the years. The overall training package is delivered over three stages: (i) initial residential training, (ii) in-school training, and (iii) refresher training.

d. Capacity Building

One of the impediments to a wider adoption of technology in school education in Nepal is the lack of overall institutional capacity within the MOE system. There is a need to build the capacity of not just the teachers, but trainers, curriculum experts, monitoring officers, school supervisors, resource persons, and policy makers and planners. Very little has been done in this area despite being mentioned in policy documents.

A manual of self-learning materials on ICT titled Online Offline Professional Capacity Development Training was prepared by NCED in 2010 for MOE officials.[12] The manual includes various resources for a 3-month training program, including 12 days of workshop followed by 11 weeks of self-learning. It has chapters on using ICT in classroom teaching and in mobile learning.

The MOE system relies too much on its IT staff to devise plans and policies related to ICT in education. While they have the technical skills and knowledge about IT, most of them do not have the insights and experience in education needed to prepare policies. As a result of the reliance on technical staff with no experience in the education profession, the plans and directives issued by the MOE and its line agencies on the use of ICT in education are focused more on technology than on improving pedagogy, curriculum, and classroom practices using ICT. Unless planners and policy makers at the MOE and its line agencies have a sound understanding and exposure to the benefits and applications of ICT, they cannot formulate prudent policies to promote the use of ICT in classrooms.

e. Educational Information Management

The use of ICT in educational information management is still at a rudimentary stage. Student information and school data are still entered using paper forms at the schools, and the collected forms are brought to the district education office (DEO), where the information is entered manually into computers. With nearly 35,000 schools and 7.5 million students, it takes the DEO several months to complete the task and send the information to the DOE, where it gets uploaded into a central database. Because of this long process, planners and policy makers do not always have updated data and information while preparing future plans.

3. Major Constraints in Mainstreaming Information and Communication Technology in Education

Lack of infrastructure. Physical infrastructure, electricity, and connectivity are the main barriers in terms of infrastructure. Many public schools will need to build and prepare rooms for ICT equipment. The building infrastructure will need major work, including securing windows and doors, and better roofs to prevent leaking. Most regions in the country face long power outages due to insufficient power supply from the national grid. Schools will have to be equipped with alternative energy sources, such as solar power systems, to run the ICT equipment. Although cellular network coverage is expanding rapidly across the

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12 Hyperlink: http://nced.gov.np/downloads/download/20130425055123/ICT%20Online-Offline%202068.pdf: Government of Nepal, Ministry of Education, National Center for Educational Development. 2010. Online Offline Professional Capacity Development Training in 2010. Sanothimi, Bhaktapur.

country, the bandwidth cost is still very high, and schools will require higher speed than what is acceptable for home and personal use. Schools and authorities have to factor in the monthly cost of internet connectivity in the overall budget. There is also an insufficient number of devices in schools.

Lack of institutional capacity and capable human resources. The MOE, line agencies, and district-level bodies lack the institutional capacity to plan, implement, monitor, and support the use of ICT in education. The MOE's teacher training centers are not equipped to run ICT-based training programs. The infrastructure in education training centers across the country have to be upgraded to include computers and connectivity to train thousands of public school teachers. Likewise, resource centers have to be upgraded to support ICT use in schools. These agencies also lack capable human resources in technical, administrative, and managerial areas. There is a massive requirement for capacity development for teacher trainers, curriculum experts, district supervisors, and resource persons.

Weak coordination and management. The use of ICT in education requires coordination of efforts between multiple ministries and government bodies, which has proven to be difficult. Coordination between the MOE's own line agencies is also lacking. Current investment in ICT in education does not align with the MOE's own master plan. There is no provision to include outside experts and nongovernment organizations (NGOs) in the planning and implementation process.

Poor budgetary allocation and management. The education budget is the largest in the country, and accounts for around 15% of the national budget. However, little is allocated to educational development. The budgets for ICT in education over the past few years have heavily favored procurement of computers, with very little going toward content preparation, training, and capacity development. This has not changed even though the ICT in Education Master Plan has emphasized the need for investment in these areas.

Attitude and awareness. The majority of staff at the MOE, line agencies, and other bodies lack understanding of how ICT should be used in education, and how it can be leveraged to transform education. Many view ICT as an extracurricular supplementary activity. As such, there is a need to change this general attitude if ICT is to be introduced as a disruptive force to transform education.

Resistance to change and low teacher motivation and qualification. There is obvious resistance not just from teachers, but also from officials, supervisors, trainers, curriculum experts, and monitoring staff, to change brought about by using ICT in education. Teachers are also unmotivated to change their way of teaching because it requires extra work beyond what they are used to. Hence, many teachers tend to revert to their familiar way of teaching based on rote learning. Many teachers lack the qualifications and skills to be able to use ICT effectively in classrooms.

Lack of readily available digital resources and outdated ICT curriculum. Teachers tend to look for organized courses on the computers that they can use in classrooms without much extra effort. Since student performance assessment is based on textbook content, teachers tend to treat digital content as supplementary materials. Moreover, the computer

subject curriculum is outdated, and the content is too heavily focused on proprietary tools such as Microsoft Word and Excel.

No clear hardware and software specification. With so many technology, hardware, and software options available, it is not clear what combination should be used in schools. Local vendors make the decision based mostly on what is in stock. With no technical staff at the schools to check the machines, many schools end up with low-quality equipment that do not last very long. Also, there is no clear direction on the operating system to be used in schools despite the master plan mentioning the use of open source software. Most schools use pirated Windows operating systems partly because that is what the local vendors provide, and partly because the computer curriculum covers only Windows software.

Technical maintenance and support. Schools that are located away from district centers and urban areas do not have technical resources that can assist in the installation and maintenance of equipment. Since most schools do not have teachers with technical skills and knowledge, they have to rely on outside help even for basic maintenance and support.

Lack of private sector involvement. There is not much opportunity for the private sector to be involved in ICT in education in public schools apart from selling hardware to schools. Schools and parents are mostly unable to pay for the services provided by private companies. Private sector involvement is possible in digital content, connectivity, technical implementation and support, and training, but many are discouraged since they will need to deal with government bureaucracy for approval to work in public schools

4. Equitable Access Using Information and Communication Technology

The inequitable distribution of access to quality education that is crippling Nepal's education system can be found across school types, geographic locations, and socioeconomic strata. Although the government has committed to the Education for All goals of ensuring quality education for all children, the system is still struggling to meet the requirements set by Education for All. While private schools have been more successful in providing quality education, the same is not true for more than three-quarters of the student population, who attend public schools. Similarly, students from urban and other accessible locations get much better opportunities for quality education than those living in rural and remote communities. This disparity in education access is reflected in the poor School Leaving Certificate exam performance of students from rural public schools and from marginalized groups.

The disparity is found not only in physical infrastructure, but also in the availability of sufficient qualified teachers and in the access to educational materials and opportunities. Many public schools in rural and remote areas have few educational resources beyond government-prescribed textbooks. Moreover, many schools in remote regions do not receive the textbooks until late in the academic session.

Creating and acquiring digital learning materials and distributing them freely through electronic media can overcome this problem of lack of educational materials in rural and marginalized communities. The same content can be made available uniformly to everyone from urban and rural areas, and from advantaged and disadvantaged communities. In

addition to making the textbooks available in digital format, other supplementary materials including reference books, course-related books, and many other modes of digital learning such as audiobooks, educational videos, and interactive learning software can be made available through the use of ICT in schools. With the majority of public schools lacking a functioning library, providing digital materials through the electronic library system can help promote activities such as reading, exploring, and independent inquiry among students from disadvantaged groups and locations

Multilingual education. In an ethnically diverse country like Nepal, the medium of instruction in schools plays an important role in the early development of students. Even though Nepali is the national language—and the medium of instruction in most public schools—it is not the mother tongue of many communities and ethnic groups. The current system has served four-fifths of the population who have Nepali as the mother tongue well, and this is evident in the domination of the Nepali-speaking ethnicities in civil service, the judiciaries, and other key positions. However, people from the minority ethnic groups are at a severe disadvantage due to the language barrier. This starts from the time the child enters primary school and has to struggle with learning concepts in a foreign language.

Many early childhood development experts suggest that it is best to teach students in their mother tongue in the primary level. Children should not be struggling to learn a new language in those grades, and instead should be allowed to learn concepts, make connections, and explore in the language that they speak at home. One of the many reasons for student dropouts in the early grades is the difficulties students face due to the language barrier. Even though Nepal's public education system has recognized the need for multilingual education to improve access to quality learning and to reduce early dropouts, it has struggled to introduce mother tongue education due to various challenges.

This disparity in access to quality education in the early grades due to the language barrier can be tackled through the use of ICT. In the traditional system, there are two main challenges in delivering multilingual education. One is the lack of qualified teachers who speak the many languages spoken in the country. The second is the lack of educational materials available in these languages. These problems can be addressed more easily through the use of technology and the digital medium.

Teachers, linguists, and other enthusiasts can work together to translate and share educational materials in other languages. This does not have to be limited to books and documents, but should cover digital learning activities and audiovisual materials. Such digital activities and multimedia content prepared in multiple languages can be used by students to learn concepts in early grades with facilitation from teachers who do not necessarily have to be fluent in the mother tongue. Providing such learning materials in the mother tongue to students in ethnically disadvantaged communities is critical to overcoming the disparity that these communities face in ensuring quality education for their children.

Nonformal education. The need for the promotion of nonformal education as a way to reach out-of-school children has been emphasized in the MOE's School Sector Reform Plan. There are many children who are not enrolled in formal schools because they live in remote locations. Much of the hills and mountains are sparsely populated, and hence

the system has faced difficulty in establishing schools in every settlement. With only a handful of children per settlement, there are practical challenges in establishing schools and providing teachers to reach all the children in the country. The MOE has introduced various alternative education programs such as the Flexible Schooling Program and the School Outreach Program to reach out to out-of-school children. These programs can be enhanced significantly through the use of ICT by providing better access to learning as well as in providing self-learning materials. Many children who have missed out on formal education in the early grades are reluctant to join classes at a later age because they are embarrassed to sit in the same class with much younger students. Allowing such students to build their basic literacy and numeracy skills through self-learning using digital content at community learning centers can ease their integration into the formal schooling system.

Quality teachers. The teacher–student ratio in the public school system is disproportionately higher in urban and accessible areas, while the rest of the schools must function with fewer teachers since most teachers are reluctant to go to remote schools. Teachers often cite the lack of opportunities for further studies and professional development as one of the reasons. It is not uncommon for teachers to simultaneously pursue courses and programs for further studies while teaching; hence, they prefer to be close to the educational institutions where they are enrolled. This lack of sufficient qualified teachers is one of the primary problems in ensuring quality education in rural areas. ICT can help tackle this problem by making teacher education and professional development accessible even in rural areas through open and distance education. ICT can also open channels for teachers to interact with their counterparts in other parts of the country and in other countries. These factors can help persuade qualified teachers to serve in the remote areas, which will help bridge the disparity in education between urban and rural areas.

5. Teacher Preparation

Teacher preparation is one of the key steps in integrating ICT in school education. Teacher preparation should include the development of IT skills and build their confidence in using technology in classrooms. The challenge is to turn teachers with little or no prior technology experience into capable and confident facilitators in technology-integrated classrooms, and that requires a lot more than simply providing training on computer hardware and software.

Teachers as facilitators. Teachers should be encouraged to embrace their changing role in an ICT-integrated classroom environment. Initially, it may not be easy to change their teaching approach from the traditional method that they have been practicing for a long time. However, they should be enlightened on how ICT integration will make teaching not just easier, but much more efficient and effective. In the traditional method, teachers are seen as the source of knowledge, and carry the burden of having to know and explain all matters related to the subject being taught. With few resources available in the classrooms in a typical public school, students always turn to teachers for information and knowledge. Further, teachers have to spend the majority of their time talking and explaining concepts, with little engagement from students. In ICT-integrated teaching and learning, teachers no longer need to have all the answers, and instead can direct the students to find information on their own using the ICT resources available. Students are more engaged and motivated to learn when they are able to find answers to their questions and earn a sense of success in doing so. Once they get the hang of the new approach where the teacher's role is that of a guide or a facilitator, teachers will realize that their workload is much lighter than before

and, in most cases, classes become more interesting and exciting for them as well as the students, offering a great learning opportunity for both sides.

While the role of the teacher changes, they need to understand that their role is in no way minimized. Even though children pick up new technologies more quickly than adults, teachers are needed in classrooms to guide the children, set lesson plans, and facilitate the process of learning. In their new role as facilitators, teachers can focus more on effective lesson delivery, and spend time working with students who need more assistance while others are engaged in their own learning. Teachers can also spend more time motivating students and inspiring them to achieve more using resources available to them at their fingertips. At the same time, teachers need to ensure that students are on track to achieve the learning objectives as per the course curriculum. Each class should be guided by the goals that the teacher has set for that particular class. Teachers should combine ICT with other classroom practices, such as discussions and interaction, along with teaching and learning tools such as the blackboard, textbooks, and other materials. In this manner, teachers can view ICT as a tool in their teaching-learning practice instead of the main focus of the class.

Teachers should also understand that the basics of teaching and learning do not change just because ICT is introduced in their classrooms. They have to fully understand that technology is just a medium, and the fundamentals of learning remain the same no matter how lessons are delivered. To this end, teachers have to be well aware of the advantages of child-centered teaching and learning practices, and how engaging students will help them become better learners regardless of ICT. The learner-centered approach is a proven pedagogical method that helps in the cognitive growth in children, and it has been practiced well before schools even thought about introducing technology to enhance learning. Once teachers are convinced that the learner-centered approach will yield better student learning, then it will be easier for them to understand how it can be integrated in their classrooms to enhance learning.

Hence, the training program for teachers should cover more than ICT literacy: it should prepare teachers to integrate technology and digital content in mainstream pedagogy. In addition to familiarizing them with the wide range of digital learning tools and their utilization, teachers need training on how to effectively apply them in the classroom. This will start with preparing lesson plans that combine digital materials with classroom instruction and activities. Teachers also need preparation in classroom management and dealing with technical and nontechnical issues that can arise in ICT-integrated classes.

Classroom management. More importantly, it is essential to realize that teachers not only have to learn this new teaching and learning tool, but use it to teach a class full of students who are also new to this technology platform. This poses an even bigger challenge for teachers. In such a scenario, teachers need ongoing support, especially in the first year, to help deal with confusion and answer queries that are bound to come up. Most of the issues can be addressed through discussions with fellow teachers and learning best practices from each other. Building discussion forums among teachers from the same and neighboring schools can be a critical step in the successful integration of ICT in schools.

Information and communication technology skills. Teachers also need to understand that the training program will help them overcome the fear of technology, and equip them with the skills needed to explore and apply technological tools and digital content. The training will not teach them everything there is to know about technology nor will it expose them to all types of digital content that are available. The idea is for them to use the training to gain the confidence and skills to explore, and find innovative ways to apply technology to enhance teaching and learning in their classrooms. They should be encouraged to keep seeking new and improved approaches, and to connect with other teachers and educators to move ahead in their own professional development.

Leadership training. Strong leadership in schools is essential for the successful implementation and long-term sustainability of ICT in schools. To achieve this, head teachers along with the school management committee (SMC) and the parent–teacher association (PTA) chairs have to be trained on the necessary leadership skills. These school leaders have to be convinced of the benefits of ICT in providing quality education to their students, and also must be able to motivate teachers and garner local support for the program. Head teachers should be able to monitor classes, facilitate discussions among teachers on ICT-based classroom teaching, and coordinate with the resource center and the district education office to improve the overall program at their schools and in the region. They should also ensure that teachers are spending enough time exploring available digital learning materials during free time and using them to prepare lesson plans.

The SMC and PTA should approach the village development committee, the village education committee, and the local community to support the program at schools and ensure the safety and security of the equipment. They can also work on after-school programs that can benefit the entire community, and promote community ownership of the overall program. The SMC and PTA chairs also have to support the head teachers in supporting and motivating teachers to adopt the new methods of teaching and learning.

Lifelong learners. Teachers hold the key to the success of any educational intervention. Since teaching is one of the most challenging professions in the world, teacher preparation should not be treated as a one-off program, but as a lifelong continuum of professional development that helps teachers become effective facilitators of learning. ICT opens up opportunities for lifelong upgrading and professional development for teachers by providing distance education in response to emerging demands. Teachers should be encouraged to take advantage of ICT, and embrace the new paradigm of lifelong learning so that they can be effective and efficient in their profession.

6. Better Education Management and Information System

The benefits of introducing ICT in schools are not limited to improving access to quality learning for students and teacher professional development—it can also be used to improve school administration and management. Many regular tasks related to student records can be automated, hence saving teachers from the drudgery of entering data manually. There are many open source tools for student record keeping and school management, with features such as school calendars, student attendance and grade recording, and course management. These tools can be customized to fit the needs of Nepal's public schools, and teachers can be trained to use them on a regular basis.

Further, ICT tools can also be used to prepare periodic reports that schools are required to send to the DEO. Currently, this process is done manually, and is found to be prone to errors and deliberate misreporting. The current process collects aggregate data on students that are filled out manually on printed forms by teachers at schools and sent to the DEO, where a few computer operators enter the data in spreadsheets before being forwarded to the DOE. It takes 5–6 months from the time teachers fill out the forms at schools until the EMIS database is updated at the DOE. One of the negative consequences of this delay is that policy makers and planners do not have up-to-date data when they are preparing plans for the new academic year.

Schools can start keeping individual student records easily using ICT tools. Teachers can update attendance and performance records on a regular basis. This data in schools can then be compiled and forwarded to the DEOs and to the DOE in electronic format and updated in EMIS. This entire process can be done in under a month, and will be less prone to errors and misreporting. Schools that have internet connectivity can even access and upload the data directly to EMIS.

7. Successful Online Educational Resources

Among the many global initiatives, massive open online courses (MOOC), OpenCourseWare (OCW), Khan Academy are resources that are found to be widely popular among users. These initiatives provide free access to quality content and allow users to learn at their own convenience through online course, educational and lecture videos. Whereas initiatives that provide computers and laptops to students and connect schools to the internet have been criticized for not improving learning among students,[13] a valuable lesson that can be learned from the success of MOOC, OCW, and Khan Academy is that any attempt to use technology in education should focus on providing appropriate content to users.

While millions of learners around the globe have registered in MOOC, studies indicate that only 10%–20% of them complete the course.[14] Many learners seem to lack the discipline and motivation required in self-directed courses. MOOC courses have had higher rates of completion in facilitated study groups settings where learners meet on a regular basis.

MOOC, OCW, and Khan Academy have been very popular among independent learners. But their integration in daily classroom teaching-learning practice will require efforts from both teachers and education planners. The Khan Academy videos need to be either translated or recreated in local languages. Similarly, a MOOC-type content for school education should be created to allow teachers to share and adapt their courses. Moreover, these types of content cannot become part of regular school education without proper teacher training and regular support.

While it may be obvious, it is important to note that MOOC, OCW, and Khan Academy would not have been successful without hardware and network infrastructure. Even with

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[13] J. Cristia, et al. 2012. *Technology and Child Development: Evidence from the One Laptop per Child Program.* Washington, DC: Inter-American Development Bank (February). http://www.iadb.org/en/research-and-data/publication-details,3169.html?pub_id=IDB-WP-304.

[14] Katy Jordan. MOOC Completion Rates. http://www.katyjordan.com/MOOCproject.html.

the free and open access, these learning opportunities are available only to those who have access to computers and internet connectivity, and to those who are proficient in the language used in preparing the content.

Hence, the lesson that can be learned is that the three key components of successful technology-based learning initiatives are content, teacher readiness and infrastructure.

8. Timeliness of ICT in Education

A few recent developments have paved the way for a wide-scale ICT intervention in schools. Hardware and connectivity costs have been declining steadily, and have reached the level where governments in developing nations can afford to use them in school education. Computer hardware prices have declined by more than half over the past 10 years, and technological innovations and advancements have recently sliced the cost by even more. Affordable laptops, tablets, and computers have disrupted the technology market and made computers more affordable to millions of lower-income people. These innovations have already brought radical changes in how people communicate, and how they create, share, and access information. The lower cost and increased prevalence of hardware and connectivity have already started to change the landscape of higher education through open and online courses. Further, there have been rapid developments in open source technology that help overcome the often-prohibitive cost of software and opened up the possibility of customizing software and content to fit the local context. Now, ICT is poised to revolutionize school education because hardware cost is no longer an insurmountable barrier.

The integration of ICT has been steadily progressing and has reached a point where it can be leveraged to provide ICT-based education in schools. The implementation of the IT policy and e-Government Master Plan have, to some extent, raised IT awareness in the bureaucracy and helped build IT capacity at some level in the ministries. There has also been improved IT infrastructure built at the national level, which has enabled affordable connectivity in more places in the country.

Most importantly, there is an urgent need to transform the educational system to challenge students to become critical thinkers and better problem solvers. Continuing the old method of rote learning will not prepare students to compete in today's global economy. Nepal must build the human resources needed to take the country forward and prosper in today's knowledge-based economy, and ICT is the right tool that will help students and teachers to realize that goal.

C. Road Map to Implement Information and Communication Technology in Education

1. The Way Forward

To achieve the desired outcome of improvement in student performance through the use of ICT, serious effort has to be made in different areas as outlined in the priorities and strategies above. The trend of simply investing in computer hardware with superficial training efforts will not deliver the desired results, as shown by past experience both in

Nepal and abroad. The Government of Nepal should be serious about following the ICT in Education Master Plan and starting work on all areas, including content development, training, and capacity building.

The systemic change that ICT is poised to bring to Nepal's public education can bear fruit only if the various stakeholders are ready to transform their attitudes and prepare for a disruptive change from the status quo. Rather than resisting the change, all stakeholders concerned need to adapt to their new roles and seek to support the transformation by building their skills in their respective fields.

The government should form a working committee consisting of ICT experts from the private and public sectors, education experts with sound ICT knowledge, and organizations who have experience in implementing ICT in education programs in schools to assist the MOE to roll out ICT programs in schools. This working committee can build on the existing policies and develop a clear road map to successfully integrate ICT in mainstream education. Further, the group can explore possible areas where public–private partnership can present a win-win situation for both sides, including in delivery of training and digital content and in setting up infrastructure in schools.

a. Build Capacity

Developing the capacity of the MOE system in planning, delivery, and support is of paramount importance for successful implementation of ICT-based education. The introduction of computers and ICT in schools will present an unprecedented shift in the nation's education system, and will require careful preparation in building the knowledge and skills, as well as changing mind-sets, of not just the teachers, but also the planning and monitoring resources. Capacity development has to be done both on the technical front— carrying out their responsibilities in the new mode of teaching and learning, and on the administrative front—making sure all the pieces are in place for the successful and smooth operation of ICT-enabled schools. And it has to cover the MOE and its line agencies, such as the DOE, CDC, and the NCED, as well as district-level and local entities such as the DEOs, education training centers, and resource centers. In each of the institutions, capacity development has to be designed to enable them to develop plans, implement and monitor activities, and provide support toward the use of ICT in their respective areas of expertise. The preparation has to go beyond developing skills and knowledge; they must also fully understand and embrace the transformation that ICT will bring to the education system.

While there have been some involvement in past ICT activities such as digital content design and development, training of teachers, and school implementations, they have been done mostly on individual capacities whereby experts from various institutions involved themselves in preparing, delivering, and supporting ICT in education efforts. However, little has been done at the institutional level, and the new approach has to look into building the institutional capacity to implement and support ICT initiatives in schools. Capacity building efforts should couple knowledge and information with hands-on activities to allow resources to fully develop the skills necessary in their respective fields.

Since capacity building for the use of ICT is a key component in the government's e-Government Master Plan, the MOE should align its efforts with the government's overall plan to promote the use of ICT in planning and service delivery.

The key steps required to build the MOE's capacity to implement ICT in education are:

(i)   Encourage the use of ICT in the MOE's daily working process.
(ii)   Promote ICT in education as a mainstream agenda, and not as a supplementary extracurricular activity in schools.
(iii) Policy makers should take online courses on ICT for policy makers and planners to fully understand the process and challenges of using ICT in education.
(iv)   Learn from ongoing implementations in the country by visiting schools; sitting through training programs; observing classes; reviewing digital learning activities; and talking with teachers, the school management committee (SMC), the PTA, and implementers.
(v)   Gain in-depth understanding about the pros and cons of various technology options, as well as about software licenses and open source software.
(vi)   Start working with practitioners in the private sector and NGOs on developing content and training programs as a way to build capacity of the institutions.
(vii) Identify areas where extra resources need to be added, especially at the district and resource center levels.

Since school principals play an integral role in monitoring the program on a daily basis, they need administrative capacity for the smooth implementation of the program. They should be able to work with teachers, check their lesson plans, and encourage collaboration among teachers so that they can help each other to strengthen the program and benefit the students. Principals should also know where and how to seek outside technical, administrative, and pedagogical assistance, when required.

Capacity building programs at the school level should include SMC and PTA members. SMC members should sit with teachers to prepare plans to maximize the use of resources and for the safekeeping of equipment in schools. It is important for SMC members to understand the process and benefits of the use of ICT in schools so that they can request local funds from the village development committees toward future maintenance, support, and expansion of the program. The SMC and the PTA can also work with teachers to utilize the resources for community learning activities during or after school hours and on holidays. These programs can be conducted by the school resource persons or in the resource centers.

b. Develop Digital Content and Improve ICT Curriculum

Digital content comprises digitized books and documents, reference materials, interactive multimedia learning activities, educational videos, and any other content that can be accessed and shared through ICT. Digital content can also include user-generated content such as lessons plans prepared by teachers and project work done by students.

The CDC under the MOE should be the lead agency in the effort to prepare these learning activities. Even though the CDC does not have ICT resources, the subject experts have

knowledge about how children learn and also have experience in the design of curriculum and learning materials. These experts can work with subject committees to conceptualize and design learning activities that can then be outsourced to software companies to develop. The software company should be required to have education and curriculum experts so that they can work together with CDC experts to ensure that the developed activities can help meet the learning objectives outlined in the national curriculum for each subject and grade.

Aligning these digital activities with the curriculum will not only ensure that they meet the objectives, but will increase the likelihood of teachers using them daily in classroom teaching and learning. Aligning activities with the curriculum will lessen the burden on teachers who may find it difficult to seek and organize the activities to fit their needs. Accompanying each of these learning software activities with detailed instructions on how to apply them in classroom teaching will further boost their effective use in classroom teaching.

This process of development of digital learning activities should leverage similar software that is already available, and build on open source materials and platforms to cut both the time and cost. The developed activities should be designed and developed to work across multiple platforms without requiring proprietary software installations that necessitate payment of licensing fees.

There are at least two efforts well under way to develop digital learning activities in Nepal that follow the national curriculum. While the E-Paath learning activities developed by a local NGO, OLE Nepal, are free and open source, private companies like MiDas have prepared digital activities that are available in the market. These existing activities can be a good starting point for the CDC to provide digital content to schools. CDC experts have been involved in the development of some of these activities, and the subject committees have approved the E-Paath activities as supplementary materials aligned with the national curriculum. Hence, there already are human resources within the CDC who are familiar with the design and development process of digital learning software.

The MOE should develop and distribute a free set of quality digital learning materials to schools to ensure that all students have uniform and equitable access to quality learning through ICT. In addition to making the materials freely available, the CDC has to make sure that the software source code does not become the property of the development firm so that future updates and modifications can be done without much hassle. Keeping the source code open will allow other developers, teachers, interested organizations, and university students to adapt it for specific purposes and build more activities to add to the repository. These variations will allow interested parties to translate the activities to other languages too, and help promote the use of digital learning to achieve the goals of multilingual education.

After the initial cost of developing these learning activities, the subsequent costs to maintain and update the activities will not be very high. In the long run, the development and distribution of digital learning activities will prove to be one of most cost-effective approaches to ensuring universal quality education in the country.

Additionally, the CDC should develop or compile other digital resources such as educational videos, reference materials, digitized books, and teaching resources that can be helpful to students and teachers. Educational videos can either be recordings of classroom lectures done by teachers, or clips recorded on a computer using tablets connected to it along with audio recording of the person explaining the concept, as done in Khan Academy videos. Although educational video is not a novel concept, the recent progress in technology and communication has made it much easier to produce, store, share, distribute, and play videos. Private schools can contribute by recording classes conducted by good teachers and sharing them on public sites, as done in massive open online courses.

Other learning videos can be adapted from existing ones, and Khan Academy videos are probably the best option to do this both because Khan Academy videos are open source and are the most popular among learners all around the world. The videos will need to be adapted to the Nepali language. The simplest one is to add Nepali subtitles to the existing videos, or to do a voice-over with subtitles, which allows the speaker to modify the explanation to fit the local context and student needs. In both these cases all the text and diagrams written and drawn to explain the concepts will remain in English. This can be addressed by recreating a new set of videos from the Khan Academy video collection using the writing pads as done by Khan Academy.

Reference materials such as Wikipedia, Wiktionary, and OpenStreetMap enable teachers and students to experience a rich classroom experience. Digital books are much cheaper to produce and distribute through the internet and on storage devices. In the context of schools, one key advantage of digital books is that all students in a class can access and read the same book simultaneously, whereas the same would not be possible with physical books, and would require stocking the school libraries with numerous copies of each book.

c. Teacher Preparation

The teacher training program should be developed as a joint effort between the NCED and the CDC, with support from universities, private institutions, and NGOs with experience in training. It is also important to make a distinction between training teachers to teach ICT as a subject and training teachers to use ICT to teach concepts in other subjects.

The NCED, which is the apex body for training teachers under the MOE, has plans for a training program for computer teachers, but there is no training program to prepare teachers to use ICT to enhance teaching and learning on other subjects. However, the NCED and its training centers are not equipped to provide ICT training to teachers, and most computer teachers get the necessary training from local computer training institutes. While such institutes may be able to provide technical training to computer teachers, they lack the capacity to train teachers to integrate ICT effectively in classrooms to teach other subjects. The NCED needs to upgrade the infrastructure of its training centers and also build the capacity of its trainers to develop and deliver training programs on improving pedagogical practices using ICT.

Another key partner in the teacher preparation component is universities that offer academic courses on education designed for future teachers. Two universities, Tribhuvan and Kathmandu, currently offer degree courses in education, but there is very little

emphasis on the use of ICT in school education. These academic institutions should be engaged by the MOE in the development of teacher education curriculum that prepares future teachers on the effective use of ICT in classroom teaching.

In addition to building the skills and confidence of teachers to use ICT, it is also important for them to understand how technology will enhance learning by promoting a learner-centered approach in their classrooms. They should be encouraged to embrace the new paradigm where students are engaged actively in their own learning process through the use of technology. Teachers have to be trained on how to be effective facilitators who allow students to explore and find information that they can share and discuss.

There are practices that teachers have to learn and adopt to successfully integrate technology in their classrooms and deliver effective lessons. This also means that teachers should maintain a healthy balance between classroom activities that use computers and those that do not require computers. To achieve this, it is important for teachers to prepare proper lesson plans that include using computers along with other classroom activities. Teachers should also be trained on improved classroom management skills that include the importance of giving clear instructions, keeping students from being distracted by other materials not related to the day's lessons, and tackling minor technical issues without disrupting the class.

Teachers should also be trained on using automated tools for student record keeping and course management. This can be done in subsequent years once the teachers have had some experience and at least a year of regular exposure to using technology. Teachers and focal teachers should be trained on using ICT tools to prepare periodic reports about students, teachers, school infrastructure, and inventory to district education offices. This training can be conducted at the resource centers.

The key steps toward preparing teachers are:

(i)   Prepare a comprehensive program to train in-service teachers to use ICT in classrooms and get them accustomed to the new teaching-learning paradigm of teachers as facilitators in a learner-centered approach.

(ii)   Trainers should engage teachers during the training program and encourage them to seek answers, discuss with colleagues, and get them involved in their own learning process, just like they are expected to do with students.

(iii)   Develop master trainers and upgrade training facilities to run ICT in education training programs; prepare resource persons and centers to support teachers and provide them with regular update courses.

(iv)   Deliver training program in phases, allowing teachers to gradually build their skills and confidence. The initial training should be followed with classroom observations and refresher trainings.

(v)   Work with universities to integrate ICT-based education courses in teacher education so that incoming new teachers already have the required skills and knowledge.

(vi)   Start a teacher accreditation program for ICT-based education. Motivate teachers by recognizing well-performing teachers with advanced certifications and providing for exceptional performers to become resource persons in future trainings.

(vii)   Make the certifications count toward teacher professional development.

(viii)   Provide leadership trainings to focal teachers and school principals.

d. School Infrastructure

To implement ICT in schools on a national scale, proper attention has to be given to ensuring that the hardware and software have some basic uniformity. This will allow easy implementation as well as better maintenance and support. The new programs have to be more forward looking when deciding on the choice of hardware and fully take advantage of the latest developments in technology.

Hardware. The key factors to consider in selecting the hardware are price, energy efficiency, durability, security, and ease of maintenance. Beyond the physical and technical specifications, the implementers also have to consider practical aspects such as ease of use and simplicity of the setup, as well as proper utilization for educational purposes.

Table A2.2 shows the various options for hardware in schools.

Based on the above analysis, single-board computers would be the most suitable for use in schools. These small devices offer the best price and energy efficiency. There may be software contextualization required for them to be introduced in schools.

Table A2.2: Comparison Chart for Various Hardware Options

	Price	Energy	Durability	Security	Maintenance
Desktop	++	+	+++	++++	++++
Thin client	+++	++	+++	++++	++
Tablet	++++	++++	+	+	+
Laptop	+++	+++	+++	++	+++
Single-board	+++++	++++	+++	+++	+++

Note :

+ = Poor, ++ = Satisfactory, +++ = Average, ++++ = Good, +++++ = Excellent

Source: Author.

For primary level students, low-power durable laptops may be a better option. For schools with both primary and secondary levels, it is important to have two separate sets of hardware so that younger students get ample time to learn to use the technology.

Each school should have a low-power server containing a digital library so that students and teachers have easy access to learning materials. The server can also act as a network gateway if and when the school is connected to the internet. Further, the server should be loaded with administrative tools to track the use of the devices and resources, and can also be loaded with EMIS software. This server can be remotely accessed through the internet for updating and to collect data.

Software. Software licensing arrangements, maintenance and upgrades, localization, and protection from computer viruses need to be addressed as well. The cost of computer operating systems such as Windows is around a third of the hardware cost, leading to widespread use of pirated versions in many developing countries. A possible alternative is to use free open source operating systems such as Ubuntu and Fedora that are based on

a Linux platform. Education-centered variants such as Skolelinux[15] and Sugar[16] operating systems can also be used. Since these are open source platforms, they can easily be customized for use in Nepal, including translating the interface to Nepali.

The Linux-based architecture is a robust design that is not prone to virus attacks. Most of these operating systems do not require extra anti-virus software. This is a big advantage over the Windows architecture, which requires users to constantly update the anti-virus software. Many school computers running on Windows get infected with viruses from external USB flash drives that people use to transfer files. And since most of these computers either do not have antivirus protection, or have outdated versions that have not been updated due to lack of internet connectivity, they are usually slowed down by viruses.

There are many other free and open software programs that can be used in schools and institutions. Instead of paying the high cost for the Microsoft Office productivity suite, free alternatives such as OpenOffice[17] and LibreOffice[18] can be introduced. LibreOffice suite has better language support, and even comes with a Nepali spell-checker. Volunteers from the FOSS Nepal community can help support localized open source software.

Connectivity. Even though recent data indicates that 30% of people in Nepal have access to the internet, this number is misleading since a majority of these people are mobile phone users in areas that are served by 3G networks. In reality, most of them do not use the cellular network to connect to the internet due to the high cost of bandwidth and slow speed. Hence, it is not practical to connect schools using a cellular network.

Nepal Telecom has recently introduced connectivity using WiMAX technology, and has plans to expand coverage to all parts of the country. This will enable schools to connect to the internet at a relatively cheaper cost. Some of the cost toward connecting schools in rural areas and maintaining the connectivity can come from the Nepal Telecommunications Authority's Rural Telecom Development Fund.[19]

While internet connectivity can be used for communications, updates, and occasional research and exploration, most educational content should be provided through a digital library loaded on local school servers so that users do not have to depend on the speed of connections to access large files and videos. In a multiple-user scenario, as in schools, the bandwidth needs to be very high to allow multiple students to access educational materials on the web simultaneously.

Power. Any plan to introduce ICT in schools must include an accompanying plan on how to address the power shortage so that students and teachers are able to use the computers on a regular basis. The Alternative Energy Promotion Board under the Ministry of Science and Technology has initiated programs to install solar power systems in schools, and the MOE should work with the board to ensure that the energy generated meets the

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[15] Skolelinux. www.skolelinux.org.

[16] Sugar Labs Wiki. https://wiki.sugarlabs.org.

[17] Open Office. www.openoffice.org.

[18] LibreOffice. www.libreoffice.org.

[19] Nepal Telecommunications Authority. Rural Telecommunication Development Fund. www.nta.gov.np/en/rural-telecoomunication-development.

requirements of the ICT programs in schools. There also must be more emphasis on the use of low-power energy-efficient devices and technologies. In schools that do not have alternative power sources, but have to work with intermittent power supply, laptops may be a better choice since they can be used even during power outages and their batteries can be charged when electricity is available.

There are many private companies in the country working in the field of alternative energy, and many of them are keen on extending their services to rural areas. The Alternative Energy Promotion Board maintains a list of approved vendors who are contracted to install the systems around the country. The private sector can work toward extending the reach of alternative energy beyond the schools and make it available to the larger community. This kind of holistic approach will benefit the community and minimize the risk of misuse of the system in schools while ensuring its proper care and maintenance. Engaging the community in energy plans is important in attracting contributions from local funds toward the cost of long-term maintenance and parts replacements.

e. ICT Program Deployment and Support

The rollout of ICT in schools has to be planned in a phased manner, and has to begin with ensuring that selected schools are ready to implement the program and benefit fully from new resources. Schools have to meet basic minimum readiness criteria before ICT resources are introduced. Thorough planning, along with the preparation of infrastructure, human resources, training, support, and content have to take place before computers are deployed to schools. The preparatory work should also look into possible local contributions to cover parts of the infrastructure and training costs.

The program should be implemented simultaneously in primary and secondary levels. Instead of distributing arbitrary numbers of computers to schools, the number should correspond to the size of the student body. Schools that have both primary and secondary grades should have separate programs for the two levels, including two separate sets of hardware to ensure enough use time for all students. While durable laptops could be the best hardware option for the basic level (grades 1–8), secondary students (grades 9–12) would benefit more from a lab setup with low-power single-board computers. As much as possible, there should be enough laptops and computers to allow for one-to-one interaction when any particular class is using them. If that is not possible, there should be at least enough machines to allow for a maximum of two students per computer. In such a case, teachers have to pay extra attention to make sure that both students are sharing the use of the computer instead of one monopolizing it. In schools with large class sizes, the students should be divided into sections and use the computers in different periods instead of having many students hovering over one student using the computer. Each school should prepare a weekly schedule for the use of computer resources by students from various grades covering different subjects.

The DEO and resource centers have to be well prepared to support the schools on logistics, technology, and pedagogy. The first phase rollout should be monitored closely. Schools should also be required to include the program in their school improvement plan, and

should be given progress indicators to include in the reports they send to the resource centers and the DEOs. Schools and teachers should also maintain daily records of the use of ICT resources, with teachers recording the lessons taught and challenges faced. There should be a separate record of technical issues and problems, and how they were solved. These documents will help implementers and monitoring officials to get information about the program at the schools while allowing teachers to improve their own practice by reviewing and sharing with their colleagues. In subsequent years, these records can be maintained electronically once the schools and teachers become more technologically savvy.

Tools to monitor the ICT program in schools should be developed, and should include technical, administrative, and pedagogical aspects. On the technical side, the monitoring tools should check the status of computers, network, and power infrastructure, and how the schools have maintained them. On the administrative front, there should be monitoring of how the school is managing the new responsibilities, how the school leadership has ensured that teachers are making maximum use of the resources, and whether the school has community support in ensuring proper utilization of technology in classrooms. On the pedagogical side, monitoring activities should focus on how well teachers are able to integrate ICT to enhance teaching and learning in classrooms. These will include classroom observations and interactions with students and parents.

Having a uniform monitoring tool will also allow planners and implementers to compare the status of the program in different schools and locations, and get a better insight into reasons for success and areas for improvement.

The purpose of monitoring is not just to collect data, but also to use to the data to strengthen the process. Hence, a feedback mechanism is critical in the monitoring process. Resource persons should be trained to provide immediate feedback to schools, especially on administrative and infrastructure matters, and to encourage the community and school leadership to better utilize the ICT resources at schools. Local education training center trainers and DEO school supervisors should use their training to provide immediate feedback to teachers after observing classes. They should be prepared to provide feedback on various aspects of ICT-integrated classes starting from lesson plans prepared by teachers, to classroom management, proper balance between computer and non-computer based activities, and if the class was effective in meeting the stated goals.

Resource persons should also be able to assist schools in coordinating technical maintenance of equipment in schools. Except for a few secondary schools, most schools will not have the technical manpower to carry out maintenance, repair, or update of the systems. Depending on the available external resources in the area, the resource persons should work with the DEOs to involve nearby universities, institutes, and/or vocational training centers to assist in the maintenance at the schools.

Table A2.3 shows activities required in schools during the first year of the program. In subsequent years, schools will only require maintenance support, monitoring, and specialized trainings that can be coordinated by the resource centers. Training programs

Table A2.3: Activities Related to Deploying Information and Communication Technology in Schools—First Year

When	Prelaunch			Launch	Months 2–3	Months 5–6	Months 7–8
Activities	School awareness and readiness	Physical infrastructure, power, network	Initial teacher training	Program launch in schools	In-school training	Monitoring and support	Refresher training
Who	DEO, RC, SMC	School, DEO, RC, SMC, private sector	NCED, ETC, RC	School, DEO, RC, private sector	DEO, RC, ETC	DEO, RC	RC, ETC
Where	Schools	Schools	DEO, ETC	Schools	Schools	Schools	RC, ETC

DEO = district education office, ETC = education training center, NCED =National Center for Educational Development, RC = resource center, SMC = school management committee.

Source: Author.

should be conducted in subsequent years when new assessment tools and EMIS are introduced at the schools.

f. Student Assessment
There are two discussions that need to take place in improving student assessment. One has to center around how assessment systems and tools have to change to make them more relevant and to measure the right performance and achievement metrics. The current testing system was designed for the rote-learning approach to education, and it does not test student problem-solving skills and critical thinking abilities. Since the use of ICT is designed to make students become better thinkers and problem solvers, the assessment system needs to be changed to measure the same.

The second part of the student assessment discussion has to revolve around how ICT can be leveraged to assess students better and in a continuous manner. Integrating assessment into the student learning management system will allow teachers to track student performance automatically.

The use of such advanced assessment tools may not be possible right from the beginning. The OCE should start discussions on the design and development of such tools with the CDC and other bodies. The assessment system can be introduced later after teachers have become comfortable with using ICT in classrooms. The introduction of ICT-based assessment system should be preceded by the use of an automated EMIS and learning management system in schools.

g. Improved Education Management Information System
Currently, the DOE maintains a database of school and aggregate student information that is updated each year based on manual forms filled out by schools. ICT can be used

to collect and maintain individualized student data, which has many advantages, such as accurate information about student performance and better resource allocation. This will also discourage the tendency to inflate the number of students reported by schools each year.

Since the DOE already has a central EMIS database, only the data collection portion of the EMIS needs to be developed and deployed in schools. The database also needs to be modified to allow individualized student information for all students. With ICT equipment becoming available in schools, individualized student records[20] and other school information can be maintained electronically at the school level, and can be uploaded to the central database periodically. This will save a lot of time and effort for schools and teachers, while also improving data accuracy and efficiency.

A simple web-based student information management system can be developed for schools to maintain student personal information, status, attendance, and grades. Principals and teachers can be trained at the resource centers on using the software. It is best to hold the training a year after ICT is introduced in schools to allow them to be comfortable in using the computers. Schools will need support for the first few years on using the software. During these initial years, it would be best to collect paper forms as well in case schools have problems using the software.

Once the EMIS client software is running in the schools, information can be uploaded to the central database via the internet. In places without connectivity, schools can send the records to the DEO using portable storage devices.

In subsequent years, ICT can be used not only to maintain educational information, but also financial information related to the schools.

2. Budget and Finance

The introduction of ICT in schools will require significant investment not just in equipment, but also in content development, training, support, and capacity building. Further, the recurrent costs associated with ICT usage in schools and replacement costs of hardware should be considered after the ICT program is launched.

Schools and communities can mobilize local funds to cover part of the hardware and implementation costs. Local funds can come from development funds that each village development committee receives every year, and from the funds that Parliament members receive toward the development of their constituency. Schools can also get funds from local community forest cooperatives. Further funds can be raised by schools by running various programs.

The Government of Nepal's current scheme of providing computers to almost 8,000 secondary and lower secondary schools requires schools to come up with 30% of the total funds with the remaining 70% coming from the national budget. In the laptop project run

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[20]   The School Teacher Record Office (www.stro.gov.np), a line agency of the MOE, maintains the individual information of teachers in public schools.

by the DOE and OLE Nepal, schools set up maintenance funds with the help of the school management committees to cover the recurrent costs of the program. Similar schemes can be continued to help cover the costs of wider implementation of ICT in education.

Other costs such as trainer preparation, teacher training, content development, and capacity building can come from the MOE's regular budget. In some cases, multilateral and bilateral development partners can be approached to cover the costs of these activities. Private partnerships can also be sought in content development and training programs.

Although the upfront cost of implementing ICT in schools seems large, it can be managed if the deployment is carried out in a phased manner. In the long run, ICT is the most cost-effective way to improve student achievement and retention by enhancing the quality of public education and ensuring more equitable access to quality education.

3. Public–Private Partnership

There are opportunities for public–private partnership in the implementation of ICT in education.

(i) Procurement and installation of hardware and network equipment in schools will need to be done by local vendors and service providers. These local service providers can also be contracted to provide regular technical maintenance support to schools.

(ii) Private service providers can assist the program by bringing internet connectivity to new areas, thus making it possible for schools to connect to the internet. The Government of Nepal can provide incentives to such providers through funds from the Nepal Telecommunications Authority's Rural Telecom Development Fund so that previously underserved regions can benefit.

(iii) Private training institutions can form partnerships with the government to help train and update teachers on using ICT in schools based on the program prepared by the NCED.

(iv) The MOE should work closely with private schools in the development of digital content, teacher training, and program support. Since many private schools are yet to integrate ICT in their classrooms, both sides can benefit from working together in these areas. High-quality digital content, teacher training, and proper infrastructure are components of ICT-based education that both private and public schools need. The partnership can lead to cost savings for both sides while indirectly reducing the disparity between private and public schools.

4. Role Chart

Table A2.4 lists the roles of the key institutions and the steps they are required to take toward the implementation of ICT in schools.

Table A2.4: Roles of and Required Actions from Key Agencies

Agency	Roles	Required Actions
National Planning Commission	• Planning and policies	• Develop internal awareness and capacity about ICT. • Integrate education in the overall ICT policies and plans for a consolidated cross-sector approach. • Confer with practitioners and involve organizations and institutions working in implementing ICT in schools in the planning exercises.
Ministry of Education	• Planning and policies • Budget allocation • Directing line agencies in the proper implementation of respective roles and responsibilities	• Establish ICT in education unit. • Develop internal awareness and capacity about ICT. • Develop detailed action plans to include ICT in education through the revision of the ICT in Education Master Plan and inclusion of detailed plans in the School Sector Reform Plan. • Collaborate with the National Planning Commission and other ministries concerned in the overall expansion of ICT in the country.
Department of Education	• Implementation plans • Monitoring	• Standardize hardware and software to be used in school education with help from universities and practitioners. • Prepare phase-wise implementation plans to introduce ICT in schools. • Monitor progress through district education offices. • Develop internal awareness and capacity about ICT. • Develop program to use ICT in school management, including automation of data collection to strengthen the education management information system.
Curriculum Development Centre	• Digital content • Training program	• Develop capacities of subject experts and committees. • Explore the large amount of digital learning content already available. • Modify computer curriculum to make it more relevant. • Promote the use of ICT within the CDC to increase institutional capacity. • Work with local content developers in the planning, development, and compilation of learning materials. • Assist the National Centre for Education Development in developing training program.

Table A2.4 *continued*

Agency	Roles	Required Actions
National Centre for Education Development	• Teacher training • Teacher professional development	• Develop training program for teachers to integrate ICT in classrooms. • Prepare trainers in various training centers and resource centers around the country. • Include ICT in education skills for teachers in their professional development program. • Work with CDC on compiling teaching and learning resources for schools. • Gain understanding of digital content, and how it can be used in classrooms.
Non-Formal Education Center	• Planning and implementation	• Develop programs to use ICT to provide quality learning tools to out-of-school children. • Use ICT to reach out to more out-of-school children and to deliver programs more effectively.
Education Review Office	• Assessment	• Develop better assessment tools using ICT to measure student achievement. • Design assessment tools that evaluate student abilities in critical thinking and creativity and not on rote learning and memorization.
Higher Secondary Education Board	• Planning and implementation	• Integrate ICT in the teaching-learning process in grades 11 and 12. • Establish a system where students are encouraged to research and explore.
Center for Technical Education and Vocational Training	• Technical maintenance and support	• Assist in the technical maintenance and support of schools surrounding vocational training centers. • Establish vocational training programs in hardware and network installation and support.
Education training centers	• Training • Monitoring and support • Teacher professional development	• Upgrade training facilities to deliver training on integrating ICT in classrooms. • Develop trainers to deliver training to teachers.
District education offices	• Planning and implementation • Monitoring and support • Training	• Build capacity to plan and monitor ICT in education programs in the district. • Prepare a multiphase district-wide implementation plan. • Upgrade technical infrastructure to provide support to schools and resource centers.
Resource centers	• Monitoring and support • Training	• Build capacity to support schools and teachers to successfully integrate ICT in classrooms. • Assist schools in preparing plans to integrate ICT in classrooms. • Monitor the use of ICT in classrooms. • Conduct ongoing training and update programs for surrounding schools.

Table A2.4 *continued*

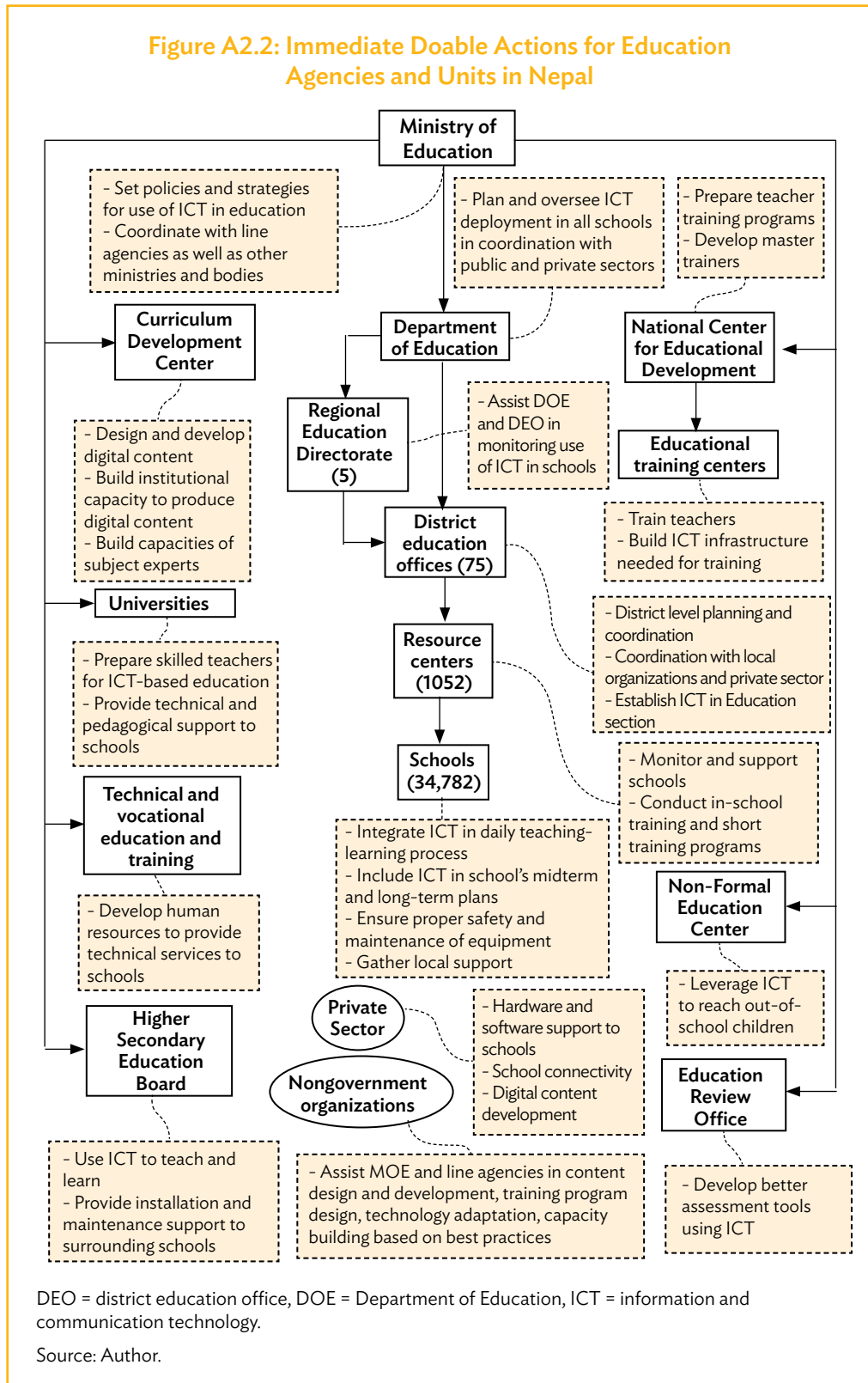| Agency	Roles	Required Actions
School management committees	• Planning • Monitoring • Support	• Work with school administration on planning and implementation at schools. • Assist schools and teachers in the smooth operation of ICT in classrooms. • Assist in the safekeeping of equipment. • Gather community support for the program. • Seek local funds for maintenance and sustainability of the program. • Develop possible activities using ICT to benefit community members in collaboration with teachers.
Universities	• Innovations and research on technology • Technical installation and support • Prepare future teachers on using ICT in classrooms	• Establish an ICT in education program within schools of education. • Integrate ICT in courses so that new teachers are capable of using ICT in classroom instructions. • Establish internship programs where final-year students provide installation and support services at schools. • Start programs that encourage innovation and challenges students to come up with solutions to practical problems in development. • Encourage students to leverage open source technology to build applications and solutions. • Improve technical infrastructure and develop human capacity to use online courses.
Nongovernment organizations and other institutions	• Planning • Capacity building • Training • Education content • Technical installation	• Actively participate in the planning of various aspects of ICT implementation in schools. • Assist in training, educational content, technical installations, and capacity building. • Share experience and learning from the use of ICT in schools. • Demonstrate successful use of ICT in schools in Nepal to planners and policy makers. • Pilot new ideas and approaches and share results with policy makers.

CDC = Curriculum Development Centre, ICT = information and communication technology.

Source: Author.

Figure A2.2 shows the organizational chart of the entire MOE system, as well as other stakeholders such as organizations and the private sector, and their key roles of each of them in the use of ICT in school education.

Figure A2.2: Immediate Doable Actions for Education Agencies and Units in Nepal

Ministry of Education

– Set policies and strategies for use of ICT in education
– Coordinate with line agencies as well as other ministries and bodies

– Plan and oversee ICT deployment in all schools in coordination with public and private sectors

– Prepare teacher training programs
– Develop master trainers

Curriculum Development Center

Department of Education

National Center for Educational Development

– Design and develop digital content
– Build institutional capacity to produce digital content
– Build capacities of subject experts

Regional Education Directorate (5)

– Assist DOE and DEO in monitoring use of ICT in schools

Educational training centers

District education offices (75)

– Train teachers
– Build ICT infrastructure needed for training

Universities

Resource centers (1052)

– District level planning and coordination
– Coordination with local organizations and private sector
– Establish ICT in Education section

– Prepare skilled teachers for ICT-based education
– Provide technical and pedagogical support to schools

Schools (34,782)

– Monitor and support schools
– Conduct in-school training and short training programs

Technical and vocational education and training

– Integrate ICT in daily teaching-learning process
– Include ICT in school's midterm and long-term plans
– Ensure proper safety and maintenance of equipment
– Gather local support

Non-Formal Education Center

– Develop human resources to provide technical services to schools

– Leverage ICT to reach out-of-school children

Higher Secondary Education Board

Private Sector

Nongovernment organizations

– Hardware and software support to schools
– School connectivity
– Digital content development

Education Review Office

– Use ICT to teach and learn
– Provide installation and maintenance support to surrounding schools

– Assist MOE and line agencies in content design and development, training program design, technology adaptation, capacity building based on best practices

– Develop better assessment tools using ICT

DEO = district education office, DOE = Department of Education, ICT = information and communication technology.

Source: Author.

5. Vision, Priorities, Strategies, and Timeline for Information and Communication Technology in Education in Nepal

Tables A2.5–A2.8 summarize the vision, priorities, and strategies for ICT in education in Nepal.

Table A2.5: Vision of Information and Communication Technology in Education in Nepal

	Short-Term	Midterm	Long-Term
Country	Increased use of ICT to promote effective governance and transparency	Comprehensive national plan to use ICT in all sectors to promote economic growth	Prosperity and growth in an ICT-enabled knowledge-based society
Education system	Improved access to quality education using ICT	Use ICT as a key component in education content development and delivery	Integrate ICT in school education and administration
Students	Comfortable using ICT tools to learn	Access, share, create, learn using ICT tools and resources	Active and engaged learners using ICT-integrated learning platform
Teachers	Use ICT to deliver some of the course content	Practice ICT-based enhanced pedagogy	Effective facilitators in a rich ICT-based learning environment
Schools	Enhanced learning through the use of ICT	Facilitating quality learning using ICT	Innovative learning environment based on ICT
Universities	Proper infrastructure to use ICT in learning and research	Faculty and students using ICT widely to prepare and share lecture and research work	Actively involved in the ICT-enabled global community of higher education

ICT = information and communication technology.

Source: Author.

The priority areas for ICT in education in Nepal are:

(i)   school infrastructure—physical, electric power, network, and connectivity;
(ii)   human resource development—teachers, trainers, curriculum experts, monitoring team, technical team, administrators;
(iii)   institutional capacity—Ministry of Education and line agencies, district education offices, resource centers; both infrastructure and human capacity;
(iv)   access—connectivity, devices, digital library, and distance and open education;
(v)   digital content—grade- and subject-specific learning content and reference materials;
(vi)   assessment—better tools that leverage technology and assess student skills and achievement;
(vii)   education management information system (EMIS)—improved school and student data collection and management; and
(viii) university involvement—teacher education, technical resources, and school support.

Table A2.6: Priority Areas for Information and Communication Technology in Education in Nepal

PRIORITIES
1. School infrastructure—physical, electric power, network, and connectivity
2. Human resource development—teachers, trainers, curriculum experts, monitoring team, technical team, administrators
3. Institutional capacity—Ministry of Education and line agencies, district education offices, resource centers; both infrastructure and human capacity
4. Access—connectivity, devices, digital library, and distance and open education
5. Digital content—grade- and subject-specific learning content and reference materials
6. Assessment—better tools that leverage technology and assess student skills and achievement
7. Education management information system (EMIS)—improved school and student data collection and management
8. University involvement—teacher education, technical resources, and school support

Source: Author.

Table A2.7: Strategies for the Successful Use of Information and Communication Technology in Education

1. Build institutional capacities
• ICT awareness and adoption must start from the MOE and its line agencies. • Capacities of training, content development, implementation, monitoring, and support institutions must be developed for the successful deployment of ICT in schools. • The capacity building process should be hands-on, and not just theoretical, and should encourage the personnel to use ICT on a regular basis. • District supervisors and resource persons should receive training alongside teachers to effectively monitor and support teachers in the future. • Add IT resources in central, district, and local levels as needed. • Prepare training and resource centers to train and support schools.
2. Build on good practices
• The DOE and OLE Nepal's laptop project has covered training, digital content, and technical infrastructure in the primary grades. This can be used as a basis to develop programs for other grades, while refining the model with feedback from schools. • The Nepal Wireless Project has set a good example of community investment and support in establishing and supporting ICT infrastructure. • Help Nepal Network has successfully mobilized university students to help install technical infrastructure in schools. • Adapt available resources on the internet.
3. Form a team of experts from the Government of Nepal, universities, the private sector, and NGOs
• Help formulate an overall plan to mainstream ICT in education. • Propose possible public–private partnership avenues. • Assist in the design and delivery of training and digital content. • Advise on possible technology infrastructure in schools.
4. Plan and design ICT intervention

Table A2.7 *continued*

• Focus should be on enhancing teaching and learning. • Keep class size in mind when determining the number of devices in schools. • Hardware and software choices should match the school's context. • Open source software should be promoted for cost savings and localization.

5. Infrastructure building

• Emphasize on low-power, low-cost, easy to maintain devices in schools. • Innovative technologies should be introduced wherever possible. • Internet connectivity should be used for communication and collaboration. • Establish a local digital library to store educational resources. • Arrange alternative energy systems in schools to provide power needed for equipment.

6. Teacher preparation and support

• Prepare teachers for their new role as facilitators. • Train not just on ICT literacy, but on using ICT effectively to enhance teaching and learning in classrooms. • Develop training program to train in-service teachers through government trainers. • Training must be hands-on and include practice teaching and classroom observations. • Prepare training centers to conduct such training programs. • New teachers graduating from university education programs should already possess skills and knowledge to conduct ICT-integrated classes. • Specialized training programs to update teachers can be done in resource centers. • Introduce accreditation program to provide extra motivation.

7. Digital Content

• Begin with reviewing and adapting content that is already available. • Work with NGOs and private sector organizations that are already developing digital content. • Build capacity within the CDC to lead the effort to develop and maintain content. • Actual software development should be outsourced, but design and review should be done by CDC experts. • Prepare interactive content for all grades and subjects. • Develop a continuous assessment program to evaluate what students have learned.

8. Budget and finances

• Budget for total cost of ownership, not just equipment and software. • Plan for recurrent and replacement costs of hardware in addition to initial investment. • Schools and communities should mobilize local funds to cover part of the costs, including recurrent costs. • Each school should establish maintenance funds for regular upkeep of the equipment. • The MOE should allocate ample funds toward content development and review and teacher training, and not just for hardware procurement.

CDC = Curriculum Development Centre, DOE = Department of Education, ICT = information and communication technology, IT = information technology, MOE = Ministry of Environment, NGO = nongovernment organization, OLE Nepal = Open Learning Exchange.

Source: Author.

Table A2.8: Timeline for Information and Communication Technology in Education Programs and Activities

	Immediate (within a year)	Mid-Term (in 5 Years)	Long-Term (in 10 years)
School infrastructure	• Prepare school physical infrastructure • Place computers in schools that are ready • Prepare plans to supply power in schools without electricity • Set up internet access in some schools	• Computers in all secondary and lower secondary schools • Alternative energy sources to supply schools with power • Digital library in all schools • Learning management system for teachers to organize and deliver courses • Set up internet in most schools	• Sufficient number of computers in all schools from primary to secondary levels • Plan in place to replace and update computers and other equipment in schools • Digital library and learning management system used regularly in all schools • Ensure internet access in all schools
Technology	• Decide the type of hardware and software appropriate for different grade levels based on requirements for usability, cost, sustainability, support, and maintenance • Standardize hardware and software for education purpose	• Use of open source operating system and software applications in schools • Wide-scale use of low-power low-cost devices • Review hardware and software standardization based on feedback from schools	• New innovations in technology introduced in schools on a regular basis, especially when hardware is replaced
Content and curriculum	• Use locally available digital learning content • Involve the CDC in the assessment and approval of existing content • Discuss modality for development of more learning tools and activities in collaboration with NGOs and private sector; update ICT subject curriculum	• Develop digital content in all subjects and grades to enhance school education • Ensure that CDC is able to lead the design and development of new activities and update existing ones in collaboration with the private sector and NGOs • Digital content in other local languages • Open source software and technology included in ICT subject curriculum	• Continually update digital content • Content available in other local languages to support mother tongue education in early grades • Teacher-created lesson plans and other content available through digital library • Regularly update ICT subject curriculum

Table A2.8 *continued*

	Immediate (within a year)	Mid-Term (in 5 Years)	Long-Term (in 10 years)
Teacher preparation	• Prepare training programs for in-service teachers • Develop master trainers • Discuss plans on where and how to train in-service and incoming teachers	• Ensure that all training centers are equipped to train teachers • Set up resource centers that are equipped to provide refresher training for teachers • Make accreditation and certification available for teachers on the use of ICT in classrooms • Universities should offer ICT in education courses to future teachers	• Ensure that all teachers are trained and certified in using ICT in classrooms • Ensure that all incoming teachers have the skills to use ICT in classrooms • Teachers should share resources with colleagues from other schools
Assessment	• Start discussions on how assessment can be improved to leverage ICT to accurately evaluate student achievement	• Develop and introduce continuous assessment system based on technology as a pilot	• Integrate automated continuous assessment system in the learning management system to track student performance
EMIS	• Develop software specifications for student records and school management	• Introduce EMIS software in schools to maintain and collect student and school information	• All schools using EMIS to maintain student and school records and integrate them into the national database
Capacity development	• Develop institutional capacity development program for various bodies in the education system	• District officials and resource persons receive training alongside teachers	• MOE system fully able to plan, design, deliver, and support comprehensive and effective use of ICT in schools

CDC = Curriculum Development Cetre, EMIS = education management information system,
ICT = information and communication technology, MOE = Ministry of Environment,
NGO = nongovernment organization.

Source: Author.

E. Conclusion and Recommendations

1. Summary and Conclusion

The overall policies and plans of the Government of Nepal are favorable toward the implementation of ICT in schools. Developments in other areas such as technology, infrastructure, digital content, and higher education have made it more feasible to use ICT to improve the quality of and access to education in Nepal's public schools. There

is increased awareness from central to local levels on the benefits of ICT in education and other sectors, leading to an increased interest in applying ICT to address various development challenges. With a collective and sincere effort from all stakeholders, the vision of ICT-integrated education can become reality in the country.

The government's plans and policies, including national plans, IT policy, and the e-Government Master Plan, propose the use of ICT in governance, education, health, communications, and delivery of other services, and have outlined strategies and plans to develop the necessary skills and encourage investments in ICT. The MOE has also stepped up by including the use of ICT in education in the School Sector Reform Plan, and included computer literacy as a subject in lower secondary and secondary grades. The government has also funded the installation of computers in a number of schools over the past few years so that students can get hands-on learning to go with theoretical learning about computers. Recently, the MOE has shown more resolve to transform school education through the use of ICT by preparing the ICT in Education Master Plan. The DOE has also prepared a directive on ICT in education that is sent to DEOs outlining responsibilities of various local bodies in this new approach to education.

On the policy level, the MOE has to open discussion on the recently prepared ICT in Education Master Plan. The experiences and learning from various ICT in education implementations in the country should be incorporated to strengthen the master plan, and a realistic action plan has to be worked out. Use of ICT in school education should be given priority in the School Sector Reform Plan, and stakeholders, including development partners, need to be convinced of the benefits of technology in improving school education and of the government's commitment to transform school education through technology-enhanced learner-centered teaching and learning methods.

The MOE has to establish a separate unit assigned to oversee the use of ICT in schools. Similar units have to be established in key line agencies such as the DOE, CDC, the NCED, and the Non-Formal Education Centre. These units will plan and coordinate the efforts at their respective institutions, collaborate with other institutions when and where needed, and be responsible for ensuring that the tasks assigned for the institutions are carried out. These units should also have clear plans for developing the capacities of their institutions toward the implementation of ICT in school education.

The implementation of ICT in schools has to include efforts in the areas of content design and development, teacher training, deployment of technical infrastructure, and capacity building. The plan should involve all departments and agencies concerned, universities and technical institutions, the private sector, NGOs, groups working in the field of ICT in education, school communities, and local institutions. A lot of work has to be done in planning, capacity building and training, and content digitization before technology is introduced in schools. The MOE should not rush into simply distributing hardware to schools, but ensure that schools and the system are ready to integrate technology in classrooms and gain the full benefit of the new approach to learning. Planners, policy makers, implementers, schools, teachers, and communities should all keep in mind that technology on its own will not solve all the problems that the nation faces in providing quality education to its children. Technology is an enabler and, at best, a magnifier, of human commitment to achieve the goals of improved learning.

The timing is right for Nepal to start the integration of ICT in school education to improve the quality of learning and to ensure equitable access to learning opportunities so that student performance can be raised to be on par with international standards. It will also help students develop other skills that will make them competitive in the global knowledge-based economy. There is now an enabling environment for integrating ICT in education. Favorable plans and policies have been introduced in recent years. Innovations and advancements have made technology more affordable and pervasive. Many digital learning materials are available for teaching and learning. The country has been developing the workforce required to deploy and support technology in education and other sectors. There is a general awareness and a sense of urgency among decision makers and the general public to leverage technology to address development challenges. Nepal is poised for a major transformation in the educational landscape enabled by the introduction of technology in schools. A comprehensive sincere effort is needed from all stakeholders to help bring the change that is long overdue in Nepal's public education and provide students with a meaningful and engaged learning environment, which will help build the qualified workforce needed to set the country on the path of economic growth and prosperity.

2. Key Recommendations

a. Planning and Policy

(i)   Establish ICT in education units at the MOE and other line agencies.
(ii)   Promote the use of ICT within the MOE and its line agencies.
(iii)   Review and strengthen the ICT in Education Master Plan; set milestones with clear roles and responsibilities.
(iv)   Collaborate with the Ministry of Science and Technology, the Ministry of Information and Communication, and other government agencies to leverage programs in ICT that can benefit schools.
(v)   Allocate budget for training preparation and delivery, content preparation, and capacity building, and not just to procure computer hardware.
(vi)   Involve district- and school-level resources in the overall design of the program.
(vii)   Include experts from local NGOs and institutions that have implemented ICT programs in schools, and incorporate the experiences so far.
(viii) Focus on learner-centered solutions involving technology.
(ix)   Deployment of ICT should be part of an overall plan that includes digital content, training, and support; this requires careful planning at the central and local levels.
(x)   Set minimum school-readiness criteria.
(xi)   Prepare a phased expansion of the program, both in terms of scale and level of technology integration.
(xii)   Prepare separate programs for the use of ICT in primary and secondary levels.
(xiii) Explore avenues for partnership with the private sector.

b. Training and Capacity Building

(i)   Develop teacher training programs that prepare teachers in their new roles as facilitators in ICT-integrated classrooms.

(ii)   Training should be provided to all teachers, and not just to a few "computer teachers."
(iii) Residential training must be supplemented with in-school training and support.
(iv)   Provide incentives to motivate teachers to use ICT effectively in classrooms.
(v)   Develop capacity at the central and local levels to train teachers, and to monitor and support schools.
(vi)   Training and capacity building exercises should be hands-on and engaging, just like the planned new paradigm of teaching and learning implemented through ICT use.
(vii) Institutional capacity building of various agencies should cover both administrative and technical capacity.
(viii) Equip training and resource centers to train and support ICT-based education.

c. Educational Content

(i)   Prepare digital learning materials that can be used in various subjects and grades; adapt and use available existing materials as much as possible.
(ii)   Introduce digital content that promotes self-learning and self-assessment.
(iii) Create guides that teachers can follow to integrate digital learning materials in classrooms.
(iv)   Revise ICT subject curriculum.
(v)   Revise assessment tools to accurately evaluate student achievement instead of testing students on their ability to memorize and retain information.
(vi)   Use ICT for improved, continuous, and relevant assessment.

d. Technology Infrastructure

(i)   Standardize hardware and software to be used in schools.
(ii)   Seek low-power innovative hardware solutions.
(iii) Maximize the use of open source software and technology.
(iv)   Discourage the use of pirated software in schools and offices.
(v)   Provide learning materials at schools using school servers and intranet instead of relying on internet connectivity.
(vi)   Promote the use of alternative energy to address the power shortage in schools.
(vii) Establish technical and vocational education and training programs to develop skills to help maintain technical infrastructure in schools.

e. University Involvement

(i)   Introduce ICT in education elective courses in university education.
(ii)   Build infrastructure and programs to take advantage of online resources at universities.
(iii) Develop internship programs for university students to work in schools to assist in the ICT integration.

APPENDIX 3: INFORMATION AND COMMUNICATION TECHNOLOGY IN EDUCATION IN SRI LANKA

A. Background

1. Current Situation of Information and Communication Technology in Sri Lanka

Information and communication technology (ICT) is a fast-growing sector of the economy that provides both direct and indirect employment and export income. It is also widely recognized that developments in ICT enhance the efficiency and competitiveness of economic sectors and the national economy. Sri Lanka is a small open economy with a per capita income of $3,280 and a labor force of 8.4 million in 2013. From 1978 to 2009, it maintained an average growth rate of 5% per annum and, during 2010–2013, it increased up to 7.4% per annum.

The structural changes in the economy over the past 2 decades have resulted in the emergence of higher value-added manufacturing and service-oriented activities as major sources of employment, foreign exchange earnings, and contribution to gross domestic product (GDP). For example, the share of the industrial sector in total GDP increased from 22% in 1990 to 28% in 2013, and the services sector increased its contribution to GDP (50% –60%) and employment significantly during the same period. Within the services sector, the major areas of employment growth have been in retail trade, health, education, and business services subsectors.

2. Current Status of Information and Communication Technology in Sri Lanka

Communication services has been one of the most dynamic sectors of the economy during the post-liberalization period.[1]

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[1] The introduction of liberalized economic policies commenced in 1977, and it continued without any major changes up to 2006.

The infrastructure support from communication services at present includes 4 fixed lines, 5 mobile, 14 data communications, and 32 external gateway operations.[2] From 2009 to 2013, the computer and information services subsector has demonstrated improved performance with an increased growth rate of 15% per annum during this period. In October 2013, Sri Lanka was named Outsourcing Destination of the Year by the National Outsourcing Association of the United Kingdom, highlighting Sri Lanka's vast potential in software and information technology-enabled services such as business process outsourcing and knowledge process outsourcing.

The sharp growth in internet services was the highlight of the telecommunication sector in 2013. Total internet connections grew by 47% from 2012 to 2013, increasing internet penetration (connections per 100 persons) to 9.8%. This was largely supported by the accelerated growth in mobile internet connections, followed by fixed internet connections. Actual internet penetration and access to the internet may be much higher than the above estimates, as these do not include those who are connected to internet via mobile phones without having a proper data package.[3] Further, in the above estimates, common access points such as workplaces, *Nenasala* centers (knowledge centers), private internet cafes, and household fixed-line internet connections have been considered as single connections, despite being accessible to multiple users. Considering the rapid expansion in the coverage of third generation (3G), fourth generation (4G), and fixed-line internet services by mobile and fixed line operators, it is expected that the growth momentum in internet penetration will continue in the upcoming years. Low entry costs, competitive pricing, and promotional schemes from operators are expected to facilitate this trend.

Sri Lanka ranks first in the world for the lowest entry-level fixed broadband charges. The demand for basic voice services appears to be reaching the saturation point consequent to the continued rapid growth in recent years. The fixed wireless telephone connections, on the other hand, continued to decline, recording a drop in fixed access telephone penetration to 13.2% in 2013 from 17.0% in 2012. The mobile penetration stood at 99.2% at the end of 2013 indicating that, on average, every Sri Lankan possesses a mobile connection. The Telecommunication Regulatory Commission continues to actively facilitate the development of the telecommunication industry. The commission released the frequency spectrum for 4G mobile broadband to support the expansion of modern mobile broadband technology, and 4G services were commercially launched in 2013. Recognizing the importance of continued provisioning of telecommunication services at affordable prices, the Telecommunication Regulatory Commission has initiated several measures to promote shared resources among service providers to reduce the cost of infrastructure expansion so that tariffs can be further reduced. The construction of the Colombo Lotus Tower, which will facilitate the transmission of signals of 50 television channels and over 35 radio stations while providing numerous commercial and entertainment amenities, is expected to be completed by 2015.[4]

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[2]   Central Bank of Sri Lanka. 2013. *Annual Report, 2013.* Telecommunication Regulatory Commission of Sri Lanka, Department of Census and Statistics. Colombo.

[3]   Central Bank of Sri Lanka. 2013. *Annual Report 2013.* Colombo.

[4]   The Tower is still under construction and will be completed in early 2018.

The government has identified information technology (IT) business process outsourcing as one of the priority sectors in view of its potential for growth, capacity to provide employment for educated youth, and potential foreign exchange earnings. The ICT workforce surveys showed steady growth in all occupational subcategories from 2003 to 2013. For example, the overall ICT workforce increased more than five times, from 15,000 in 2003 to 80,000 in 2011.[5]

The emphasis on ICT as a tool to promote education became prominent worldwide in the early 1990s. Use of ICT in education is more critical today than before because of its potential in promoting student-centered learning. Thus, the use of ICT is widely accepted as an important means to promote students' skills for cooperation, communication, problem solving, and lifelong learning. In spite of significant achievements in primary and secondary education, Sri Lanka is far behind in infrastructure support for the use of ICT in education. Its relative ranking in terms of quality of math and science education and enrollment at the tertiary level is significantly low relative to some of the best performers in Asia.[6] With respect to ICT competitiveness in particular, Sri Lanka needs to make significant progress in vital areas such as internet access in schools and internet usage. In the network readiness index, Sri Lanka has improved its ranking from 71 in 2012 to 69 in 2013, and to 79 in 2014. Sri Lanka is ranked no. 1 under the affordability pillar of the readiness sub-index for the low costs of its fixed broadband internet tariffs and no. 4 for its prepaid mobile cellular tariffs. In terms of quality of education system conducive to ICT, Sri Lanka ranked highly, at no. 28 (Table A3.1).[7]

Table A3.1: Competitiveness in Information and Communication Technology: 2007–2008 and 2013–2014, Sri Lanka

Category	2007–2008	2013–2014
Quality of primary education	51.0	43.0
Primary education enrollment rate	97.0	84.0
Secondary education enrollment rate	82.5	102.0
Tertiary education enrollment rate	11.0	14.3
Quality of the educational system	55.0	28.0
Quality of math and science education	55.0	46.0
Quality of management schools	56.0	37.0
Internet access in schools	77.0	108.0
Local availability of specialized research and training services	67.0	53.0
Extent of staff training	51.0	52.0
Internet users	118.0	105.0
Fixed broadband internet subscriptions	95.0	100.0
Mobile broadband subscriptions	101.0	102.0

Source: World Economic Forum. *Global Competitiveness Report,* 2007–2008 and 2013–2014. Geneva.

[5]   Information and Communication Technology Association. 2013. *National ICT Workforce Survey, 2013.* Colombo.

[6]   World Economic Forum. 2013. *Global Competitiveness Report 2013–2014.* Geneva.

[7]   World Economic Forum. 2007. *Global Competitiveness Report, 2007–2008 and 2013–2014.* Geneva.

3. Information and Communication Technology Policies and Plans

The first attempt to develop ICT in Sri Lanka was taken by the Natural Resources, Energy and Science Authority of Sri Lanka in 1983. A committee appointed by the Natural Resources, Energy and Science Authority produced the National Computer Policy Report (COMPOL). The government's acceptance of the report gave rise to the establishment of Sri Lanka's Computer and Information Technology Council (CINTEC) through Act No. 10 of 1984, to function directly under the then president. The Science and Technology Development Act No. 11 of 1994 changed the name to Council for Information Technology, but retained the acronym CINTEC.

In November 2002, the e-Sri Lanka Project was launched with the objective to develop a national ICT road map or action plan. The road map resulted in the formulation and implementation of the Information and Communication Technology Act No. 27 of 2003, which is now known as the Sri Lanka e-Policy, and established the Information and Communication Technology Agency (ICTA), repealing the relevant section of the Science and Technology Development Act that established CINTEC. ICTA has been operational since July 2003. In 2001, the Government of Sri Lanka also entered into a contract with the Swedish International Development Agency to support these initiatives.

The e-Sri Lanka Development Initiative is an ICT development strategy implemented by ICTA. The primary objective of the project's first phase is to leverage ICT to develop the national economy, reduce poverty, and improve the quality of life.[8] It consists of seven programs: (i) ICT policy; (ii) leadership and institutional development; (iii) information infrastructure; (iv) re-engineering government; (v) human resource development; (vi) ICT investment and private sector development; and (vii) e-society. The e-society program promotes ICT in education through the Community Assistance Program and Partnership Assistance Program. The government has approved phase 2 of the Sri Lanka Development Initiative. Subject to stipulations laid down by the General Treasury, the second phase of the project is to be implemented over 5–6 years, and started in the first quarter of 2014.

ICTA has been consistently enabling general public accessibility to information and communication services while improving efficiency, effectiveness, and quality of services in government organizations. In 2013, 54 new *Nenasala* centers were established nationwide, increasing the total number of *Nenasala* centers to 741, giving the rural communities better access to ICT-based services. Out of these, 41 new *Nenasala* centers were established in the Northern Province to support rapid development in conflict-affected areas. In 2013, 74 government organizations were connected to the Lanka Government Network, which provides remote services to citizens through secure electronic communications. By the end of 2013, around 550 central and provincial government organizations have been connected to the Lanka Government Network.

Sri Lanka's development strategy as articulated in the Mahinda Chintana Vision for the Future is to achieve a growth rate of 8% per annum and double the per capita income from

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[8]   This was launched in 2004 in collaboration with the World Bank and is worth $83 million. Phase 1 of the project concluded in December 2013.

$2,375 in 2010 to $4,470 by 2016.[9] The five hubs strategy also involves the creation of job opportunities in several subsectors of industry and services sectors (Mahinda Chintana 2010, p. 15).[10] The government's vision is to drive the economy as a knowledge-based economy, paying particular attention to IT, automation, innovation, and research (Mahinda Chintana 2013, p. 25). One of the 12 priority sectors identified by the government in its medium- and long-term development plans is IT business process outsourcing. As stated in the Mahinda Chintana Vision for the Future and the Public Investment Strategy 2014–2016 (National Planning Department [NPD] 2013, p. 185), the government's strategy is to equip future generations of Sri Lankan citizens with competencies to meet the challenges of a changing, globalized, knowledge-driven economy. The Budget Speech 2014 also stated that the government's vision over the next 3 years is to "lift Sri Lanka into the category of 'Top 30 Countries' and to double the foreign earnings as well as employment opportunities in ICT industry" (Budget Speech 2014, Section 34.1). The government has also proposed to "develop an ICT Zone at Hambantota as the emerging ICT Hub of South Asia, capitalizing on the newly built infrastructure such as the port, airport, expressway and the railway network, and by promoting investments in this zone" (Budget Speech 2014, Section 34.2).

4. Information and Communication Technology Policies and Plans in Education

People in the 21st century live in a technology and media-driven environment. It is characterized by access to an abundance of information, rapid changes in technology tools, and the ability to collaborate and make individual contributions on an unprecedented scale. To be effective in the 21st century, new entrants to the labor market must be able to exhibit a range of functional and critical thinking skills. Modern life and work environments require far more than thinking skills and content knowledge: they involve knowledge and skills in creativity and innovation, critical thinking and problem solving, and communication and collaboration. Thus, an ICT-oriented education system needs to be created to help students master the multidimensional abilities required of them in the 21st century.

Sri Lanka is yet to make significant progress in the adoption and use of ICT in education despite major achievements in the telecommunication industry and the existence of the medium- and long-term development programs of the government, which identified ICT as major sector for growth and modernization of the education sector as a priority development strategy. The policy documents at the subsectoral level include the use of modern technology in education.

The policy emphasis of the government is to focus on the next century in developing the education system (NPD 2010, p. 71). The government is aiming for an education system that will provide the competencies and technological skills required for rapid economic and social development. Thus, the education policy aims at creating a knowledge-based society, with educational institutions producing a workforce with the skills required to face emerging societal challenges. It recognizes the necessity of promoting equity and enhancing the quality and relevance of education, while improving governance in service delivery. The

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[9]   The per capita income in 2013 was already $3,280. It is projected that it will reach $4,470 in 2016, exceeding the target in the Mahinda Chintana Vision for the Future 2010.

[10]   Naval, aviation, commercial, energy, and knowledge hubs.

policy also aims at promoting values and attitudes needed by individuals to live in peace and harmony in a disciplined society (NPD 2010, p. 112).

The policy documents also state that the quality of basic and secondary education will be improved through diversification of the curriculum and improving student achievement in secondary schools in English, science, mathematics, ICT, and management (NPD 2010, p. 116). With respect to the use of ICT in improving information systems, it states that a dynamic online information center, which is intended to house a database system and function as resource center for ICT-based learning materials and sources, will be established in the Ministry of Education to provide the necessary information and material for students, teachers, parents, and school administrators. The latest and most reliable information in relation to schools and school-based assessments, postsecondary education planning, apprenticeship training, career planning, curriculum, teaching resources, exams, and health and safety measures will be disseminated to students, teachers, parents, and school administrators through this online information center (NPD 2010, p. 117).

The latest policy document, Unstoppable Sri Lanka 2020 (NPD 2013), states that the government`s vision is that the future generations of Sri Lankan citizens are equipped with competencies to meet the challenges of a changing, globalized, and knowledge-driven economy. The knowledge path covers the entire education sector representing general education, skills education, and higher education. The first strategy is to create a child-friendly education system by improving physical and learning facilities, teacher development, and capacity development. This involves providing *Mahindodaya* technological labs for 1,000 secondary schools.[11] In these laboratories, a language lab, mathematics lab, distance education unit, and a computer lab are to be established. Facilities of about 5,000 primary schools in isolated or remote areas will also be improved.

A special education affairs advisory committee in Parliament presented new education policies and proposals to the cabinet and to Parliament (Ministry of Education [MOE] 2014). Its policy recommendations on ICT (Section 3.9) include the use of modern technology in education, equitable distribution of resources, human resources development, legal support systems, and self-financing. It states that students of Sri Lanka should be made children of the new millennium by providing them with modern technology applications in education such as the internet, multimedia technology, computer technology, distance education methods, and electronic media including TV (Section 3.9.3). Suitable cocurricular tools are also to be provided for the enhancement of education of the children (Section 3.9.5). It also proposes to develop teachers, principals, and education administrators through training (Section 3.9.9).

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[11]   At least three for each divisional education secretariat so that they are distributed evenly throughout the island.

B. Analysis of Information and Communication Technology in Education in Sri Lanka

1. Programs and Projects Implemented

ICT education in Sri Lanka dates back to the early 1980s, with certain schools acquiring computers in 1983. A national policy on IT in schools was implemented in 2002 to create a computer-literate generation that would be able to use computer technology in the workforce and be prepared to join the IT profession. In 2006, the government stated that "all *Maha Vidyalayas* and Central Colleges will be fully developed with all modern facilities. Science laboratories for advanced level students, language centers with facilities to teach Sinhala, Tamil, and English, Computer laboratories, library and sports centers will be among such facilities" (NPD 2006, p. 69). Subsequently, the Government of Sri Lanka declared 2009 the country's year of IT and invested greatly in computer education programs all over the country.

The initial national policy on ICT affirms the government's commitment to provide state-of-the-art knowledge of ICT to Sri Lanka's younger generation to prepare them to face the challenges of the 21st century (Vithanage 2004). There was an action plan from 2000 to 2007 in the form of a strategic plan for policy implementation. This 6-year project period was divided into three stages: Stage 1, 2002–2003; Stage 2, 2004–2005; and Stage 3, 2006–2007. During these 6 years, the action plan focused on the use of ICT both in education (learning and teaching) and in the management of the education system.

The Education Sector Development Framework Program (2012–2016) adopted by the MOE specifically aims at transforming the Sri Lankan school system to lay the human capital foundation needed for growth and development (Chandrasiri 2010). Accordingly, several measures have been taken to promote ICT in education with active support from the donor community (Table A3.2).

The government has also developed another web-based platform—www.ebook.gov.bd—where digital copies of all textbooks are available in PDF format. A total of 300 textbooks and 100 auxiliary books are available in this portal. Initiatives are underway to make them interactive so that, by double-clicking on a particular topic, one can get additional information, images, and even videos.

On the strength of these interventions, the school education system in Sri Lanka has been able to offer ICT courses to general certificate of education ordinary level (GCE O/L) and advance level (GCE A/L) students and a general information technology course to A/L students. The main objective of the ICT O/L syllabus is fivefold: (i) impart basic computer literacy and develop a base for further studies in ICT, (ii) develop the understanding of the use of different types of ICT applications and the effects of their use, (iii) develop the concepts and principles related to ICT, (iv) improve the skills necessary for the development of ICT-based solutions for real-world problems, and (v) create an awareness of the benefits and problems of ICT use. As in other subjects, ICT is taught in three languages (Sinhala, Tamil, and English) and technical terms are in English. At the end,

Table A3.2: Various Information and Communication Technology in Education Initiatives in Sri Lanka

Project/Program Implementation	Target Outcome	ICT in Education Component(s)	Main Strategies	What Is Missing?	What Should Be Done?
Secondary Education Modernization Project 1, 2000–2006 (supported by ADB)	Modernization of 2,300 secondary schools

800 secondary schools with computer learning centers (CLCs) | Technology-directed learning

Computer training

Hardware and connectivity | Narrow the digital divide | –School readiness assessment –Teacher training –Proper follow-up and monitoring –Uniformity in hardware standards | – Ensure school readiness so that they can take full benefit of the resources – Train teachers on using digital content in classroom |
| General Education Project, 2003–2006 (supported by the Word Bank) | Capacity building

Establish computer centers

Curriculum development | – Train 6,400 teachers in ICT literacy – 400 schools equipped with computer centers – Pool of 80 IT trainers | Promote ICT-based education

Capacity building | Limited coverage

Inadequate infrastructure support | Inadequate emphasis on ICT in school education

Inter-institutional coordination |
| Secondary Education Moderation Project II, 2004–2009 (supported by ADB) | SchoolNet facility

Isuru Schools Development Programme

Train teachers in ICT applications | Provide ICDL/computer-assisted learning training for 10,600 teachers

Provide IPICT for 18,000 teachers

Establish management information system | Enhance connectivity

Establish MIS applications within school system

Popularize web usage | Inadequacies in infrastructure support

Inadequate support from school administrators | Proper maintenance and updating of School Net

Encourage private sector participation in teacher training |
| Education for Knowledge Society Project, 2008–2013 (supported by ADB) | – ICT facilities for 2,125 type II schools – Provide ICDL training for 10,600 teachers – Provide IPICT for 18,000teachers – Establish management information system | Strengthen the use of computer and software for ensuring best practices in teaching and learning process, the innovative ICT skills of schools, IT literacy | Enhance ICT literacy

Enhance ICT applications in school education and administration | Inadequate staff to get maximum benefits from SchoolNet program

Inadequate technical support for ICT system maintenance at school level | – Provide administrative and technical support for ICT-based school education –Fund the maintenance of ICT infrastructure at school level – Make computer education more relevant and hands-on |

Table A3.2 *continued*

Project/Program Implementation	Target Outcome	ICT in Education Component(s)	Main Strategies	What Is Missing?	What Should Be Done?
Transforming the School Education System as the Foundation of a Knowledge Hub Project, 2012–2017 (supported by the World Bank)	Curriculum development and soft skills development	Enhance ICT skills of teachers, school administrators, and students	Empower school system with greater managerial authority	Limited ICT coverage Low computer–student ratio Specifications for operating system	–Develop an integrated plan for ICT use in school education –Increase the number of computers per school –Prepare and provide digital content
Education Sector Development Program, 2013–2017 (supported by ADB)	ICT Infrastructure development Staff development	119 ICT labs 318 science labs	Promote GIT and ICT programs in school education	Inadequate ICT infrastructure support Inadequate staff development in ICT	–Strengthen NIE capacity to provide more training on ICT – Medium-term plan to expand ICT infrastructure support system
1,000 School Programme, 2012–2014 (funded by the Government of Sri Lanka)	Provide 1,000 schools Mahindodaya technological labs at a cost of SLRs25 million per lab	Strengthen ICT infrastructure at school level	Establish attractive and viable school networks.	Limited coverage	–Make plans to cover another 1,000 schools with same facilities.
5,000 Primary School Development Project, 2012–2014 (funded by the Government of Sri Lanka)	Computer facilities at primary level	This is an important area that requires ICT orientation immediately	Expand ICT coverage to primary education segment	Inadequate coverage at primary level	Seek nongovernment sector support to provide ICT facilities

ADB = Asian Development Bank, GIT = general information technology, ICDL= International Computer Driving License, ICT = information and communication technology, IPICT= International Pedagogical ICT License, NIE = National Institute of Education.

Source: Compiled by the author.

students can choose their medium of instruction for their O/L examination. In grades 10 and 11, the ICT subject comprises eight units.[12]

General information technology was implemented as a subject in the school system in 2004. GIT is taught only in Grade 12 (first-year GCE [A/L]) to students following any stream of studies, for two periods per week. Although the medium of instruction is English, where necessary, Sinhala and Tamil are used for the purpose of explanation. It emphasizes computer applications for day-to-day work, promotes appreciation of the role of ICT in development and the use ICT tools with due respect to ethical and social norms. The GIT syllabus is designed to develop 10 competencies in ICT education.[13]

2. Human Resource Development in Information and Communication Technology

Human resource development in ICT is being fulfilled by both public and private service providers. Within the public sector, universities, the University of Vocational and Technology Education, Sri Lanka Institute of Advanced Technical Education, technical and vocational education and training (TVET) institutions, the National Institute of Education, and the National Colleges of Education conduct programs on computing at the certificate, diploma, and degree levels. Similarly, the private sector providers offer a wide range of ICT programs leading to certificate, diploma, and degree level qualifications. They also train individuals for professional examinations conducted by the National Computing Centre–UK, the Australian Computer Society, and the British Computer Society.

The National Institute of Education (NIE) is the prime institute in the country responsible for providing leadership for the development of general education with quality, equity, and relevance in a pluralistic society. It is organized into four faculties and two divisions: (i) Faculty of Languages, Humanities, and Social Sciences; (ii) Faculty of Science and Technology; (iii) Faculty of Education Leadership Development and Teacher Education; (iv) Faculty of Education for All; (v) Division of Research, Planning and Development; and (vi) Division of General Administration.

Of the four faculties, the Faculty of Languages, Humanities and Social Sciences and the Faculty of Science and Technology are responsible for curriculum development, curriculum research, and evaluation in the primary, secondary, and senior secondary cycles. Each faculty has separate units for different subject areas gathered according to broader

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[12] Unit 1: Fundamentals of ICT (theory 10 hours and 3 hours practical); Unit 2: Data Representation and Internal Operation of the Computer (theory 11 hours and 2 hours practical); Unit 3: Generic Software (theory 8 hours and 44 hours practical); Unit 4: Information Systems (theory 26 hours and no practical); Unit 5: Programming Concepts (theory 17 hours and 35 hours practical); Unit 6: Website Development (theory 8 hours and 18 hours practical); Unit 7: ICT and Society (theory 13 hours and no practical); and Unit 8: Group Project (theory 13 hours and required practical hours).

[13] If they set the above objectives, the contents of the syllabus are as follows: Unit 1: Explores the computer and its potential to reap timely benefits (11 periods); Unit 2: Uses information and communication efficiently and effectively in day-to-day life (2 periods); Unit 3: Uses internet efficiently and effectively to accesses and communicate information (3 periods); Unit 4: Uses computers efficiently and effectively with awareness of operating system (4 periods); Unit 5: Word processing software to create various types of documents (4 periods); Unit 6: Makes electronic presentations to enhance attractiveness (4 periods); Unit 7: Uses spreadsheet software to solve simple statistical problems and present findings (4 periods); Unit 8: Uses database management systems software to manage information (6 periods); Unit 9: Uses selected high-level language effectively to solve simple problems (14 periods); and Unit 10: Uses ICT effectively and efficiently to be successful in life (6 periods).

categories. The Faculty of Education Leadership Development and Teacher Education is responsible for enhancing managerial and leadership competencies of education managers and the professional development of teachers and teacher educators. The faculty provides specialist courses in management and leadership in education, and professional courses in teacher education. It also offers programs leading to degrees, diplomas, and certificates for education personnel, including education managers, teacher educators, and teachers in government institutes and private organizations.

While computer lessons prevail in schools, privately run IT courses lead the country's computer education field. A number of IT institutes exist to help all kinds of students learn aspects of computing, from the basics and using the internet to more advanced programming and certification courses. Several universities in the country have computer studies faculties, offering bachelor of science and master of science degree programs as well as shorter diploma courses on ICT.

Development of educational websites jointly by the MOE and the NIE is a significant contribution toward the integration of ICT in education. This broadly covers eight educational websites: (i) SchoolNet, Sri Lanka; (ii) e-*thaksalawa*; (iii) Wikipedia—English; (iv) Wikipedia—Sinhala; (v) Wikipedia—Tamil; (vi) Howstuffworks; (vii) Botanic Gardens; and (viii) Khan Academy.[14]

The web portal SchoolNet Sri Lanka is the main internet resource page for all government schools in Sri Lanka. This is a wide-area network connecting more than 1,500 schools island-wide, computer learning centers, computer resource centers, provincial education offices, zonal education offices, provincial ICT centers, National Colleges of Education, the NIE, and the MOE. SchoolNet opens up a wide array of opportunities to raise the quality of general education. It facilitates the efficient distribution of electronic content to all participating schools. Teachers and students can exchange information among themselves to facilitate the teaching and learning environment.

SchoolNet provides a novel learning and teaching environment for both students and teachers, taking collaboration to a new level. It is also possible to create forums and interest groups within the SchoolNet community where members can come from any school. For example, there can be an online teacher forum for the subject of Grade 10 science where teachers from all connected schools, trainee teachers, and curriculum specialists can participate.

In addition to the primary online learning management system (LMS) server, an LMS server for each province has been set up and the networking feature among these LMS has been activated. The objective of the provincial Moodle LMS servers is to provide a separate LMS space for schools in that province. All schools are encouraged to make use of this facility.[15]

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[14] These websites have been developed by various other organizations under the overall supervision of the MOE and funding support from different organizations.

[15] The primary site is http://moodle.schoolnet.lk; http://www.e-thaksalawa.moe.gov.lk/; https://en.wikipedia.org/wiki/Main_Page; https://si.wikipedia.org/; https://ta.wikipedia.org/; https://www.howstuffworks.com/;and https://www.khanacademy.org/.

Similarly, EduLanka.LK is the largest online education website in Sri Lanka and the most popular educational website among Sri Lankan students. EduLanka provides education-related resources from primary, O/L, A/L, university, postgraduate education, and vocational training. EduLanka is a nonprofit educational website that provides large numbers of online lessons, education-related course information, teacher information, e-books, examination result alerts, government job alerts, tuition information, a career guide for school leavers or graduating students, and more resources related to education in Sri Lanka.

There is no detailed specification on what the training in the use of ICT and computers in schools should include, nor any monitoring mechanism to verify whether teachers receive the training or how effective the training was. In most cases, schools do not send teachers for training for various reasons, including the lack of clear specifications; the unavailability of suitable training institutes in their area; and the lack of funds remaining after procuring computers and printer, setting up the lab, and installing internet connectivity.

As a result of these initiatives, IT literacy levels have risen from 8% in 2002 to 38% in 2011. The government aims to achieve 75% IT literacy by 2015.[16] The MOE made arrangements to train ICT teachers with assistance from multinational companies, including Intel and Microsoft. These efforts also involved the development of digital content, software, and internet connectivity to widen the country's ICT skill base.

In Sri Lanka, 45% of schools have computer labs while about 21% have internet facilities. A total of 3,500 schools offer ICT as a subject at GCE O/L or 35% of government schools. Up to 5% of public schools offer ICT at GCE A/L. A total of 4,000 teachers have been trained in ICT and 150,000 teachers underwent basic ICT training. As many as 100,000 teachers or 45% went through Information and Computer Driving License training.

3. Strengths, Weaknesses, Opportunities, and Threats Analysis

ICT in education started early in Sri Lanka in 1982, but its growth and expansion commenced in 2002. The implementation of eight major projects related to ICT in education since 2000 led to the introduction of three ICT courses to the school curriculum, development of ICT infrastructure facilities and educational websites, and training of teachers. These developments could also be attributed to several internal and external factors. Strong policy support from the government, particularly on school education and communication services, has contributed significantly toward this development. Besides institutional and policy support, the industry response has also been a major contributor in transforming the education system to develop ICT skills in school, technical and vocational, and higher education systems.

Considering the medium- and long-term development goals of the government (both at national and sectoral level) and current status of ICT in education, a strengths, weaknesses, opportunities, and threats (SWOT) analysis has been carried out to examine various external and internal factors affecting the adoption and use of ICT in education (Table A3.3). The evidence on internal factors revealed several strengths including clear-cut policy

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[16] National Planning Department. 2013. *Unstoppable Sri Lanka Vision 2020: Mahinda Chintana Vision for the Future.* Colombo.

focus at the subsectoral level, high growth of the communication services sector, presence of service providers at the tertiary level, high level of awareness on potential benefits of ICT education, and continued integration of ICT in education. The analysis also revealed some of the weaknesses that retard the progress of ICT adaptation, such as inadequate institutional support, lack of intra-institutional coordination within the education sector, and absence of incentives to motivate principals and teachers in the use of ICT in education and school administration.

The analysis relating to external factors highlighted several opportunities for rapid integration of ICT in education (e.g., high growth of the ICT/business process outsourcing sector and heavy use of ICT in business and government organizations). The clear long-term vision to build a globalized and knowledge-driven economy and economy-wide efforts to promote ICT usage were also identified as policy-oriented opportunities for promoting ICT in education. The analysis also revealed several threats to effective integration of ICT in education. The major ones include problems of implementation, inadequate inter-institutional coordination, and inadequate funding. Based on the past experience of some of the neighboring countries, including those in East Asia, the absence of a master plan was also identified as a major threat to integration of ICT in education.

**Table A3.3: Strengths, Weaknesses, Opportunities, and Threats Analysis—
Information and Communication Technology
in Education in Sri Lanka**

STRENGTHS	WEAKNESSES	
• Strong support from the government • High level of awareness on ICT benefits • Medium- and long-term policy focus • Presence of service providers at tertiary level • High growth in communication services sector	• Absence of an incentive mechanism to motivate teachers for ICT • Inadequate institutional support (e.g., central and provincial) • Lack of leadership at school level • High workload of teachers • Inadequate infrastructure support	INTERNAL
OPPORTUNITIES	THREATS	
• High growth of information technology business process outsourcing • Vision to build globalized and knowledge-driven economy • Heavy use of ICT in business and government organizations • Economy-wide efforts to promote ICT usage	• Problems associated with implementation • Inadequate funding • Lack of coordination between tertiary education institutions • Absence of a master plan	EXTERNAL
POSITIVE	NEGATIVE	

ICT = information and communication technology.

Source: Author.

C. Conceptual Framework for Information and Communication Technology in Education in Sri Lanka

1. The Need for Promoting Information and Communication Technology in Education in Sri Lanka

With the globalization of economic activities, knowledge and skills have become an important factor in modern knowledge-driven economies. High-quality education makes the workforce more productive to support economic growth. Knowledge and skills have become the key ingredients in the 21st century's economic activity and wealth creation. Knowledge and know-how are replacing buildings and machinery as the most valuable assets of business. In the future, a nation's competitive advantage will come from the application of intellect and knowledge to solve business problems.

ICT offers a unique opportunity to focus on improving quality in the education system, while also addressing quality or access problems. It has the potential to transform the educational landscape to provide more equitable access to quality education. However, ICT intervention in school education has to go beyond providing computers to schools and connecting schools to the internet. The focus still has to be on education more than on technology. The introduction of equipment and connectivity has to be complemented through programs designed to help schools and teachers use technology to improve education quality. Pedagogy remains a key factor in promoting the adoption and use of ICT in education. There is a growing recognition that, to progress in the global economy, the country needs to provide computer knowledge and skills to its citizens, and it has to start with using ICT in school education (Vecchi and O'Mahony 2005).

Sri Lanka is in transition from a factor-driven to an efficiency-driven stage of economic growth (World Economic Forum 2013–2014). The quality of education has become more vital at this stage as a continuous supply of well-educated and trained workers is needed to transform the economy from low value-added to high value-added production systems. Today's globalizing economy also requires economies to nurture pools of well-educated workers who are able to adapt rapidly to a changing market environment. Sri Lanka has already recorded good progress with respect to infrastructure facilities to promote ICT in education.[17] On the demand side, the ICT business process outsourcing sector has emerged as one of the key sectors with high potential for growth, foreign exchange earnings, and absorption of educated labor. Moreover, both the government and private sector organizations are increasingly using ICT in carrying out administrative and management functions.

The telecommunication sector has also made a significant progress over the past decade in terms of market efficiency, product innovation, rural penetration of services, and commitment to social responsibility. Thus, the education sector should be ready to implement the necessary reforms and integrate ICT into primary and secondary education. It should also be ready to use ICT in teaching other subjects and school administration and management.

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[17] World Economic Forum. *Global Competitiveness Report for 2007–2008 and 2013–2014.* Geneva.

ICT has been a tool for educational transformation in many countries (e.g., the Republic of Korea, Malaysia, and Singapore).[18] Sri Lanka should be able to learn from them to improve teaching and learning in our school education system. Wider use of ICT in schools will also facilitate better school administration and student management as well as to equip students with skills required to succeed in the knowledge economy. Recent developments in online educational materials in the country such as SchoolNet and Sri Lanka e-*thaksalawa* have already shown the power of technology in improving access to quality education, as well as the necessary components essential for successful technological interventions in schools. The openly available content is a key factor in successful integration of technology in classrooms. Further, there have been rapid developments in open source technology that helped overcome the often-prohibitive cost of software and opened up the possibility of adapting software and content to fit the local context.

Moreover, hardware and connectivity costs have been declining steadily, and are now at the level where governments in developing nations can afford to use them in school education. Computer hardware prices have declined by more than half over the past 10 years, and there are technological innovations and advancements that have sliced the cost by even more in recent years. Affordable laptops, tablets, and desktop computers have raised computer ownership per household. The lower cost and prevalence of hardware and connectivity have already started to change the landscape of higher education through online courses. ICT is poised to revolutionize both secondary and tertiary education.

Integrating ICT in mainstream pedagogy has a number of benefits that can help transform the educational landscape and address some of the critical problems that have contributed to low student performance. For instance, a well-managed ICT-integrated class promotes a learner-centered approach, which is a fundamental shift from the traditional teacher-centered method of teaching and learning. With improved access to learning materials, it will be easier for students to get in the habit of researching, investigating, and reading, thereby promoting student-centered learning. In an ICT-enabled classroom, since students are interacting with software and technology, they are more likely to be at ease to explore freely and learn from their mistakes. ICT also offers ample opportunities for peer interaction and collaboration, and allows students to express their thoughts and ideas easily.

2. Local Digital Content

Digital content is one of the key elements in using ICT in education. Digital materials can help students understand concepts better. Incorporating audio, video, and animation in lessons can add new dimensions to teaching and learning that have so far been limited to text and graphics. Students can use technology to listen to, watch, and interact with lessons. Use of multimedia and other ICT technologies in teaching will not only make lessons more effective, it will also increase the motivation of students and make learning more attractive to young learners.

The use of digital learning software content also promotes student-centered learning and encourages self-learning. Combining such learning tools with access to an education-centered digital library will further enhance learning by providing ample opportunities for independent inquiry. Access to books, reference materials, and educational videos

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[18]   UNESCO (2010).

through such digital libraries can nurture the innate curiosity in children, while making learning interesting and lasting at the early stages of education. This will lay the foundation for lifelong learning by showing students how and where to seek information. With some facilitation from teachers, students can process information and knowledge through sharing and group work.

Another interesting aspect of digital content is that students and teachers can create, modify, adapt, and share content. For teachers, this is a powerful tool to customize content, as well as adjust teaching techniques, to the needs of the students. For students, this feature can nurture their creativity, and motivate them to build on their knowledge by developing projects with their peers and sharing with others.

As discussed in Section B, Sri Lanka has made significant progress in providing digital material for teaching and learning over the past 8 years. However, the digital divide (the gap between those who have access to and control of technology and those who do not) is a major challenge in the introduction and integration of ICT at different levels and in various types of education, as well as in different areas of the country. Failure to meet the challenge would mean a further widening of the knowledge gap and deepening of existing economic and social inequalities.

A universal introduction of ICT-enhanced teaching and learning in all schools will help reduce the digital divide. However, it may not be possible to provide effective and adequate ICT support to all schools at the same time in Sri Lanka. The government can systematically introduce ICT in education by phases based on a comprehensive plan and sound investment programming. A sequencing to cover deprived schools within the same district may be required due to resource constraints.

3. Learning from Global Initiatives

The recent successes of various technology-based initiatives in promoting access to education helped many countries to use such experience in promoting ICT in education. While there are many lessons that can be learned from these successes, we also need to analyze the evidence before applying them to Sri Lanka.

Among the many global initiatives, massive open online courses (MOOCs), OpenCourseWare (OCW), and Khan Academy are the more successful ones based on their popularity among users. These initiatives focus on providing content to users and allowing users to learn at their own pace. They use technology and connectivity to provide better access to quality learning materials freely to everyone. A valuable lesson that can be learned from the success of these initiatives is that any attempt to use technology to improve education should focus on providing appropriate content to users. Implementers need to recognize that technology is only the medium, and education will not improve unless there is right content to go with the medium. In MOOCs, OCW, and Khan Academy, technology allows sharing of quality digital content through online courses and educational videos.

MOOC, OCW, and Khan Academy have been very popular among independent learners. But their integration in daily classroom teaching and learning will require efforts from both

teachers and education planners. For instance, Khan Academy videos will be more useful to school education in Sri Lanka, if the videos are either translated or recreated in local languages. Similarly, content of other videos should be recreated or edited to enable school teachers to use the materials for the course units taught in schools. These types of content cannot become part of regular school education without proper teacher training and regular support. Content such as that from Khan Academy will be most effective if used for self-learning by students with facilitation from teachers.

Hence, the three key components of successful technology-based learning initiatives include content, teacher readiness, and infrastructure. This requires the application of a transformation approach rather than using a marginal approach. It must be developed as a major strategy of transforming the education system by improving equitable access, quality,[19] and efficiency;[20] leveraging funding; and connecting educational institutions with alumni groups and mobilizing their support.

With the emergence of an increasingly interconnected and digital world, skills required by the industrial economy are increasingly superseded by the demands of the knowledge economy. As a result, governments have been trying to adjust school curricula to equip their students with new 21st century skills. In this regard, similar to many countries in Asia, Sri Lanka has been somewhat slow to adapt, narrowly focusing on technical ICT skills rather than the full range of skills needed. These programs require that students think creatively, use problem-solving skills, communicate effectively, identify and analyze existing information, and create knowledge. A range of pedagogical approaches have been proposed to help learners develop those "information age" skills that are now in high demand. Based on international best practice on how people learn, these approaches include student-centered learning, active learning, project-based learning, and inquiry-based learning.

4. Conceptual Model

A conceptual framework is suggested for effective integration of ICT in Sri Lanka's education system (Figure A3.1). It is based on a standard approach to ICT in education framework represented by "policy/strategy-input-process-output/outcomes." The purpose is to establish synergy across policy directions, infrastructure development, teacher professional development, curriculum development, student learning outcomes and assessment, and public–private partnership in promoting ICT in education. It also illustrates the evolution of information needs with the stages of nationwide implementation of ICT policies and with the changing levels of ICT penetration in educational systems over time. These factors should be understood within the context of a larger operational and conceptual framework for ICT integration in education.

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[19]   High-quality materials from open source learning, access to the best teachers from around the world and their lectures and materials, reliable testing, and self-paced progression

[20]   Delivery, uniform quality, ability to reach out to many at the same time.

The model has seven major components: (i) policy goals at the national level; (ii) policy goals at the sector level (e.g., education); (iii) infrastructure facilities; (iv) curriculum development and digital content; (v) enabled pedagogy; (vi) usage of ICT in teaching and learning functions; and (vii) learner performance evaluation and monitoring. These aspects will be covered in detail in Section D. It should be noted that the application of the proposed conceptual model is in line with Sri Lanka's existing policies and plans for ICT in education.

In summary, the emergence of knowledge-based economic activities resulted in the application of intellect and knowledge becoming a key determinant of national competitiveness. Thus, integration of ICT in education is vital for Sri Lanka to realize its long-term development targets. Application of a two-dimensional model to ICT education in Sri Lanka indicates that the education system at present is at the stage of "applying" ICT in education and it needs to develop strategies to reach the next stage of ICT development in education—"infusing"—by at least 2016. Though the basic computer skills of teachers and students are satisfactory, the level of advanced computer skills is still weak. The use of internet and e-mail in schools is poor and opportunities for computer education for students, particularly those in the periphery schools, are not sufficient. Overall, Sri Lanka has great prospects in enhancing its innovative pedagogies with the use of ICT in education.

Figure A3.1: Conceptual Framework for ICT in Education
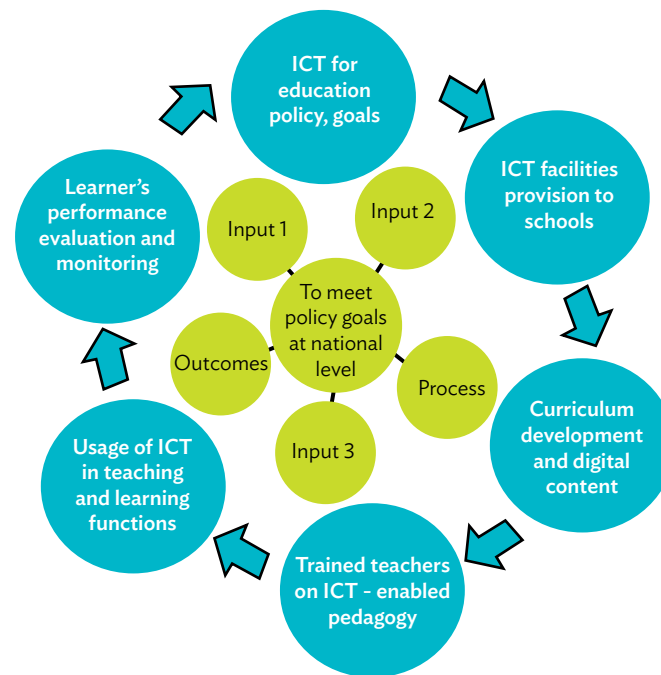
ICT = information and communication technology.

Source: UNESCO Institute of Statistics. 2009. *Guide to Measuring Information and Communication Technologies (ICT)* in Education. Canada.

D. Road Map to Implement Information and Communication Technology in Education

This section outlines a road map to integrate ICT in education to help promote growth in the emerging knowledge economy of Sri Lanka.

1. Past Experience in Promoting Information and Communication Technology in Education

The adoption of ICT in education has been quite rapid in Sri Lanka over the past 10 years. Inclusion of computer education in the school curriculum as an optional subject was started only in 2002 despite policy initiatives in the early 1980s. The long delay in implementing ICT policy in the 1980s and 1990s has been attributed to changes in the political sphere and absence of institutional support, including inter-institutional coordination.

ICT is a proven tool for educational transformation. It should be adopted in Sri Lanka to equip students with skills required to succeed in the knowledge economy. A small-scale survey by De Silva et al. (2014) revealed that, out of 2,921 youth respondents, 57% were computer literate. In the 18–24 age group, 65% could manage basic functions of the computer, as opposed to the 25–29-year-olds, where only 43% demonstrated knowledge in computer usage. This indicates that the older group had a lesser opportunity at gaining computer knowledge, which is a fairly recent development in Sri Lanka. It was also revealed that 33% of youth who have a basic knowledge in computer usage have their own computers, while 33% have used the internet. In terms of usage and frequency, out of the 57% youth who are computer literate, 50% use their computers on a daily or weekly basis. This evidence suggests that youth equipped with basic computer knowledge tend to use computers more frequently.

Integrating ICT in mainstream pedagogy has a number of benefits that can help transform the educational landscape by addressing some of the problems that have contributed to low student performance and facilitating better school administration and student management. ICT interventions in education so far appear to have been undertaken without paying adequate attention to the required ICT ecosystem in which they work. As shown in the conceptual framework, an ICT ecosystem encompasses the policies, strategies, inputs, processes, outcomes, and stakeholders that work together to build a technology-enabled environment that ensures full integration of ICT in education.

2. Current Sri Lanka Road Map in Integrating Information and Communication Technology in Education

Future plans to integrate ICT into education are partially covered in the education sector strategy matrix given in Unstoppable Sri Lanka Vision2020. It clearly recognizes ICT as a major strategy to improve quality and access to education at both the secondary and tertiary levels. It also covers curriculum development and teacher professional development. This needs to be translated into an action program with a clear-cut medium and long-term targets, performance monitoring indicators, and institution-specific responsibilities.

Policy support. Clear-cut policy support at the national and sectoral levels is vital in promoting ICT in education. In the case of Sri Lanka, development of ICT in education as a part of long-term growth strategy began in 2006 with the introduction of a 10-year development framework (NPD 2006). This has been further elaborated upon in the medium- and long-term development programs introduced in 2010 and 2013. The most recent policy documents clearly recognize ICT as a key sector of the economy and ICT education as a key strategy to promote growth and development.

As envisioned in the Mahinda Chintana (NPD 2010) and the Mahinda Chintana Vision for the Future (NPD 2013), the government aims to restructure the education system to provide an equitable and quality education for all, thereby transforming the country to become a key hub for knowledge and learning in Asia. This would lead to a paradigm shift in educational thinking and bring far-reaching changes in the sector. The government has already taken several initiatives in recent years to strengthen the equitable access and dispersion of resources in education. The latest policy document, Budget Speech 2014, further states that "The Government has attached significant importance for reforms in the entire education system, to increase science and technology subjects in the mainstream of education and to enhance labor force capabilities through skills development under tertiary education, to be able to meet the demands of the ICT industry."

It should be noted, however, that the success of ICT integration in education in some Asian countries, such as Malaysia and Singapore, was guided by master plans implemented in the late 1990s. For example, Singapore developed and implemented two ICT master plans over the past 15 years. The first ICT Master Plan (1997–2002) laid the foundation for integrating ICT in education while the second ICT Master Plan (2003–2008) adopted a systematic and holistic approach to further strengthen the integration of ICT in education. It comprised four components: (i) infrastructure, (ii) curriculum and assessment, (iii) professional development, and (iv) student learning and culture of the school. Malaysia implemented a similar program under the Smart School approach to speed up the process of integrating ICT in education.

For Sri Lanka, the action programs stipulated in Unstoppable Sri Lanka Vision 2020 (NPD 2013) spells out specific activities to promote ICT in education. The alternative paths to become a graduate provide opportunities for individuals to enhance knowledge and skills including ICT either through technical vocational education and training (TVET) or higher education system. However, intra-institutional support systems need to be worked out with specific interventions. One of the key strategies proposed in the Public Investment Strategy, 2014–2016 is the creation of a student-friendly environment by improving physical and learning facilities. The program designed for this purpose includes the development of a *Mahindodaya* technological lab, at a cost of SLRs25 million each, in 1,000 schools to improve student learning outcomes. The labs include an ICT laboratory, language laboratory, a distance learning center, and a mathematics laboratory. Similarly, the government expects to increase student enrollment in the technology stream from 14,000 students in 250 schools in 2013 to 80,000 students in 1,000 schools in 2017.

Sri Lanka is yet to develop a master plan or overall program to ensure full integration of ICT in education. Given the multi-institutional character of the education system in Sri Lanka, development of a master plan is vital in providing direction and promoting the use of ICT

as an enabler in improving access, quality, and relevance of education and student learning outcomes. The ICT master plan needs to be guided by a long-term vision of reaching the "infusing" and "transforming" stages in the adoption and use of ICT in education.

ICT infrastructure development. Project interventions over the past 7 years have improved the infrastructure support system with respect to availability of desktop computers, computer printers, scanners, multimedia projectors, overhead projectors, laptop computers, electricity, telephone, internet, e-mail, computer laboratory, and books on ICT. But the proportion of schools equipped with these facilities is around 50% and it varies quite significantly across different types of schools. For example, the proportion of schools having computer labs was 34% at the national level and it varies from 80% to 31% between 1AB and Type 2 schools. Within the school system, 1AB and Type 2 schools account for about 8% and 39% of schools in Sri Lanka, respectively.

Survey evidence on student–computer ratios in five districts revealed significant variation across five districts within a range of 4–26.[21] Another estimate based on MOE data came up with computer–student ratio of 1:24 in schools offering ICT as a subject. The ratio would be around 1:50 if schools are to use ICT as a tool for teaching other subjects. The high computer–student ratio has been confirmed by 59% of principals representing five districts.

ICT resource utilization at the school level indicates significant differences between 1AB and 1C schools (Senaka 2006).[22] The resource gap was even higher between urban and rural schools and across districts. These variations have also been observed with respect to the use of students' time for ICT education, utilization of teachers' time on ICT education, and time allocated for students in the computer lab, among others, suggesting a wide digital divide among rural and urban schools.

The one laptop per child (OLPC) project concept was also implemented in Sri Lanka with a focus on content development in local languages. Schools chosen for this pilot project were to be classified as the poorest of the poor and located in rural areas. An assessment of this project by Peter Mozelius et al. (2012a) revealed all the sample schools have had technical as well as pedagogical problems during the first year. They also observed that there has been an impact on formal learning in subjects like mathematics and English, and hence recommended that the pilot project be extended with a clear focus on poor schools in nonurban areas. In another study, Mozelius et al. (2012b) observed several positive benefits of the Sri Lankan OLPC initiative and recommended that it is worth extending to more primary schools in nonurban areas. However, content development was one of the key limitations of OLPC (Mozelius et al. 2012a and 2012b).

Teacher training on ICT–enabled pedagogy. This has been one of the key activities carried out by the MOE, NIE, College of Teacher Training, the donor community, and private sector organizations over the past 14 years. But it needs to be strengthened in terms of

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[21] Nuwara Eliya's ratio of 1 computer for 4 students, with 36 computers being shared by 128 students, while Puttalam has a significantly higher ratio at 26 students to 1 computer since 158 students are sharing 6 computers.

[22] This is a cross-sectional sample comprising 1AB and 1C schools selected form Colombo, Gampaha, and Kaluthara districts. It included 440 students, 20 GIT and ICT teachers, and 8 principals.

coverage (e.g., different target groups, schools in the periphery, and administrative officials), institutional support, and progress monitoring.

A survey on the skills profiles of teachers conducted by Fernando (2014) revealed that 52% of ICT teachers do not have ICT teaching appointments. Only about 29% of ICT teachers have received less than 3 months of training to teach ICT for O/L and 42% have received more than 1 year of training. The ICT teachers are being trained at private institutes, computer resource centers, NIE, and provincial educational institutions. An assessment of teacher training provided by various institutions revealed that training provided by zonal computer centers with a duration of 2 weeks or more has benefited about 54% of teachers. Another work (Senaka 2007) also revealed that 59% of teachers were not happy with ICT training. This has been confirmed by school principals. ICT teachers have also identified training on the use of English language data presentation, database management, network and internet ICT, programming, and web design as vital in improving quality and effectiveness of ICT education. About 59% of principals have also obtained basic training on computing.

The education sector strategy matrix given in Unstoppable Sri Lanka 2020 spells out specific action programs for continuous professional development of teachers and it needs to be expanded to cover ICT applications in school education. More specifically, the ICT training component needs to cover both technical and advanced training on digital resources development, technology planning and evaluation, action learning and research, and specialized ICT applications in humanities, mathematics, science, and languages. It also requires an action program on capacity building of training providers.

Curriculum development and digital content. One of the most important components in promoting ICT in education is the development of curriculum and digital content. Curriculum development includes both acquisition of factual knowledge and the mastery and applications of concepts and the development of individual curiosity, creativity, and enterprise. Besides revising the existing curriculum, efforts should also be made to develop students' information skills, thinking skills and creativity, communication skills, knowledge application skills, and self-management skills to improve quality and relevance of ICT education. Survey evidence indicates an urgent need for revising the ICT syllabi, teacher guide, and student guide on ICT.

Digital content comprises digitized book and documents. It is what teachers use to enhance classroom teaching and move away from conventional methods such as prescribed textbooks. The following are different types of digital content that can be used in school education: (i) interactive digital learning activities, (ii) educational videos, (iii) reference materials, (iv) e-books, and (v) teaching resources.

As a non-English-speaking country, Sri Lanka needs custom-tailored digital content to promote the use of ICT in education. Currently, teachers are being trained to develop instructional materials in the native language. It also maintains a web-based repository where any teacher can store instructional material, use others' materials, and comment on the usefulness of materials or how to make them more useful. These efforts need to be strengthened, streamlined, and better coordinated with a view to ensuring maximum benefits to students. The private sector service providers led by Information and

Communication Technology Agency have also been playing a key role in digital content development.

Use of ICT in teaching and learning functions. This is an important operational component at the applying stage of ICT education. It is required not only to support teachers when some technical problem arises, but also to integrate ICT in a full range of subjects. The existing body of evidence on issues relating to usage of software reveals that the majority of students (89%) use Microsoft Windows operating system and only 8% use open source operating systems. The majority of ICT teachers (67%), however, have recommended use of both open and Microsoft systems. Survey evidence also indicates that only 34% of ICT teachers have the ability to install operating systems and software applications and troubleshoot. Moreover, 60% of ICT teachers have reported unavailability of a formal mechanism designed by the MOE or relevant provincial authorities for computer maintenance. This has been confirmed by 66% of principals. The evidence on network maintenance revealed about 56% of schools do not have the ability to maintain their computer networks. This is an important aspect as stability of the network system is a key determinant of resource sharing in internet, e-mail, SchoolNet, and other e-learning facilities.

E-learning. This is an established delivery mode among tertiary level higher education institutions with the assistance of private sector support. For example, some universities and higher education institutions deliver undergraduate and postgraduate programs using the internet platforms maintained by private sector service providers. This could be extended to cover secondary education as well. For example, the Faculty of Graduate Studies of the University of Colombo offers two executive diplomas, two postgraduate diplomas, and two master's programs using the internet platform maintained by the Sri Lanka Mobitel. Several other universities and higher education institutions also conduct their undergraduate and postgraduate study programs through e-learning mode.[23]

Learners' performance evaluation and monitoring. Despite various efforts to promote ICT education, the entire system of supervision on ICT education is unsatisfactory. Supervision of ICT subjects by district education officers and internal supervision at the school level is inadequate (Senaka 2007). As viewed by ICT teachers, inspection of ICT teaching by principals or other officials has been taking place at the minimum level.[24]

Researchers have evaluated ICT teaching within the classroom using three main criteria: preparation, presentation, and evaluation.[25] The findings highlighted that presentation of subject matter was satisfactory for about 75% of schools. The ratings on in-class student attention and participation during teaching sessions were average for about 63% of schools. The evidence on the teaching process also indicated that 75% of teachers were not ready with clearly defined learning objectives, and only 12% of schools used teaching methodologies efficiently and effectively. This indicates an absence of teachers trained in presenting ICT material to students. Similarly, application of evaluation methodologies

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[23] Some of the examples include University of Colombo Computer School, Open University of Sri Lanka, and Kothalawala Defense Academy.

[24] K. U. Senaka. An Assessment of ICT Education in Sri Lankan Schools. Unpublished thesis submitted to the Faculty of Education, University of Colombo.

[25] Senaka (2007) has details on evaluation methodology.

was satisfactory with respect to 38% of teachers. In overall terms, it appears that teaching of ICT requires continuous support to improve ICT pedagogy and the efficient use of ICT resources.[26]

Performance evaluation and monitoring is an important activity that requires immediate attention of policy makers, administrators, and other stakeholders of the education sector. The cost of project interventions on ICT education has been very high in Sri Lanka over the past 14 years and its progress needs to be assessed in terms of sector-wide coverage, learner performance, and socioeconomic impacts. This requires a good database on investment of ICT in education, rate of resource utilization, and learning outcomes. At present, this function is not carried out systematically despite some observations by key policy making bodies. For example, in 2004, the National Education Commission (NEC) stated that no reasonable impact assessment has been done since the first computer was introduced into the education system. Inspection and progress monitoring at school level is also unsatisfactory. The only census on computer literacy of school academic staff (Department of Census and Statistics 2006) needs to be repeated to measure the progress achieved from 2006 to 2014.

3. Public–Private Partnerships in Teacher Training

Public–private partnerships in ICT education in Sri Lanka dates back to major project interventions commencing from Secondary Education Modernization Project I (2000–2006). During this period, private training providers were selected to train the teachers in ICT and use the skills and knowledge in computer-assisted learning and teaching. Subsequently, private sector participation in ICT could be seen in digital content development, internet connectivity, educational websites, and infrastructure support. In overall terms, however, it appears that the full potential of using public–private partnership in promoting ICT in education has not been fully exploited in Sri Lanka. Interviews with leading service providers in the ICT and telecommunication industries indicate that they are willing to partner with ongoing ICT integration in education with clearly defined contributions indicated by the MOE in its ICT development program or master plan.

E. Summary and Recommendations

1. Summary of Findings

In Sri Lanka, integration of ICT in education has been steadily progressing over the past 10 years, and it can be expanded to cover the entire secondary and primary sectors of the education system. The implementation of the IT policy and e-government project and developments in the telecommunication industry has enhanced the IT awareness among different user groups of the economy, including the education sector. There has also been improved IT infrastructure built at the national level, which has enabled affordable connectivity across the country. These developments have serious implications for the nature and purpose of educational institutions, and hence schools cannot continue with the conventional mode of instruction (i.e., transmission of a prescribed set of information from teacher to student over a fixed period of time). Instead, schools must promote

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[26] Senaka (2007) has more details.

student-centered learning and acquisition of knowledge and skills that make continuous lifelong learning possible.

Developing a comprehensive framework for 21st century learning requires more than identifying specific skills, content knowledge, expertise, and literacies. An innovative approach to integrating ICT in education needs to be created to help students master the multidimensional abilities required of them in the 21st century. The economy of Sri Lanka is also transforming from a production-oriented system to a knowledge-based economy. Its demographic bonus period is also expected to end in 2017.

The experience of introducing different technologies in the classroom and other educational settings across the world over the past several decades suggests that the full realization of the potential educational benefits of ICT education and effective integration of ICT into the educational system is a complex and multifaceted process that involves technology, curriculum, pedagogy, institutional readiness, teacher competencies, and long-term financing.

The integration of ICT in education in Sri Lanka has been rather slow. In other words, ICT is yet to transform the education system despite major project interventions since 2000. However, many of the necessary preconditions that can help enable such a transformation have already been put in place through major project interventions and clear-cut policy directions at the national level.

Currently, the impact of project interventions on ICT education cannot be fully assessed due to lack of data that directly link it to learning outcomes, as well as information on utilization of ICT resources, teacher professional development, and costs of investment and maintenance of ICT infrastructure. So far, no reasonable impact assessment has been carried out to monitor the progress and learning outcomes of ICT in education. Some of the sample-based studies indicate that these interventions have helped students to improve knowledge on theoretical aspects of ICT, information systems, and internet facilities. It has also helped teachers in professional development and to gain experience in curriculum and digital content development.

The sample-based studies on student feedback reveal unsatisfactory performance with respect to learning outcomes on programming, web designing, and database management. Teachers highlighted several constraints affecting progress of ICT integration in education, such as virus threats, internet and e-mail issues, lack of upgraded facilities, lack of ICT library books, lack of English proficiency, and inadequate training on ICT teaching methodology. Principals consider lack of ICT-trained teachers, absence of planning to commence ICT as a subject at A/L, lack of textbooks on ICT, and absence of proper guidelines to use ICT as a tool to teach other subjects as major constraints.

The evidence on ICT resource utilization at the school level indicates significant differences between 1AB, IC, Type 2, and Type 3. The resource gap was even higher between urban and rural schools and across districts. These differentials have also been observed with respect to the use of student's time for ICT education, utilization of teacher's time, and time allocated for students in the computer lab. This suggests a digital divide among rural and urban schools.

The SWOT analysis on ICT in education revealed several strengths for the continued integration of ICT in education, including policy focus at subsectoral level, high growth of the telecommunication sector, presence of service providers at the tertiary level, and a high level of awareness on potential benefits of ICT education and its application in the business sector. The analysis also revealed some of the weaknesses that may retard the progress of ICT adaptation in education: inadequate institutional support, lack of intra-institutional coordination, and absence of an incentive scheme to motivate both principals and teachers to use ICT in education and school administration.

With respect to external factors, the high growth of the ICT business process outsourcing sector, the heavy use of ICT in the business sector, and the emergence of a knowledge-driven economy have been identified as opportunities for promoting ICT in education. The major threats affecting effective integration of ICT in education include the absence of a master plan, problems of implementation, inadequate inter-institutional coordination, and inadequate funding.

To be effective in the 21st century, new entrants to the labor market must be able to exhibit a range of knowledge and skills, including creativity and innovation, critical thinking and problem solving, and communication and collaboration. Thus, the effective integration of ICT in the education system needs to be created to help students master the multidimensional abilities required of them in the 21st century.

A two-dimensional model (e.g., technology and pedagogy) on stages of development in adoption and use of ICT in school education revealed that Sri Lanka has reached the stage of "applying" ICT in education, and that the education system needs to move up to the next stage of development: the "infusing" stage. At this stage, all classrooms are equipped with computers and schools with internet connections. It is also characterized by both learner-centered and collaborative learning. Students are slowly given more control over their learning, and teachers use ICT to assist their students to assess their own learning in achieving learning outcomes of project work.

As elaborated in the conceptual model in Section D, the successful integration of ICT in education involves five stages: infrastructure, curriculum, human resources, use of ICT in education, and learner performance monitoring. In line with these considerations, key recommendations of the present study are summarized below.

2. Recommendations

Promotion of ICT in education would require coordinated action in different areas of the education system. Such activity would not only require a good deal of resources to meet the cost, but also human capital to successfully pursue it. Therefore, the government should adopt a sequential approach with clear milestones to achieve in different years. A master plan with identified actions for short-term and medium- to long-term impacts on the use of ICT in education should be adopted.

Software is a prime concern in learning. Therefore, open source is recommended for a developing country like Sri Lanka to achieve international quality standards of ICT education. Free and open source software provides a greatly flexible environment—economically, operationally, and technically—to implement ICT applications in education.

Administrative authorities of the school education system should be motivated and provided with guidelines for the use of free and open source software in the school environment. Moreover, an incentive scheme for local software developers to develop mother tongue software for school requirements is also recommended.

Pedagogical usage in Sri Lankan ICT education and quality can be raised significantly with the use of adoptive learning technologies along with the existing infrastructure. Pedagogical blended learning (e.g., web-based training, e-learning) and other methodologies (e.g. activity-based learning, role model, peer activities) should be adopted to provide more facilities to achieve international standards in ICT education. Blended learning approaches, especially e-learning resources and web-based training, may promote the learning process in ICT education.

Human resource development in ICT educational activities should be embedded to facilitate the pedagogical transformation and motivations of ICT teachers. A sizable proportion of teachers and students are reluctant to use e-learning approaches and lead peer discussions. They need support to improve their knowledge in English. This deserves the immediate attention of training providers to improve communication skills of in-service teachers and popularize e-learning among students. Teacher motivation in their teaching and learning paradigm needs to be improved through the introduction of postgraduate, diploma, and certificate courses with the assistance of NIE, universities, and leading TVET service providers. The current opportunities for ICT teachers to enhance knowledge and acquire additional qualifications are very limited. The existing system promotes postgraduate undertakings more, but not so much on ICT or ICT applications in education.

An overall assessment of ICT in education should be carried out with a view to understanding achievements in ICT education. A good database on learning outcomes, utilization of resources, costs of various activities, and ICT resource gaps needs to be established to ensure continuous progress in monitoring and evaluation of ICT in education. It would also be useful for future planning purposes. Table A3.4 summarizes the recommended actions to improve ICT in education in Sri Lanka in the short, medium, and long term.

Table A3.4: Recommended Actions to Improve Information and Communication Technology in Education in Sri Lanka

Areas	Activities and Initiatives
Short Term (within 1 year)	
1. Planning and policy at subsector level	• Prepare a master plan for ICT in education • One laptop per child project
2. Technology infrastructure	• Standardize hardware and software to be used in schools • Encourage use of open source software and technology • Provide separate funds for maintenance of computer labs • Appoint an ICT director for each zone • Introduce cluster school system to improve access to ICT infrastructure within the school system • Keep computer labs open during the weekend and after school hours both at school and zonal levels
3. Educational content	• Prepare digital learning materials • Set up a high-powered national level committee to promote development of digital content.
4. Trained teachers on ICT–enabled pedagogy	• Provide training on the use of ICT in education to all teachers covering both ICT and non-ICT teachers • Continue with in-school training • Provide incentives to motivate teachers to use ICT effectively in classrooms • Introduce programs on installing software and computer repair and maintenance, jointly with TVEC
5. Usage of ICT in teaching and learning functions	• Universities and higher education institutions (e.g., SLIATE) to provide training and guidance on usage of ICT in teaching and learning functions • Restructure all postgraduate diploma programs and introduce ICT as a separate subject • Provide educational software and CDs
6. Learner performance evaluation and monitoring	• Universities to conduct surveys on ICT learner performance, resource utilization, evaluation and progress monitoring • Encourage postgraduate students to undertake studies on performance evaluation and progress monitoring of ICT in education • Strengthen both ICT and planning divisions of the MOE • Coordinate with the National Education Research Centre in setting up databases, and conducting progress monitoring of ICT in education
7. University involvement	• Help school education sector in usage of ICT in teaching and learning functions. • Undertake studies on learner performance, evaluation, and progress monitoring • Initiate postgraduate, graduate, and certificate level programs for ICT teachers
8. TVET sector involvement	• Introduce ICT courses for GCE O/L and A/L students • Help school education sector in usage of ICT in teaching and learning functions • Conduct short courses on repair and maintenance of computers

Table A3.4 *continued*

Areas	Activities and Initiatives
9. Private sector involvement	• ICTA to assist in the areas of digital content and usage of ICT in teaching and learning functions • Key service providers in the ICT sector to assist in developing ICT infrastructure and assist school education sector in providing work experience for school leavers
Medium Term (within 5 years)	
1. Planning and policy at subsector level	• Collaborate with the Ministry of Higher Education, the Ministry of Youth and Skills Development, the Ministry of Science and Technology, the University Grants Commission, the Tertiary and Vocational education Commission, and other government agencies • A pool of trainers drawn from universities, NIE, and TVET sector institutions to train ICT teachers • Focus on student-centered solutions with the application of ICT • Plan for another cycle of Mahindodaya technological labs for another 1,000 schools
2. Technology infrastructure	• Provide learning materials at school level using school servers • Set up separate computer labs for primary, lower secondary, and upper secondary level students • Introduce a cluster school system to improve access to ICT infrastructure within the school system • Facilitate contributions from different sources (private philanthropists, business organizations, and alumni) to develop ICT infrastructure in schools • Cost-recovery by allowing after-school commercial use of ICT facilities, wherever possible
3. Educational content	• Prepare digital learning materials • Introduce digital content that promotes self-learning and self-assessment • Create guides that help teachers integrate digital learning materials in classrooms • Increase the quality and relevance of the digital content
4. Trained teachers on ICT-enabled pedagogy	• Develop teacher training programs on their new roles as facilitators in ICT-integrated classrooms • Provide training on the use of ICT in education to all teachers covering both ICT and non-ICT teachers • Continue with in-school training • Provide incentives to motivate teachers to use ICT effectively in classrooms • Develop capacities on ICT applications in school administration and management at central, provincial, and zonal levels • Equip training and resource centers to train and support ICT-based education • Introduce programs on installing software and computer repair and maintenance, jointly with TVEC • Organize a separate program for both teachers and students to improve their language fluency in English

Table A3.4 *continued*

Areas	Activities and Initiatives
5. Usage of ICT in teaching and learning functions	• Universities and higher education institutions (e.g., SLIATE) to provide training and guidance in use of ICT in teaching and learning functions • NIE to add a few more programs on use of ICT in teaching and learning functions • Restructure all postgraduate diploma programs and introduce ICT as a separate subject • Provide educational software and CDs
6. Learner performance evaluation and monitoring	• Universities to conduct surveys on ICT learner performance, resource utilization, evaluation, and progress monitoring • Carry out a progress review/performance monitoring survey on ICT integration in education sector • Strengthen both ICT and planning divisions of the MOE • Coordinate with the National Education Research Centre in setting up databases, conducting progress monitoring of ICT in education • Repeat the Census on Computer Literacy of Academic Staff of the Schools • Formalize existing ICT inspection system at ministry, provincial, zonal, and divisional levels
7. University involvement	• Help school education sector in the areas of curriculum development and digital content, teacher professional development, usage of ICT in teaching and learning functions. • Undertake studies on learner performance, evaluation, and progress monitoring • Initiate postgraduate, graduate, and certificate level programs for ICT teachers with different educational qualifications
8. TVET sector involvement	• Introduce ICT courses for GCE O/L and A/L students • Help school education sector to initiate short courses on ICT • Assist the school education sector in providing work experience for school leavers at GCE O/L and A/L • Help school education sector in the areas of curriculum development and digital content, teacher professional development, usage of ICT in teaching and learning functions • Assist the school education system by providing computer repair and maintenance services and conducting short courses on repair and maintenance of computers
9. Private sector involvement	• ICTA to assist in the areas of digital content and use of ICT in teaching and learning functions • Key service providers in the ICT sector to assist in developing ICT infrastructure • Assist the school education sector in providing work experience for school leavers at GCE O/L and A/L

Table A3.4 *continued*

Areas	Activities and Initiatives
	Long Term (within 10 years)
1. Technology infrastructure	• Promote the use of alternative energy to address the power shortage in schools
2. Educational content	• Increase the quality and relevance of the digital content
3. Private sector involvement	• Key service providers in the ICT sector to assist in developing ICT infrastructure • Assist the school education sector in providing work experience for school leavers at GCE O/L and A/L

CD = compact disc, GCE A/L = general certificate of education advanced level, GCE O/L = general certificate of education ordinary level, ICT = information and communication technology, ICTA = Information and Communication Technology Agency, MOE = Ministry of Education, NIE = National Institute of Education, SLIATE =Sri Lanka Institute of Advanced Technological Education, TVEC = Technical Vocational Education Commission, TVET = technical vocational education and training.

Source: Author.

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Innovative Strategies for Accelerated Human Resource Development in South Asia
Information and Communication Technology for Education
Special Focus on Bangladesh, Nepal, and Sri Lanka

Information and communication technology (ICT) has the potential to revolutionize education equity, quality, and efficiency. South Asia's governments have recognized this potential and invested in ICT-focused education initiatives and projects. While these efforts helped to introduce ICT-enabled teaching and learning practices, they may not be sufficient for widespread sustainable adoption within their countries. The stage of implementation and impact of investments also vary significantly from country to country in South Asia. This paper examines the existing state and gaps of ICT in education of three South Asian countries—Bangladesh, Nepal, and Sri Lanka—and suggests strategies to address these gaps.

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