ICT-in-Education Toolkit
for Policy Makers, Planners and Practitioners

Version 2.0

ICTs for Education

A Reference Handbook

Part 1: Decision Makers Essentials

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The purpose of *ICTs for Education: A Reference Handbook* is to provide decision makers, planners, and practitioners with a summary of what is known about the potential and conditions of effective use of ICTs for education and learning by drawing on worldwide knowledge, research, and experience.

The handbook has four parts, each of which addresses different users and serves different functions. These parts are organized in a parallel manner for ease of use and to allow cross-referencing.

Part 1: Decision Makers Essentials
Part 2: Analytical Review
Part 3: Resources
Part 4: PowerPoint Presentation

This part (**Part 1**) presents decision makers with a summary of:

- Challenges facing decision makers
- Characteristics and uses of ICTs
- Options and choices for leveraging the potential of ICTs in achieving national and educational goals and solving educational problems
- Prerequisite and corequisite conditions for effective integration of ICTs into the educational process
- Processes to integrate ICTs into education

Part 2 of the handbook:

- Analyzes the rationales and realities of ICTs for education,
- Examines the options and choices for leveraging the potential of ICTs in achieving national and educational goals and solving educational problems, and
- Outlines the prerequisite and corequisite conditions for effective integration of ICTs into the educational process

Part 3 provides resources in the form of case studies, experiences, examples and demonstrations of the potential of ICT-enhanced policies and interventions outlined in Part 2. There resources are referenced in the respective sections of Part 2.

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1 Introduction

Thomas Edison, the father of electricity and inventor of the motion picture, predicted in 1922 that "the motion picture is destined to revolutionize our educational system and...in a few years it will supplant largely, if not entirely, the use of textbooks."

Since then high levels of excitement and expectation have been generated by every new generation of information and communication technologies (ICTs): compact discs and CD-ROMs, videodiscs, microcomputer-based laboratories, the Internet, virtual reality, local and wide area networks, instructional software, Macs, PCs, laptops, notebooks, educational television, voice mail, e-mail, satellite communication, VCRs, cable TV, interactive radio, etc. The list of "hot" technologies available for education goes on and on.

In 1984, Seymour Papert, when he was at the MIT Technology Lab, predicted that, "there won't be schools in the future.... I think the Computer will blow up the school, that is, the school as something where there are classes, teachers running exams, people structured in groups by age, [who] follows a curriculum—all of that" ("Trying to Predict the Future," *Popular Computing* 3(13), pp. 30-44.).

Where are we today?

2 Challenges Facing Decision Makers

Decision makers face two types of challenges that have significant implications for education development.

2.1 National Challenges

- Countries are experiencing significant shifts in the global economic environment characterized by changing patterns of trade and competition, technological innovation, and globalization of information. Together, these developments are producing a new worldwide economy that is global, high speed, knowledge driven, and competitive.
- At the national level, all facets of modern society are becoming knowledge dependent, and without the essential knowledge and skills for modern living, people will remain on the margins of society, and society itself will lose their vast potential contributions.
- There is a digital divide between and within countries. The challenge is to bridge this divide and extend access information and technological skills.

2.2 Educational Challenges

Despite the dramatic progress in education achieved so far at the national and school levels, much remains to be done:

- Each country, to varying degrees, continues to struggle with issues of children out of school and illiterate youths and adults.

- Inequities in educational opportunities, quality of educational services and level of learning achievement persist by gender, rural/urban locality, ethnic background, and socioeconomic status.
- The quality of learning and the capacity to define and monitor this quality is lacking in most developing countries.
- The means and scope of education continue to be narrow and confined to historical models of delivery, and the use of other channels continues to be ad hoc and marginal.
- The increase in quantitative and qualitative demand for education is not matched by an increase in resources.

2.3 Implications for Education

These challenges pose serious questions for planning education and training systems and force rethinking in the way education is perceived, delivered, and managed. Where does this leave education development? With six far-reaching implications:

1. ***Holistic Education Structure.*** Each country needs a whole spectrum of knowledge and skills to deal with technology and the globalization of knowledge and to adjust to continuous economic and social changes.
2. ***Focus on Learning.*** The ancient objective of education, to teach how to learn, problem solve, and synthesize the old with the new, is now transformed from desirable to indispensable.
3. ***Education for Everyone.*** Modern economic, social, political, and technological requirements demand that all members of society have a minimum level of basic education.
4. ***Education Anytime.*** The need for continuous access to information and knowledge makes education lifelong to help individuals, families, workplaces, and communities to adapt to economic and societal changes, and to keep the door open to those who have dropped out along the way.
5. ***Education Anywhere.*** To cope with the diversity and complexity of and the changing demands for education services, learning cannot be confined to the traditional classroom. It is unrealistic and unaffordable to continue to ask learners to come to a designated place every time they have to engage in learning.
6. ***Preparation for the Future.*** The future is changing so dramatically and quickly that it poses a nightmare for educational decision makers, strategists, and planners. We are educating students for the unknown, so the best we can do is to equip them with the necessary conceptual, cognitive, attitudinal, and social tools to continue learning anytime, anywhere, on demand.

3 The Question of ICTs

It is going to be very difficult—if not impossible—for countries to meet the objective of ***effective learning***, ***for all***, ***anywhere***, ***anytime***. Our inability to meet this challenge, however, is self-inflicted because we tend to think of linear scaling, that is, using the same model of education (a school constrained by space and time) but more of it and on a larger scale. What we really need is to think radically and differently.

Here ICTs are offered as a solution to this dilemma. Almost every decision maker in every school system is under tremendous pressure to provide every classroom (if not

every student) with technologies, including computers and their accessories and connectivity to the Internet. The pressures are coming from many directions:

- Vendors who wish to sell the most advanced technologies
- Parents who want to ensure that their children are not left behind in the technological revolution
- Businesses that want to replicate in schools the dramatic impact that ICTs have had in the worlds of commerce, business, and entertainment
- Technology advocates who see ICTs as the latest hope for reform education

The question that many decision makers are asking is: If technologies have the potential to significantly improve the teaching/learning process and revolutionize the education enterprise, in the same manner in which they revolutionized business and entertainment, why haven't we experienced such drastic effects consistently? If technologies are the solution they claim to be, then where is the problem?

Research and experience have shown that the answer to this question is embedded in two critical explorations of the nature and use of ICTs and in two crucial applications of the potential of ICTs and the conditions for their effectiveness.

1. What technologies are we talking about?
2. To what use are we putting ICTs?
3. Is the potential of ICTs properly exploited?
4. Are the conditions for ICT effectiveness met?

The first two questions are discussed below; the second two are elaborated in the next sections.

3.1 What Technologies Are We Talking About?

Decision makers frequently talk about technology ***in the singular***. Technologies differ in their properties, scope, and potential. An audio technology can only capture sound, while a video technology depicts sound and motion. A CD provides multimedia digital content, while a Web version adds interactivity.

Under pressures to be fashionable and adopt the latest educational innovations, the temptation is to limit ICTs to the Internet and exclude other technologies such as radio and television. These technologies use reception equipment that is readily available in homes, have proven to be effective and inexpensive in packaging high-quality educational materials, reach "unreachable clientele," and overcome geographical and cultural hurdles.

Additionally, it is important to distinguish among three types of technologies: instrument technologies, instructional technologies, and dissemination technologies. For instance, a video is an instructional technology, a TV or DVD is an instrument, and a TV broadcast is a dissemination technology. Similarly, a multimedia module is an instructional technology, the CD or Web is a dissemination technology, and a computer is an instrument. In planning for, implementing, and assessing ICT-enhanced projects we need to be clear about the types of technology we are talking about.

3.2 To What Use Are We Putting ICTs?

The impact of ICTs for education depends to a large extent on the purpose for which ICTs are used. For example, if videos are talking heads and software is digital text, we should not expect learning results significantly different from classroom lecturing or

textbook use. However, these instructional technologies may extend educational opportunities to situations where there is no lecturer or textbook.

Thus the selection of a technology and the way it is used is partially determined by what is expected of it in terms of educational, learning, or teaching objectives. Educational objectives are discussed further in Section 4 below. Learning objectives expected from technologies range over the following spectrum:

Storage and Display → Exploration → Application → Analysis → Evaluation → Constructing a Project

Teaching objectives expected from technology use range over the following spectrum:

Presentation → Demonstration → Drill & Practice → Animation/Simulation → Research → Collaboration

The selection of a technology is also determined in part by whether it is meant to be used

- on location or at a distance, or
- for enrichment, an integral part of a school program, or stand-alone (e.g., virtual course or program).

4 Is The Potential Of ICTs Properly Exploited?

Research and experience have demonstrated that different ICTs have the potential to contribute to different facets of educational development and effective learning: expanding access, increasing efficiency, enhancing quality of learning and teaching, and improving policy planning and management. ICTs also offer possibilities in facilitating skill formation, sustaining lifelong learning, and advancing community linkages. Planning for effective use of ICTs for education necessitates an understanding of the potential of technologies to meet different educational objectives and, consequently, to decide which of these objectives is pursued. This decision affects the choice of technologies and modalities of use.

4.1 Expanding Educational Opportunities

It is unrealistic to assume that conventional delivery mechanisms will provide educational opportunities for all in affordable and sustainable ways. ICTs have the potential to help reach this objective. They can overcome geographic, social, and infrastructure barriers to reach populations that cannot normally be served by conventional delivery systems. Additionally they provide feasible, efficient, and quick educational opportunities. The potential of ICTs to reach large audiences includes the following mechanisms.

Radio

Radio has the potential to expand access to education. It is almost universally available, inexpensive, reliable, easy to use and maintain, and usable where there is no electricity infrastructure. Radio can offer many educational advantages, but it also has some drawbacks, including:

- Radio programs are restricted to the audio dimension of knowledge.
- Radio programs follow a prearranged schedule, to which listeners have to adjust.
- There is no interactivity with broadcast programs. Since there is no explicit response from students, it is difficult to know how effective the program is.

There are mechanisms to deal with this last issue, however, such as Interactive Radio Instruction (IRI). IRI is a methodology that requires learners to stop and react to questions and exercises through verbal response to radio characters, group work, and physical and intellectual activities, all *while the program is on the air*. Short pauses are provided throughout the lessons after questions and during exercises to ensure that students have adequate time to think and respond.

Television
TV programs can bring abstract concepts to life through clips, animations and simulations, visual effects, and dramatization. They can also bring the world into the classroom. However, TV broadcast shares with radio programs' rigid scheduling and lack of interactivity.

Experience has shown that TV can be successful in expanding educational opportunities at a national large scale by:

- targeting young adults who have left primary or secondary schools before graduation, allowing them to follow the curricula by watching television, and
- facilitating effective installation and implementation of schools in sparsely settled rural areas.

Virtual High Schools and Universities
Virtual institutions generally provide all the services that a conventional institution does except for physical facilities. It is important, though, to distinguish between Websites that provide individual courses and those that offer a complete online program through which a student can obtain a diploma.

4.2 Increasing Efficiency

The capacity of ICTs to reach students in any place and at any time has the potential to promote revolutionary changes in the traditional educational model.

- ICTs eliminate the premise that learning time equals classroom time. To avoid overcrowded classrooms, a school may adopt a ***dual-shift system*** without reducing its students' actual study time. Students may attend school for half a day and spend the other half involved in educational activities at home, in a library, at work, or in another unconventional setting. They may be required to watch an educational radio/television program and complete related activities or work on an online lesson at the school technology lab or in a community learning center.
- ICTs can make ***multigrade schools*** in areas with low population density viable institutions rather than a necessary evil. While the teacher attends to certain students who need individual attention, other students can listen to an educational program on the radio, watch a television broadcast, or interact with multimedia computer software.
- ICTs can provide courses that ***small rural or urban schools*** cannot offer to their students because it is difficult for those institutions to recruit and retain specialized teachers, particularly to teach mathematics, science, and foreign languages. Schools that do not need a full-time physics or English teacher can use radio, TV, or online instruction, using already developed multimedia materials and sharing one "teacher" among several schools. Alternatively, retired or part-time teachers who live hundreds of miles away can teach the online courses.

4.3 Enhancing Quality of Learning

Research and experience have shown that ICTs, ***used well in classrooms***, enhance the **learning process**, in the following ways:

- They motivate and engage students in the learning process. Students are motivated only when the learning activities are authentic, challenging, multidisciplinary, and multisensorial. Videos, television, and computer multimedia software can be excellent instructional aids to engage students in the learning process. In addition, sound, color, and movement stimulate the students' sensorial apparatus and bring enjoyment to the learning process.
- They bring abstract concepts to life. Teachers have a hard time teaching, and students have a hard time learning, abstract concepts, particularly when they contradict immediate intuition and common knowledge. Images, sounds, movements, animations, and simulations may demonstrate an abstract concept in a real manner.
- The foster inquiry and exploration. The inquiry process is a source of affective and intellectual enjoyment. This sense of adventure is taken away in a traditional classroom, where questions and answers are established a priori and are unrelated to students' interests, and where research is reduced to a word in the textbook. ICTs have the potential to let students explore the world in cost-effective and safe ways. Videos and computer animations can bring movement to static textbook lessons. Using these tools, students can initiate their own inquiry process, develop hypotheses, and then test them.
- They provide opportunities for students to practice basic skills on their own time and at their own pace.
- They allow students to use the information they acquire to solve problems, formulate new problems, and explain the world around them.
- They provide access to worldwide information resources.
- They offer the most cost-effective (and in some cases the only) means for bringing the world into the classroom.
- The supply (via the Internet) students with a platform through which they can communicate with colleagues from distant places, exchange work, develop research, and function as if there were no geographical boundaries.

4.4 Enhancing Quality of Teaching

Teaching is one of the most challenging and crucial professions in the world. Teachers are critical in facilitating learning and in making it more efficient and effective; they hold the key to the success of any educational reform; and they are accountable for successful human development of the nation and for preparing the foundation for social and economic development. Obviously, teachers cannot be prepared for these unfolding challenges once and for all. One-shot training, no matter how effective and successful, will not suffice. A new paradigm must emerge that replaces training with a lifelong continuum of professional preparedness and development of teachers.

ICTs can contribute significantly to the main components of this continuum:

- First, ICTs and properly developed multimedia materials can enhance the initial preparation of teachers by providing good training materials, facilitating simulations, capturing and analyzing practice-teaching, bringing world experience into the training institution, familiarizing trainees with sources of

materials and support, and training potential teachers in the use of technologies for teaching/learning.

- Second, ICTs open a whole world of lifelong upgrading and professional development for teachers by providing courses at a distance, asynchronous learning, and training on demand. ICTs' advantages include ease of revisions and introduction of new courses in response to emerging demands.
- Finally, ICTs break the professional isolation from which many teachers suffer. With ICTs, they can connect easily with headquarters, colleagues and mentors, universities and centers of expertise, and sources of teaching materials.

4.5 Facilitating Skill Formation

There was a time when planning for vocational and technical training was a straightforward exercise, but this is no longer the case. Sectoral needs, job definitions, skill requirements, and training standards are changing faster than the life cycle of a training program. Traditional training programs cannot address these new realities adequately; they are costly in terms of travel and lost time on the job, disruptive, slow to be modified, and incapable of responding to new needs and provisions in a timely fashion.

ICTs have the potential to contribute to skill formation in the same way that they enhance the quality of learning and teaching in general. Additionally, network technologies have the potential to deliver the most ***timely and appropriate*** knowledge and skills to the ***right*** people, at the most ***suitable*** time, in the most ***convenient*** place. E-training allows for personalized, just-in-time, up-to-date, and user-centric educational activities.

ICT-enhanced solutions that advance educational opportunities, efficiency, quality of learning, and quality of teaching are also applicable for improving skill formation. Certain solutions, however, have been particularly effective in this area. Examples include simulations, competency-based multimedia, video and interactive media, and workplace e-training—providing synchronous and asynchronous opportunities through the Internet, video conferencing, videos, CDs, television, etc.

4.6 Sustaining Lifelong Learning

The modern demands on countries, societies, and individuals necessitate lifelong learning for all, anywhere and anytime. Some of the reasons for such a need are:

- The fast-changing, technology-based economy requires worker flexibility to adjust to new demands and the ability to learn new skills.
- The increasing sophistication of modern societies demands constant updating of the knowledge and skills of their citizens.
- The escalating knowledge makes the "educated" obsolete unless they continuously update their knowledge.
- As society evolves, we are unlikely to continue the present life-cycle pattern of prolonged education at the beginning of life and an extended retirement period at the end.
- Lifelong learning provides opportunities for those who are unemployed to reenter the workforce.

Certainly, formal, traditional systems cannot cope with this demand, even if they are well financed, run, and maintained. It is not possible to bring learning opportunities to all of the places where adult learners are. Likewise, it is not feasible to accommodate all

learners in adult education centers and offer them programs that meet their many needs. The diversity of requirements and settings calls for a diversity of means.

ICTs may provide their most valuable contribution in this domain. They are flexible, unconstrained by time and place, can be used on demand, and provide just-in-time education. They have the potential to offer synchronous as well as asynchronous learning opportunities. Above all, if well prepared, they can pack a wealth of expertise and experience in efficient packages that can be modified and updated in response to feedback, new demands, and varied contexts. Possibilities fall in a wide range of technologies, including videos, correspondence, Internet, and e-learning superstructure.

Many of the specific solutions cited for expanding education opportunities and for skill formation are equally relevant for providing and sustaining lifelong learning. Two additional solutions are increasingly adopted:

- Open universities provide opportunities for lifelong learning, not only through degree programs but also through nondegree offerings to enhance knowledge and skills for occupational, family, and personal purposes.
- "Third Age" universities for persons aged 60 and over—the University of the Third Age in China has been one of the most successful programs in promoting lifelong learning.

4.7 Improving Policy Planning and Management

Many educational institutions and systems have introduced simple management and statistical information systems, but this should be only the beginning. More specifically, technology for management can be the underpinnings of reform in two areas:

- **Management of Institutions and Systems**: At the school/institution level, technologies are crucial in such areas as admissions, student flow, personnel, staff development, and facilities. At the system-wide level, technologies provide critical support in domains such as school mapping, automated personnel and payroll systems, management information systems, communications, and information gathering, analysis, and use.
- **Management of Policy Making**: Here ICTs can be valuable in storing and analyzing data on education indicators, student assessment, educational physical and human infrastructure, cost, and finance. More important, they can assist in constructing and assessing policy scenarios around different intended policy options to determine requirements and consequences and to help select those that are the most appropriate. During policy implementation, ICTs can facilitate tracer studies and tracking systems as well as summative and formative evaluation.

4.8 Advancing Community Linkages

Every country experiences disparities in the spread and use of ICTs. Modern ICTs have not corrected the divide between technology-rich and technology-poor areas. The technology gap is not the result of the choices made by individual households, but poor neighborhoods and rural communities lack the necessary infrastructure available in affluent and more populated areas.

Access to ICTs opens vast opportunities for individuals and communities to improve their economic and social well-being, and to bring them from the margins into the mainstream of society.

Where there is a technological gap, a digital divide, there is also a gender divide. This divide cannot be attributed to inherent female characteristics, as evidenced by the high percentage of female ICT users in the industrialized world and by the thousands of offices around the world where women are frequently more competent in dealing with computers and the Internet than are men. Where access to ICTs is limited, there seem to be extra barriers hindering women's access to and use of ICTs. Some of the barriers have to do with disadvantages that women have in terms of education, social value, and economic status. Other barriers include ambivalence, technophobia, lack of training opportunities, and uninviting ICT environments for women.

Community Telecenters
Despite the importance of access to ICTs, achieving such access at the home or individual levels in poverty-stricken areas is untenable because of barriers of infrastructure, ICT literacy, and costs. The community telecenter, one answer to this problem, is a public facility that allows individuals within the served community to have access to ICTs on demand for free or at low cost. Also, some centers provide training in the use of ICTs and others provide educational opportunities via ICTs.

Women and Telecenters
Many telecenter projects have carefully and creatively crafted outreach efforts to attract women. The most successful are those designed with adequate attention to the needs, capacities, and preferences of local communities in general and of women in particular.

5 Are The Conditions For ICT Effectiveness Met?

It is essential to distinguish between potential and effectiveness. No ICT potential is realized automatically. Placing a radio and a TV in every school, putting a computer in every classroom, and wiring every building for the Internet will not solve the problem automatically. The problem is not strictly technological; it is educational and contextual, so constraints must be alleviated and conditions met. Experience points to seven parameters necessary for the potential of ICTs to be realized in knowledge dissemination, effective learning and training, and efficient education services.

5.1 Educational Policy

Technology is only a tool: no technology can fix a bad educational philosophy or compensate for bad practice. Therefore, educational choices have to be made first in terms of objectives, methodologies, and roles of teachers and students before decisions can be made about the appropriate ICT interventions. (See section 2.2 above.) The effectiveness of different levels of sophistication of ICTs depends to a large extent on the role of learners and teachers as practiced in the educational process and on the purposes behind using ICTs for student learning and for teaching.

5.2 Approach to ICTs

Classrooms are constrained environments, and conventional instructional materials are static. If technology-enhanced education programs are taped classrooms, digital texts, and PowerPoint transparencies, then we are missing out on the tremendous potential of technologies that can animate, simulate, capture reality, add movement to static concepts, and extend our touch to the whole universe. Movies and TV programs are not

replicas of theater-packaged theater plays; they tell the same story in a more dramatic and multifaceted manner. So should ICT-enhanced education.

5.3 Infrastructure

It is important to identify the most appropriate, cost-effective, and sustainable technology and level of application for the different educational objectives. Then, the whole prerequisite hardware infrastructure needs to be in place with the supporting elements, such as electricity, maintenance, and technical services. It is not realistic to expect teachers, who will be struggling with a new role and pedagogy, to assume technical responsibility for the hardware.

5.4 ICT-Enhanced Content

ICT-enhanced instructional content is one of the most forgotten areas, but evidently the most crucial component. Introducing TVs, radios, computers, and connectivity into schools without sufficient curriculum-related ICT-enhanced content is like building roads but without making cars available. Acquisition and development of content software that is integral to the teaching/learning process is a must.

5.5 Committed and Trained Personnel

People involved in integrating technologies into the teaching/learning process have to be convinced of the value of the technologies, comfortable with them, and skilled in using them. Therefore, orientation and training for ***all concerned staff*** in the strategic, technical, and pedagogical dimensions of the process is a necessary condition for success.

5.6 Piloting and Evaluation

The strong belief in the potential of technology, market push, and enthusiasm for introducing technology into schools creates the temptation to implement it immediately and full scale. Integrating technologies into education is a very sophisticated, multifaceted process, and, just like any other innovation, it should not be introduced without piloting its different components on a smaller scale. Even technologies we are sure about need to be piloted in new contexts. No matter how well an ICT project is designed and planned for, many aspects need to be tested on a small scale first. Among these aspects are appropriate technologies, suitability of instructional materials, production process, classroom implementability, learning effectiveness, and cost-benefit ratio.

Depending on the results of the evaluation of a pilot scheme, the elements of implementation or the ICT-intervention policy itself may need modifications. Then plans need to be drawn for scaling up the ICT intervention. At this stage more care needs to be given to implementation planning because of the higher risks, larger scope, and more intricate application issues.

5.7 Financial Resources

Acquiring ICTs, no matter how hard and expensive, may be the easiest and cheapest element in a series of elements that ultimately could make these technologies sustainable or beneficial. Educational authorities need to budget sufficiently for all of the parameters outlined earlier, including maintenance.

6 Integrating Technology into Education

The challenges facing education will escalate, and the struggle between needs and resources will deepen. The quest for radical solutions will intensify, and the pressure on decision makers to "do something" with ICTs will keep mounting. The temptation is to introduce ICTs immediately and full scale. Since the potential is great and the stakes are high, decision makers should be bold but not reckless, cautious but not slow, and calculating but not procrastinating.

The worst that could happen is for each country to deal with these issues in isolation by reinventing the wheel and failing to learn from the experiences (and mistakes) of others. It is essential therefore for decision makers, planners, and practitioners to be well aware of the wealth of worldwide knowledge, research, experience, and thinking. This awareness should not lead to transplantation of ideas and experiences but, rather, should enlighten, guide, and inspire locally conceived and implemented decisions and plans.

Experience has consistently taught us that integrating technology into the educational process is not a simple, one-step activity. It is an intricate, multifaceted process that involves a series of deliberate decisions, plans, and measures:

- *Mapping of the present situation in terms of national goals, educational context, ICTs in education, and the dynamics of change*
- *Identification of educational areas for ICT intervention and formulation of corresponding ICT-in-education policies*
- *Planning for implementation— infrastructure, hardware, ICT-enhanced content, personnel training, and cost*
- *Evaluation of ICT intervention and subsequent adjustments and follow-up actions*

Technologies have great potential for knowledge dissemination, effective learning, and efficient education services. Yet, if the educational policies and strategies are not right, if ICT-in-education policies are not well thought out, and if the prerequisite conditions for using these technologies are not met concurrently, this potential will not be realized.