CONNECT ALL SECONDARY SCHOOLS AND PRIMARY SCHOOLS WITH ICTs

Target 2: Connect all secondary schools and primary schools with ICTs[1]

Executive summary

Target 2 reflects the importance of connecting all schools with ICTs. ICT connectivity in schools provides pupils with new resources and pedagogical tools, allows them to acquire the skills required for the information society, improves administrative processes and supports teacher training. Outside school hours, connected schools can provide access to ICTs for the community, including marginalized groups.

Target 2 is tracked using four indicators, which address both newer and older types of ICT. Radio and television, including both broadcast and ad hoc modes of delivery, represent traditional forms of ICT that nevertheless remain key for connecting schools in both developed and developing countries. This is particularly so in rural and remote areas, where financial resources and/or human resources are often lacking. In areas where electrical infrastructure is absent, radio has the added advantage that it only requires batteries.

The first two indicators – 'proportion of schools with a radio used for educational purposes' and 'proportion of schools with a television used for educational purposes' – show varying levels of achievement amongst countries. Penetration of radio and television for educational purposes has been universally achieved in a number of developed and developing countries, while they lag in a number of others. More importantly, the availability of radio and television frequently remains very low in a number of developing countries despite the fact they can play an important role in connecting schools, especially where more advanced forms of ICT are absent. While radio and television are known to be increasing in some countries to fill connectivity gaps, they are decreasing in others, particularly where the emphasis is shifting towards more advanced forms of ICT including computers and the Internet.

Despite such challenges and consistent with the evolving information society, schools in a large proportion of countries (both developed and developing) are progressing towards increased use of computers – albeit at very different speeds. The third indicator, the 'learners-to-computer ratio' (LCR), tracks general access to computers. Tracking the LCR is important since its value is inversely proportional to time on task. In other words, the greater the number of learners sharing a single computer device, the less time overall that pupils can use computers during class time. LCRs vary substantially between regions and countries. They are lowest in Europe and other OECD countries, typically below 10:1, while they are relatively high in developing countries. LCRs are highest in a number of least developed countries (LDCs) in Asia and Africa, where computers are unevenly distributed across the education system, resulting in a lack of availability for the majority of students. While progress has been difficult to measure conclusively in most regions and countries, data show that LCRs are falling in a number of countries. This is particularly so in developing countries that have implemented strong policy initiatives and programmes with high-level governmental support and a sector-wide approach. The adoption of low cost laptops and tablets has been relatively effective to rapidly decrease LCRs in a number of countries.

The fourth indicator, the 'proportion of schools with Internet access, by type of access', shows that while Internet access has been universally achieved in the majority of European and other OCED countries, Internet connectivity is lagging behind in most developing countries. It remains under 10 per cent in some countries from all developing regions, including Latin America and the Caribbean, Asia and Africa. Data on Internet access are the most frequently available for all the indicators used to track Target 2. However, collecting data on schools with broadband Internet access is more challenging. Where available, data show that the availability of broadband Internet varies. In many European and other OECD countries, broadband Internet is universally available, while this is also true for some developing countries with strong ICT in education initiatives. In some developing countries, all schools with Internet are connected using broadband – suggesting that a leapfrogging phenomenon may be occurring, with schools bypassing the use of older forms of Internet access such as narrowband.

Significant progress has been achieved connecting schools with ICTs during the ten years since the Geneva phase of the WSIS. However, progress has not been uniform across countries and regions. As universal connectivity remains elusive for many countries, a post-2015 ICT monitoring framework should continue to track ICT connectivity in schools. Based on current analysis, and considering the rapidly evolving ICT landscape, some additional indicators for monitoring ICT in education during the post-2015 agenda could include an additional version of the 'learner-to-computer ratio' that includes only schools with computer-assisted instruction (CAI). This indicator would shed light on the actual level of computer access available in schools, particularly in developing countries where access is unevenly distributed. Additionally, the 'learner-to-computer connected to the Internet ratio' (LCCIR), would provide information on the technological capacity of computers and other digital devices. Analysis has shown that while countries may have some success in building a computer infrastructure, connecting these devices to the Internet may lag behind. While data on LCCIR have been somewhat more challenging to obtain, particularly in developing countries, they would shed additional light on the relative connectivity of schools, as indicators 2.3 (LCR) and 2.4 (proportion of schools with Internet access) do not capture the full extent to which all computers in schools are connected.

The UIS regularly collects the relevant data to calculate both these indicators. While data will not be universally available in the post-2015 environment, increased capacity building in countries will contribute to improvements of ICT in education statistics over time.

Finally, this report offers some policy recommendations for connecting all schools with ICTs:

- Strengthen existing electrical infrastructure.
- Recognise the potential of fixed broadband, WiMax, and mobile broadband (3G and 4G) Internet for equipping schools with high-speed Internet.
- In countries with difficult terrain, consider building a combination of wireless and satellite-based telecommunications with low-cost Very Small Aperture Terminal (VSAT) apparatus for downlink of data and images.
- Consider the use of both radios and televisions to connect schools in situations where more advanced forms of ICT are not feasible or available.
- Low cost computers are an effective strategy to rapidly increase the computer resources in a country, but this policy option should be weighed against other educational priorities.

- Recognise the role of community media centres to play a role in extending the reach of ICT to pupils when ICTs are not available in schools.
- Establish partnerships with multiple levels of government and the private sector, particularly with telecommunications companies, to negotiate low cost access to Internet services.
- In countries where universal Internet service is not feasible, governments should promote the installation of public Internet facilities in rural areas.

Introduction

The advent of the knowledge economy and global economic competition compel governments to prioritise educational quality, lifelong learning, and the provision of educational opportunities for all. Policy-makers widely accept that access to information and communication technology (ICT) in education can help individuals to compete in a global economy by creating a skilled work force and facilitating social mobility. They emphasise that ICT in education has a multiplier effect throughout the education system, by:

- enhancing learning and providing students with new sets of skills
- reaching students with poor or no access (especially in rural and remote regions)
- facilitating and improving the training of teachers
- minimising costs associated with the delivery of traditional instruction
- improving the administration of schools in order to enhance the quality and efficiency of service delivery.

Outside official school hours, schools with ICT may also be used to provide learning opportunities for the community, including marginalized groups, such as the elderly, minorities, the unemployed and people with disabilities.[2]

However, beyond the rhetoric, and of equal importance to policy-makers, are basic questions related to the measurement of ICT in education, such as connectivity, participation, usage and outcomes, including retention and learning achievement. While some of these dimensions are difficult to measure, Target 2 indicators measure basic components of ICT connectivity in primary and secondary schools.

As illustrated in Figure 2.1, WSIS Target 2 is closely related to three WSIS action lines. For example, Action Line C2 (Information and communication infrastructure) states that:

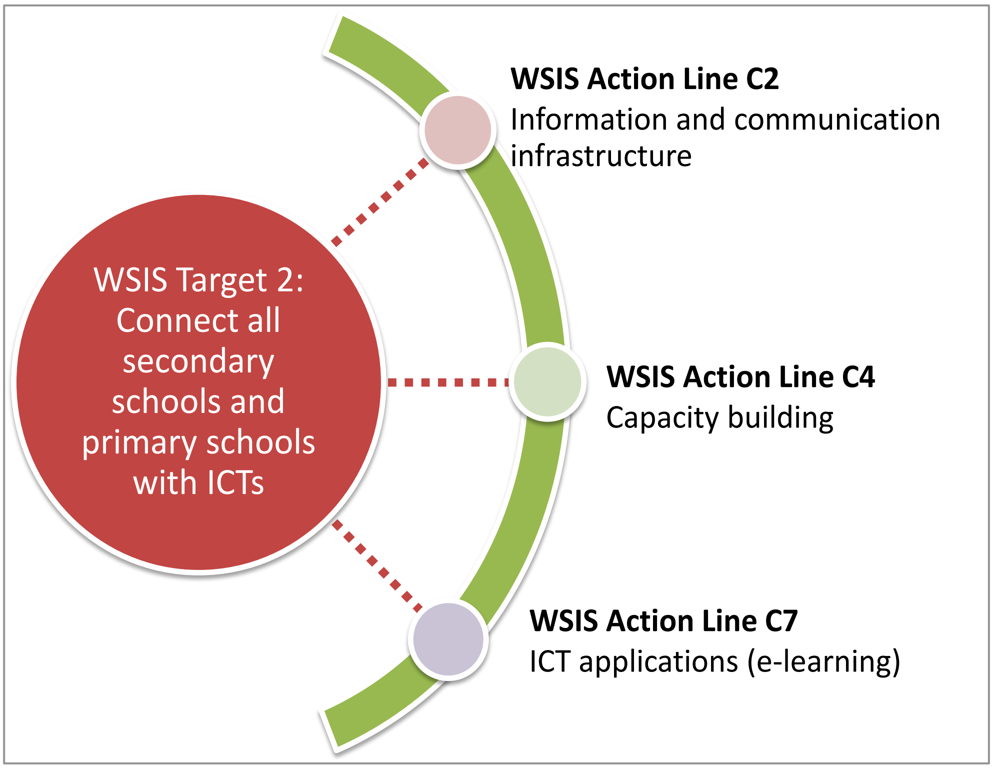
> "In the context of national e-strategies, provide and improve ICT connectivity for all schools, universities, health institutions, libraries, post offices, community centres, museums and other institutions accessible to the public, in line with the indicative targets." (ITU, 2005)

Target 2 is also significant in the context of Action Line C7, in respect of promoting e-learning, and Action Line C4 (Capacity building), which enumerates a number of policies such as integrating ICT in education and promoting e-literacy skills for all:

> "Everyone should have the necessary skills to benefit fully from the information society. Therefore capacity building and ICT literacy are essential. ICT can contribute to achieving universal education worldwide, through delivery of education and training of teachers, and offering improved conditions for lifelong learning, encompassing people that are

outside the formal education process, and improving professional skills."
(ITU, 2005

Figure 2.1: Relevance of Target 2 to WSIS action lines



Data availability and scope

Despite the growing demand for ICT in education statistics, there have been few global initiatives to identify indicators or to provide data on ICT in education. Periodic surveys on schools have been carried out in Europe, usually under a project of the European Commission (European Schoolnet, 2013) as well as in a number of regions, including Latin America and the Caribbean (Hinostroza and Labbé, 2011), and Asia (World Bank, 2010; ADB, 2012). However, data on ICT in education are generally not comparable across countries and are based on different sets of indicators and definitions. Despite its limitations in terms of geographical coverage, the OECD's Programme for International Student Assessment (PISA) dataset has been a relatively reliable source of information on access, use and outcomes regarding ICT in education (OECD, 2011; Scheuermann *et al*., 2009).

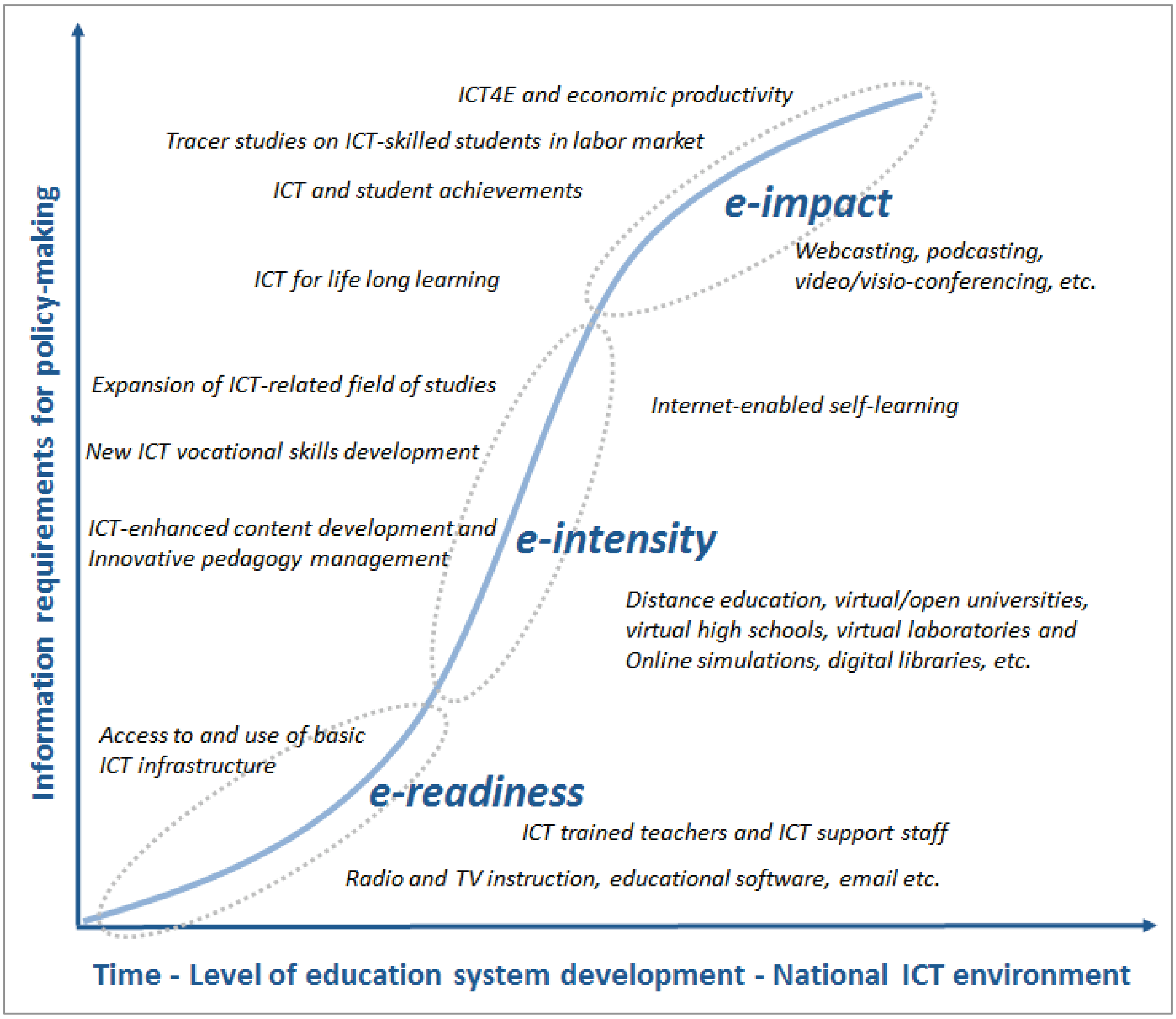
The Partnership on Measuring ICT for Development is mandated to establish internationally comparable statistical indicators and associated standards for monitoring of the information society. However, in order to monitor ICT in education from an international perspective, it is necessary to build consensus on a conceptual framework. Under the auspices of the *Partnership*, the UNESCO Institute for Statistics (UIS), in 2009, led a process for the development and pilot testing of internationally comparable core indicators of ICT for education (ICT4E). These were a subset of the indicators described in the UIS *Guide to Measuring Information and Communication Technologies (ICT) in Education* (UNESCO-UIS, 2009a). Since the release of the UIS *Guide* in 2009, the approach has emphasized that schools are the main units of data collection, with aggregation at the country level.

A set of core 'ICT in education' indicators that measure aspects of e-readiness and access to ICT in education systems were submitted by the *Partnership* to the United Nations Statistical Commission (UNSC) at its 40th session in February 2009 (*Partnership*, 2010). As a response to the need to expand the initial core list, UIS established the international *Working Group for ICT Statistics in Education* (WISE). The purpose of the working group was to bring together statisticians (as national focal points) from ministries of education (or national statistical offices) from 25 countries to pilot the international *Questionnaire on Statistics of ICT in Education* (UNESCO-UIS, 2009b). The four indicators identified to monitor Target 2 in the following sections result from this initiative.

While the results of the UIS surveys presented in this chapter provide important insights into the status of ICT in education in both developed and developing countries, the survey has not yet been disseminated globally and this chapter is therefore limited to 118[3] countries from various data collections. Initially, data were collected from 25 countries using the pilot questionnaire (UNESCO-UIS, 2009b); those data were analysed and included in the *World Telecommunication/ICT Development Report 2010: Monitoring the WSIS Targets, A mid-term review* (WTDR) (ITU, 2010). Since then, UIS has conducted regional data collections and released reports for Latin America and the Caribbean (UNESCO-UIS, 2012), Arab States (UNESCO-UIS, 2013) and Asia (UNESCO-UIS, 2014). UIS began collecting ICT in education statistics in sub-Saharan Africa in late 2013. Since several countries have yet to complete the UIS survey, data in this chapter are complemented with indicators collected using the *Partnership on Measuring ICT for Development WSIS Targets Questionnaire, 2013* (*Partnership*, 2013) as well as from other regional or national sources.

At an individual country level, the most appropriate indicators to measure Target 2 depend on a country's development status and the penetration of ICT in education. Thus, the concerns of policy-makers and their information needs will shift over time. Countries that are in the early stages of introducing ICTs (*e-readiness* stage) have different information needs than countries that have longer experience with technology. For instance, in the initial stages, countries require information on underlying infrastructure to support ICT, including electricity and Internet connections; on access to different types of ICT-assisted instruction; and, on training for teachers to give them basic ICT skills. During the second stage (*e-intensity* stage), the underlying infrastructure has been established, thus facilitating the rapid uptake of ICT in education. This results in changing information needs, including those related to the management of pedagogical innovation, adaptive and inclusive curricula, organizational change, sustainable technical support and continued staff development. Finally, countries in the most advanced stage of ICT use in education (*e-impact* stage) require information on enhancing student outcomes and the effects on economic productivity (see Figure 2.2).

Figure 2.2: Information needs at different levels of ICT penetration in educational systems



Source: UIS, adapted from (UNTAD, 2007).

Indicators to track WSIS Target 2

While Target 2 promotes connection of all primary and secondary schools with ICTs, it does not specifically state which ICTs should be used (*Partnership*, 2011). Clearly ICT-assisted instruction must encompass technologies that are consistent with national circumstances and realities. In this sense, technologies and supporting infrastructure may include 'older' or more traditional ICTs, such as radio and television broadcasts (live and off-air), as well as more recent digital technologies, such as broadband Internet, cloud (distributed) computing, computer e-learning software and mobile learning models.

The following four indicators were defined in the 2011 WSIS statistical framework (*Partnership*, 2011) to track Target 2:[4]

Indicator 2.1: Proportion of schools with a radio used for educational purposes

Indicator 2.2: Proportion of schools with a television used for educational purposes

Indicator 2.3: Learners-to-computer ratio

Indicator 2.4. Proportion of schools with Internet access, by type of access (broadband, narrowband).

Indicator 2.1 refers to the proportion of a country's primary and secondary schools that have at least one radio that is used for educational purposes. The indicator measures the potential use of radio(s) by teachers and pupils in education, but not the quality nor actual use. The indicator is the *Partnership* core ICT indicator, ED1 (*Partnership*, 2010).

Indicator 2.2 refers to the proportion of a country's primary and secondary schools that have at least one television that is used for educational purposes. The indicator measures the potential use of television(s) by teachers and pupils in education, but not the quality nor actual use. The indicator is the *Partnership* core ICT indicator, ED2 (*Partnership*, 2010).

Indicator 2.3 refers to the number of pupils on average sharing a computer. The indicator measures the potential access to computers by pupils and teachers, but not the quality nor actual use. It can be calculated in two different ways:

1. the average number of all pupils nationally sharing a single computer
2. the average number of pupils in schools that have computers for educational purposes, sharing a single computer (*Partnership* core ICT indicator, ED4 (*Partnership*, 2010)).

While Indicator 2.3 in the 2011 WSIS statistical framework is defined per the first form of the indicator, the second form is a useful complementary indicator and is therefore included in this chapter.

Indicator 2.4 refers to the proportion of a country's primary and secondary schools that have Internet access, as well as the proportion with various types of access, in particular fixed broadband. The indicator measures the extent of Internet access among schools, but does not measure the degree to which it is used for educational purposes, as many schools in developing countries reserve Internet for administration. Moreover, the indicators do not measure the quality or speed of Internet connectivity, which is known to vary significantly between countries. The indicator is the *Partnership* core ICT indicator, ED5 (*Partnership*, 2010).

All of the Target 2 indicators are in the *Partnership*'s core list of ICT indicators and, at the international level, are collected and published by UIS. While relatively few have done so, a number of countries and regions have set specific targets on ICT in education (see Box 2.1) that can be monitored by the *Partnership*'s indicators.

Box 2.1: Setting targets for integrating ICT in education – regional and national level examples

While Target 2 does not specify the proportion of schools that should be connected to ICT, some regions and countries have set their own targets:

In Latin America and the Caribbean, eLAC 2015 set the goal of connecting all educational establishments to broadband and increasing computer density, while promoting the use of convergent educational resources such as mobile phones, video games and open interactive digital television (UNECLAC, 2010).

In Georgia, the Deer Leap Programme was established to facilitate the modernization of the education system by creating a country-wide, school-based ICT infrastructure and building capacity in modern information technology. One of its goals was to provide access to computers and the Internet in all schools by 2008 (Ministry of Education and Science, 2007). While this was not achieved, the government programme 2008–2012, 'Georgia without Poverty', reaffirmed its pledge to modernize all public schools and implement the Deer Leap Programme successfully, equipping schools with computers and connecting them to the Internet.[5]

In 2009, Australia committed funding to provide 90 per cent of all schools with optical fibre progressively over the next eight years and to achieve a 1:1 learner-to-computer ratio (LCR) for secondary schools by 2011. Schools connected will have access to broadband speeds of up to 100 Mbit/s (Department of Broadband, Communications and the Digital Economy, 2009).

In South Africa, the Department of Communications developed a draft national broadband policy, which restated its vision for broadband for all South Africans by 2030. From baseline data, which states that there were 25 per cent of schools connected to the Internet via broadband in 2013, 50 per cent of schools will be connected by 10 Mbit/s in 2016, and all schools will be connected by broadband in 2020 (Department of Communications, 2013).

Achievements against Target 2

Proportion of schools with a radio/a television used for educational purposes

Considered 'older' more traditional forms of ICT, radio and television have been used in education since the 1920s and 1950s, respectively. Experience has shown that radio and television represent effective solutions for delivering educational content, by expanding access on a large scale and at a low cost. Strategies include: targeting of young adults who have left primary or secondary schools before graduation, allowing them to follow curricula from a distance; and providing otherwise unavailable instruction in sparsely settled rural and remote areas (Haddad *et al.*, 2007; Trucano, 2010; World Bank, 2010).

While there are numerous benefits to be gained from connecting schools using computers and the Internet, many developing countries continue to see broadcast technologies as a viable alternative. Live radio broadcasts and off-air audio-assisted technologies as well as television broadcasts and off-air video-assisted technologies are still considered valid modes of education delivery. Radio-assisted instruction (RAI), in particular, has an added advantage in rural and remote areas where there may be little or no access to electricity and devices can be operated using batteries. Addressing the perceived lack of interactivity of radio broadcast technologies in delivering educational content, interactive radio instruction (IRI) requires that pupils react to questions and exercises through verbal responses to programme contributors during broadcast. This technology might alleviate some of the concerns of educators and learners alike (Trucano, 2010).

For the purposes of measuring radio-assisted instruction, a radio is defined as being a stand-alone device (in working condition) capable of receiving broadcast radio signals, using popular frequencies (such as FM, AM, LW and SW). Radio-assisted instruction includes both radio broadcast education and interactive radio instruction. Radio broadcast education may also be an audio lecture or lesson, with printed material for learners to follow. Any teacher who is not qualified in the subject matter, can use the radio broadcast as a primary instructional source. Broadcast programmes follow the traditional model of education and can cover every subject in many different languages, depending on the target audience.

For the purposes of measuring television-assisted instruction, a television is defined as a stand-alone device (in working condition) capable of receiving broadcast television signals using popular access means (such as over-the-air, cable and satellite). Television-assisted instruction is similar to radio-assisted instruction, with the additional benefit of video. It helps to bring abstract concepts to life through clips, animations, simulations, visual effects and dramatization. While television-assisted instruction can connect a classroom to the world, it shares the same rigid scheduling and lack of interactivity as radio broadcast education.

Chart 2.1 shows indicators 2.1 and 2.2: the proportion of schools that have a radio for educational purposes and the proportion of schools that have a television for educational purposes. Of the Target 2 indicators, 2.1 and 2.2 are more difficult to assess due to lack of available data. The data show that there are countries in each region that do, and do not, use radio- and television-assisted instruction. In fact, a number of developing countries that do not provide televisions and radios universally for educational purposes may benefit significantly, especially where computers and Internet connectivity are absent (see Box 2.2).

Box 2.2: Connecting schools through interactive TV-assisted instruction in a remote state in Brazil

Faced with a significant deficit of qualified teachers, especially in remote regions and in subjects like mathematics, science and foreign languages, several countries are engaged in long-term efforts to recruit and train additional teachers, as well as upgrade the knowledge and skills of those already in their education systems. Where there are pressing needs for teachers that cannot be met through conventional approaches or according to the traditional timelines dictated by the capacity and effectiveness of teacher training institutes, educational authorities are looking to see how ICT can be leveraged to help reach students in schools without qualified teachers – or in some cases, without any teachers at all (Trucano, 2014).

In Amazonas, which is Brazil's largest state by area, significant logistical challenges exist in the deployment of quality education. For example, there are 6 100 rural/riverside communities outside the capital city of Manaus, which is home to about half of the state's 3.8 million residents. The main forms of transportation are by air or river. Suffering from remoteness, pupils have lower completion rates compared to the national average, and a high number of overage students in a total student population of 864 000. To extend educational opportunity and enhance the quality of teaching, educational authorities in the state are promoting the widespread use of interactive educational television through public media centres (Centro de Mídias do Amazonas) (IDB, 2014).

This programme utilizes satellite television in the service of what is essentially multi-point videoconferencing (and thus interactive). Classes are taught remotely by teachers in Manaus and lessons are broadcast to students in schools in rural communities, who are supported by a professional face-to-face tutor in their classrooms. One lesson is typically shared by multiple municipal schools simultaneously. These municipal schools serve as primary schools in the morning, and then older students come to school in the afternoon for the educational TV offerings. Each class is mediated by an onsite tutor, who coordinates the questions and answers, provides further explanations and directions, and helps support the equipment to ensure that the experience is as interactive as possible. Students have access to textbooks and other educational resources (both paper-based and via the Internet). Students in these settings follow the same curriculum as other schools across the state, but on a block schedule, whereby (for example) students have three consecutive weeks of mathematics, then four weeks of biology, followed by three weeks of English, instead of studying multiple subjects simultaneously as in a typical school (Trucano, 2014).

The initiative grew substantially between 2007 and 2013, quadrupling the number of pupils exposed, doubling the number of schools, and serving seven times more communities (Box Table 2.2). While there are plans to expand coverage substantially (for example, increase the number of schools covered to 960), it is not easy to deploy satellite antennas in these rural, remote communities. A rigorous evaluation agenda has been proposed, looking at project impact, for example, on academic performance, dropout and repetition rates (IDB, 2013).

Box Table 2.2: Measuring interactive educational television in amazonas

	2007	2013	Future Goals
Pupils	10,000	38,000	53,000
Classrooms	260	1,809	not available
Schools	200	400	960
Communities	334	2,400	3,900

Source: Trucano, 2014.

In Latin America and the Caribbean, radio(s) and television(s) are universally available for educational purposes in a number of small island countries including Anguilla, Bahamas, Barbados, Saint Lucia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, and Trinidad and Tobago. In contrast, in 2010 just 1 per cent of private schools in the Dominican Republic provided radio for educational purposes through the private sector rural community education and development programme, *Escuelas radiofónicas*, while televisions were available in 15 per cent of all schools. Radio and television were also poorly integrated in a number of other Latin American and Caribbean countries including

Antigua and Barbuda, British Virgin Islands, Costa Rica, Ecuador, Guatemala, Sint Maarten, Venezuela and Mexico.

Mexico, where 14 per cent of schools had televisions used for educational purposes in 2009,[6] represents one of the best known television-assisted initiatives in the region. Commonly known as *Telesecundaria*, this initiative was launched in 1968 as a means of using television to extend lower secondary education to remote and small communities, at a lower cost than establishing conventional schools. The early model included lessons transmitted live through open public channels to television sets placed in remote classrooms, where students listened and took notes in the presence of a teacher. Each hour of class was made up of the television broadcast itself, followed by a discussion with the teacher of what had been seen. More recent versions of the programme include additional interactivity. The system was inexpensive because public networks donated airtime to the Ministry of Education and because it required fewer teachers than traditional schooling (Hinostroza and Labbé, 2011; UNESCO, 2012).

Asia demonstrates a similar pattern where radios and televisions are not evenly available. Radio and television are universally available in China, Hong Kong; Bahrain; and the Republic of Korea, but were only available in a minority of schools in Myanmar[7] (13 per cent and 5 per cent) in 2012, Yemen (37 per cent and 11 per cent) in 2013, and Azerbaijan (5 per cent and 36 per cent) in 2012. In Palestine, where Internet access was available in less than a third of schools, radios were universally available and televisions were present in 77 per cent of schools in 2012 (UIS, 2013).

In Jordan, the integration of radio and television for educational purposes (94 and 59 per cent, respectively) is decreasing given the discontinuation of radio broadcasts in 2009 and television broadcasts in 2002. Broadcasts have been replaced by an ad hoc approach using existing hardware in schools for instruction. For example, radios/recorders are used for English language and Islamic education, while televisions continue to be used to view educational video tapes (Ministry of Education, 2013a). Similarly, policies shifting away from the use of conventional radio in Oman resulted in a decrease in the proportion of schools with a radio from about 100 per cent in 2008 to 55 per cent in 2013, while the use of televisions decreased from 100 per cent to 80 per cent.

Similar patterns are evident in Eastern Asia. For instance, radio(s) and television(s) for educational purposes are decreasing in Thailand, having been available in 72 per cent and 100 per cent (respectively) of schools in 2008 compared to 29 and 30 per cent (respectively) in 2012. Radio access also decreased in Malaysian schools from 100 per cent in 2008 to 27 per cent in 2011, while television access remained universal (100 per cent).

In Africa, basic electrical infrastructure lags behind most other regions, strengthening the rationale for extending the use of conventional ICTs, particularly radio. However, while few data are available in Africa, evidence suggests that significant disparities exist. For example, as far back as 2008/2009, schools in Botswana and Mauritius had high proportions of radio(s) – 77 per cent and 93 per cent, respectively – while most schools also had television(s) – 100 per cent and 97 per cent. In contrast, just 58 per cent and 23 per cent of schools in Lesotho had radio(s) and television(s) for educational purposes, respectively, in 2009. Moreover, despite its role in filling gaps in connecting schools to ICTs, only one third of schools (35 per cent) in Ethiopia had television(s) for educational purposes in 2008.

Similarly, radio and television are also not prioritised in schools in Egypt, even though large populations live in rural areas, where radios could serve a useful function. Radios were available in 46 per cent of schools in 2010, while televisions were available in 64 per cent of schools. Television connection is often through the use of mobile technology equipped with transmission receivers to the Egyptian Satellite (Nile Sat) television broadcasts, which air educational programmes for children and general literacy programmes (UIS, 2013).

Finally, many countries in Europe no longer collect data on radios and televisions in school. However, for countries with available data, radios and televisions for educational purposes are generally provided in schools. They are available in all schools in Croatia, Finland, Sweden and the United Kingdom. In contrast, they are least available in Bosnia and Herzegovina, where 9 per cent and 75 per cent of schools had radio(s) and/or television(s) for educational purposes, respectively in 2008.

Chart 2.1: Schools with radio/television used for educational purposes, 2012 or LYA[8]

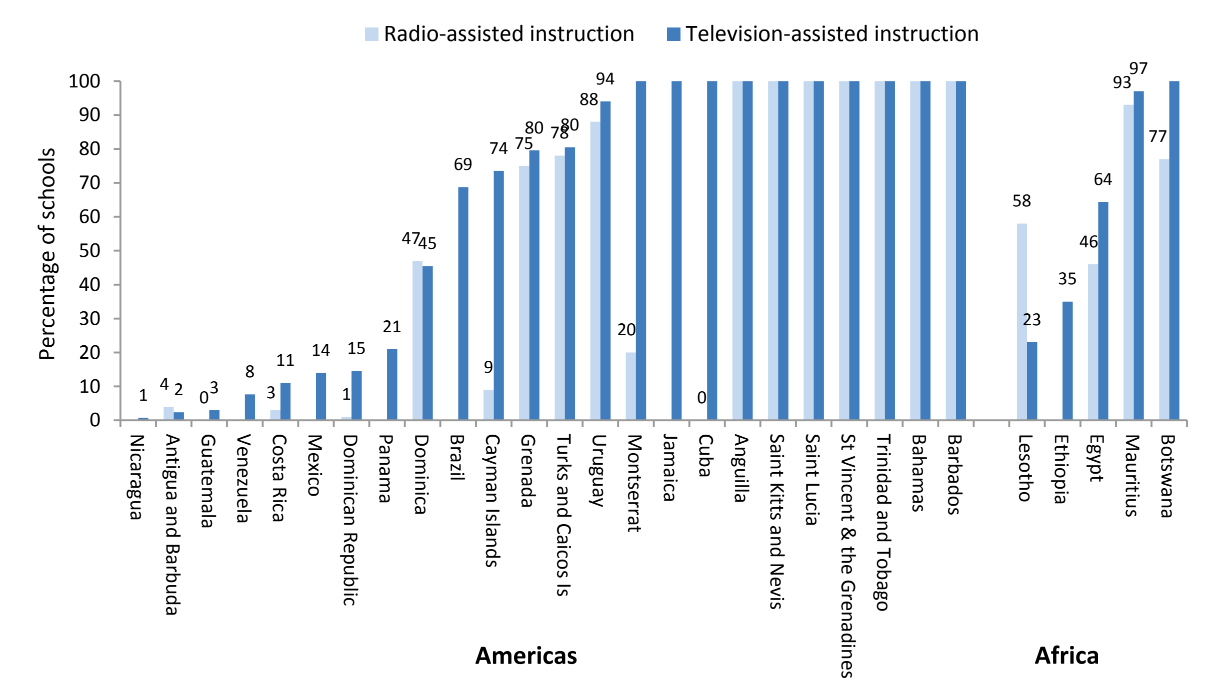
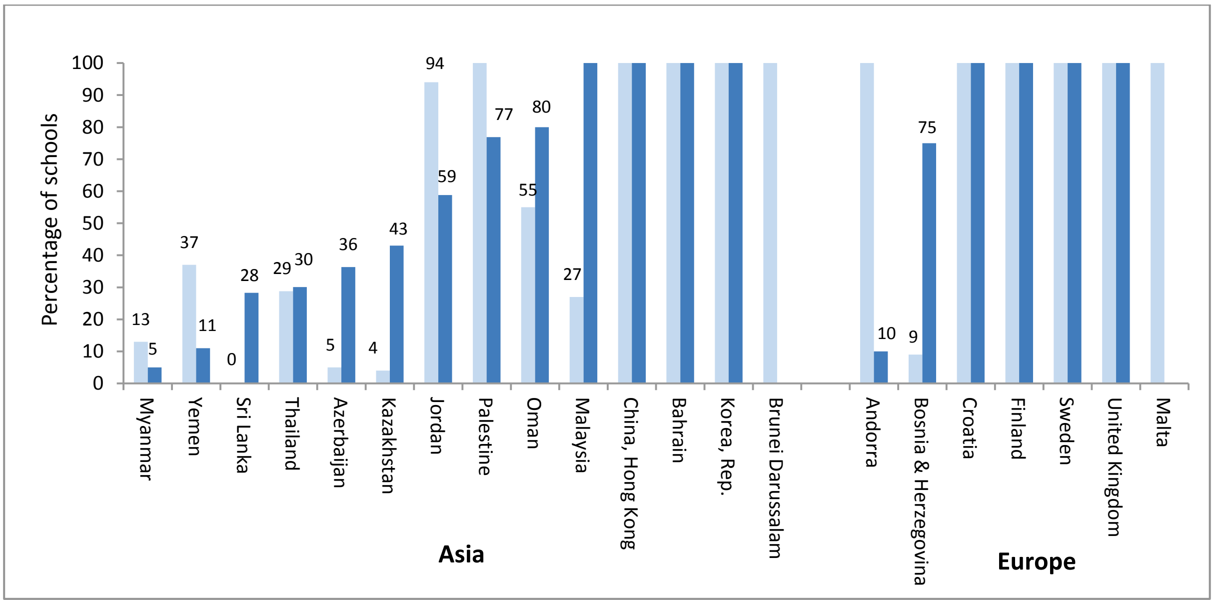


Chart 2.1: Schools with radio/television used for educational purposes, 2012 or LYA (cont.)



Source: UIS database, Partnership on Measuring ICT for Development WSIS Targets Questionnaire, 2013 (*Partnership*, 2013).

Notes:

1. Reference years range from 2008 to 2013 (2008 to 2012 for the Americas, 2008 to 2010 for Africa, 2008 to 2013 for Asia and 2008 to 2009 for Europe). Full details can be found on the UIS website, http://www.uis.unesco.org/Communication/Documents/wsis-tables-2014.pdf.
2. Data on televisions in Mexico refer to primary and lower secondary education, in Panama to lower secondary education, and in Dominican Republic and Jamaica to upper secondary. Data on radios for Myanmar refer to secondary only. Data for Nicaragua refer to primary and lower secondary only. Data for Uruguay refer to primary education only. Data on televisions for Antigua and Barbuda, Barbados, Costa Rica, Dominican Republic, Mexico, Uruguay and Venezuela, reflect public schools only. Data on radios for Thailand and China, Hong Kong refer to public schools. Data for Azerbaijan, Bahamas, Jamaica, Malaysia and Nicaragua refer to public schools only. Data on radios for Dominican Republic refer to private schools only. Data for Palestine refer to West Bank schools only.

Learners-to-computer ratio

In order to provide advanced forms of ICT-assisted instruction, including computer-assisted instruction (CAI) and Internet-assisted instruction (IAI)[9] (see Target 7), ICT resources must be available and able to keep pace with demand and technological evolution.

Depending on the measurement objective, Indicator 2.3, 'learners-to-computer ratio' (LCR), measures access in two different ways. The most basic method refers to the mean number of learners sharing a single computer available for educational use. It is calculated by dividing the total number of learners in a country by the total number of computers available for educational purposes in all primary and secondary schools. A high value for this ratio depicts a situation where, on average, there are many learners nationally for each available computer. However, the national aggregate level LCR is rather a gross measure of computer use for educational purposes, as CAI might not be available in all schools in a given country. In order to shed light on access for pupils enrolled in schools that actually offer CAI, UIS also calculates the complementary indicator, 'learners-to-computer ratio in schools with CAI'. A high value for this indicator suggests that not only is there strain on computer resources across the entire education system, but more specifically that this strain also exists in schools equipped with computers. In many developing countries, such as India, where computers may be shared with the general community, available resources are even more strained, unless scheduling is established to prioritise pupils (Department of School Education and Literacy Ministry of Human Resource Development, 2012).

In the absence of an international target or national norms, a ratio of one learner to one computer may seem to suggest that computer provision is adequate. However, since countries vary in their curricula and levels of financial resources, the sharing of school-owned computers might reflect pedagogical as well as cost-efficiency decisions (see Box 2.3). It is noteworthy that in many countries not all educational levels nor curricular subjects require the support of computers in all classes. Additionally, this indicator should be analysed in the context of parallel use of other, non-computer ICTs in schools – especially radio and television.

Where national standards exist, an aggregate LCR higher than the official norms implies that more efforts are required from policy-makers to equip schools with computers in order to ensure equitable opportunity for all learners across the country. In contrast, a LCR lower than the norm suggests that additional resources might be reallocated to schools where resources are scarce. By frequently updating this indicator, countries can monitor the LCR and ensure that all schools meet the required standard.

The LCR is an aggregate measure of the digital divide, irrespective of the type of school. Chart 2.2 shows the highly variable LCR values across regions and countries. In countries where the basic LCR is greater than 100:1, computer resources are greatly overstretched. This is the case for a number of countries from all regions except Europe. In Latin America and the Caribbean, 122 pupils on average shared a computer in the Dominican Republic in 2010, while in Asia, there has been a considerable lack of computers in Yemen, Indonesia and Philippines, where national level LCRs were 376:1, 136:1 and 128:1, respectively, in 2012. The lack of computers is even greater in Nepal and Cambodia, where nationally at least 500 primary and secondary pupils share a computer.[10] Computer resources are also greatly overstretched in Africa. For example, approximately 500 pupils or more shared a computer in Niger and Principe and Zambia in 2013, while in Ghana and Morocco, national LCRs were 117:1 in 2009 and 174:1 in 2008, respectively. In Sao Tome and Principe, computers at the primary level are only used for administrative purposes, resulting in a secondary level LCR of 158:1 in 2013.

Where enrolment data in programmes offering CAI are available, the calculation of the 'learner-to-computer ratio in schools with computer-assisted instruction' (LCR in schools with CAI) sheds light on how computer resources are distributed amongst schools that have computers for educational purposes. Generally, the larger the difference between the LCR and the LCR in schools with CAI, the smaller the proportion of pupils nationally that have access to computers for learning. Chart 2.2 shows that while computer resources may be strained at the national level in many countries, the LCRs in schools with CAI in the same countries reveal a distribution pattern that is more conducive to learning. For example, while 33 pupils shared one computer on average in Iran (Islamic Republic of) in 2012, there were just 11 pupils on average sharing a computer in schools with CAI. Similarly, in Latin America and the Caribbean, there were 75 pupils, on average, sharing a single computer in Paraguay in 2010, compared to 22 in the schools with CAI.

In some countries, not only are computers strained nationally, but they are also strained in the schools where they are available. In Asia, 128 and 98 pupils shared a computer at the national level in the Philippines in 2012 and in Sri Lanka in 2011, respectively, compared to 69 and 55 in schools with CAI.

Box 2.3. Implementing 1:1 computing through low cost laptops and tablets – costs versus benefits

Few, if any, national ICT in education policies provide a rationale for specified learners-to-computer ratios (LCRs), nor do they suggest how these ratios relate to achievement in curriculum outcomes, student performance, skills development, classroom methodologies or levels of usage. Given the apparent lack of any informed policy rationale, there is indeed a strong feeling that a clearer vision is required (Camfield *et al.*, 2007).

Nonetheless, one-to-one computing, which is being introduced in several countries has demonstrated itself as an effective ICT model to decrease LCRs. The two most common initiatives include *One Laptop Per Child* (OLPC), which manufactures the XO laptop computer specifically designed for children in developing countries, and the similar INTEL Classmate PC laptop computer. The advantage of these laptops is their low cost, durability and low energy requirements – they use significantly less electricity than standard laptops.

One-to-one computing has been most prevalent in Latin America and the Caribbean, with some of the largest deployments of XO computers in Uruguay (510 000 laptops) and Peru (860 000 laptops) (OLPC, 2014), and Classmate computers in Argentina (projected 3 million laptops) and Venezuela (almost 2 million laptops since 2009) (Reardon, 2010; Robertson, 2012).

One-to-one computing is also seen in Asia. For example, Thailand adopted the *One Tablet per Child* (OTPC) scheme, distributing one device per child in grade 1, beginning in 2012. Given that each year, every new grade 1 cohort is given a tablet, all primary pupils will have their own tablet by approximately 2018. In 2014, this scheme will also be extended to cover secondary grade 7 pupils to achieve one-to-one computing in secondary education (Ministry of Education, 2013b). Turkey, under its Fatih national programme, is introducing tablets across its educational system (Fatih, 2014). Meanwhile, smaller OLPC deployments are also occurring in Nepal (6 000 laptops) and Mongolia (14 500 laptops) (OLPC, 2014). In Africa, Rwanda has deployed 110 000 laptops nationally.

The financial implications of one-to-one computing are potentially significant, particularly for many developing countries. In some cases, the cost could have a considerable impact on other areas of education provision, especially in countries where more classrooms and teachers are urgently needed. For example, India opted not to expand their one-to-one computing project beyond a pilot phase because of such considerations (Kraemer *et al.*, 2009).

In addition to financial barriers, operational challenges also exist. Teachers need to be trained to use computers and servicing and maintenance facilities for the laptops need to be made available. In the programme conducted in Uruguay (El Ceibal), repairs have been the responsibility of the family, which has led to complaints that poorer families are at a disadvantage, thus contradicting the notion that the laptops help to eliminate the domestic digital divide (OLPC News, 2010).

The impacts of one-to-one computing in developed countries are mixed. In the United States, one-to-one laptop projects in primary schools did not lead to measurable improvements in reading or writing skills – but nor did they harm them (Camfield, 2007). Results such as this can be interpreted in two ways – either technology does not improve learning, or standardized tests failed to measure the skills learned using technology. The study did find that laptop programmes improved students' abilities to deal with information and to collaborate. More recently, a report on one-to-one learning initiatives in 19 countries in Europe carried out by European Schoolnet (EUN), on behalf of the Institute for Prospective Technological Studies (JRC-IPTS), provided preliminary evidence of a variety of impacts that ICT may have in education. In addition to enhancing learning outcomes, ICT might beneficially affect students' motivation, foster student-centred learning behaviours, diversify teaching and learning practices, and improve parents' attitudes (Balanskat *et al.*, 2013).

However, less is known about the effects of the OLPC and other similar initiatives in developing countries. In Peru, which has the largest deployment of XO computers globally, the expansion in access translated into substantial increases in computer use both at school and at home. While there was no evidence of positive impacts on enrolment or test scores in mathematics and languages, some positive effects were found in general cognitive skills (Cristia *et al.*, 2012).

Source: UIS research.

LCRs are relatively low in most developed countries for which data are available. In Europe, for example, most countries have a LCR of 10:1 or less. LCRs are lowest in Sweden (2:1), with Denmark, Estonia, Norway and Spain at 3:1. In contrast, LCRs were relatively high in some Eastern European countries, including Albania, and Bosnia and Herzegovina where the LCRs were 32:1 in 2009 and 30:1 in 2008, respectively.

A number of developing countries have been very effective in reducing LCRs across their educational systems. For instance Uruguay's *El Ceibal* initiative, which partners with the *One Laptop per Child* (OLPC) project, has acquired low cost highly durable XO computers and is a pioneering country in achieving one-to-one computing (a LCR of 1:1). In Asia, Thailand is also in the process of implementing its *One Tablet per Child initiative* (OTPC), and as a result the LCR decreased from 25:1 in 2008 to 14:1 in 2012 (Thailand, 2013).

Even though not participating in one of the well-known one-to-one computing initiatives, Colombia and Georgia have made substantial progress in building their educational computer resources by obtaining financial support from different levels of government, local communities and businesses. For example, between 2002 and 2013, the LCR in Colombia decreased from 142:1 to 13:1 (see Box 2.4), while in Georgia it decreased from more than 200:1 in 2004 to 7:1 in 2012 (see Box 2.5). Finally, while the Dominican Republic also reduced its LCR in primary and secondary schools from 179:1 in 2008 to 122:1 by 2010, the average number of pupils sharing a single device remained high (UIS, 2012).

Chart 2.2: Learner-to-computer ratios, national aggregate/schools with CAI, 2012 or LYA[8]

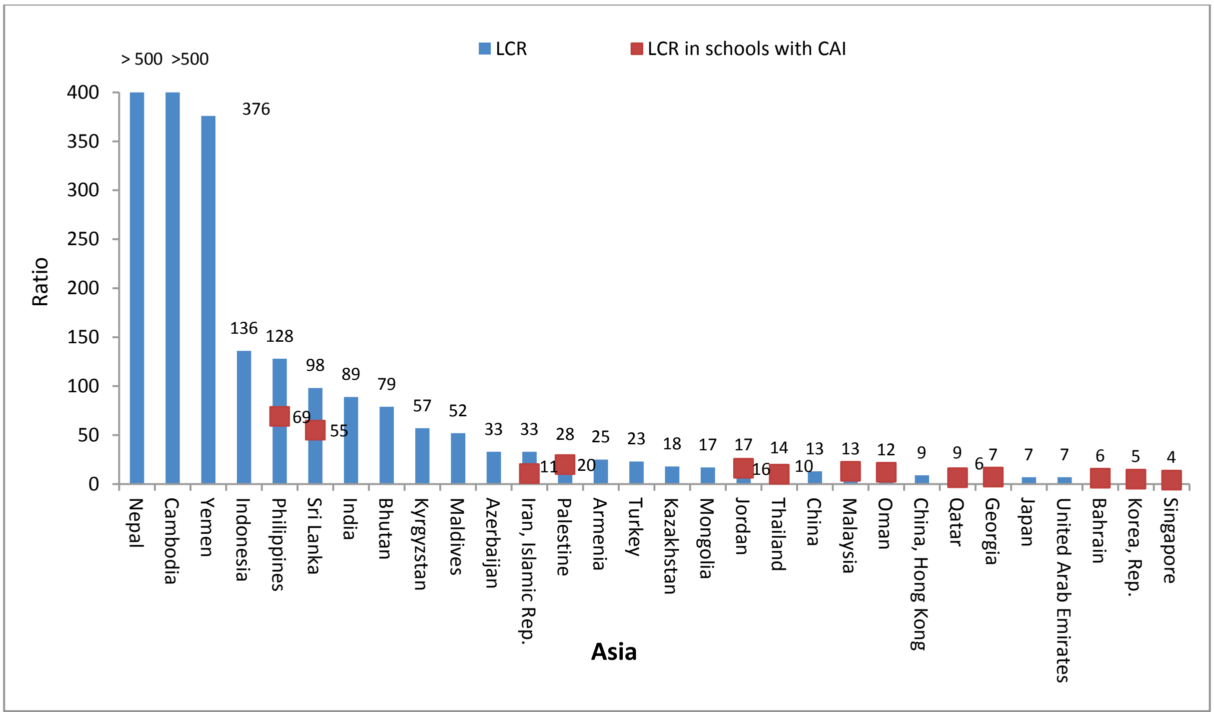
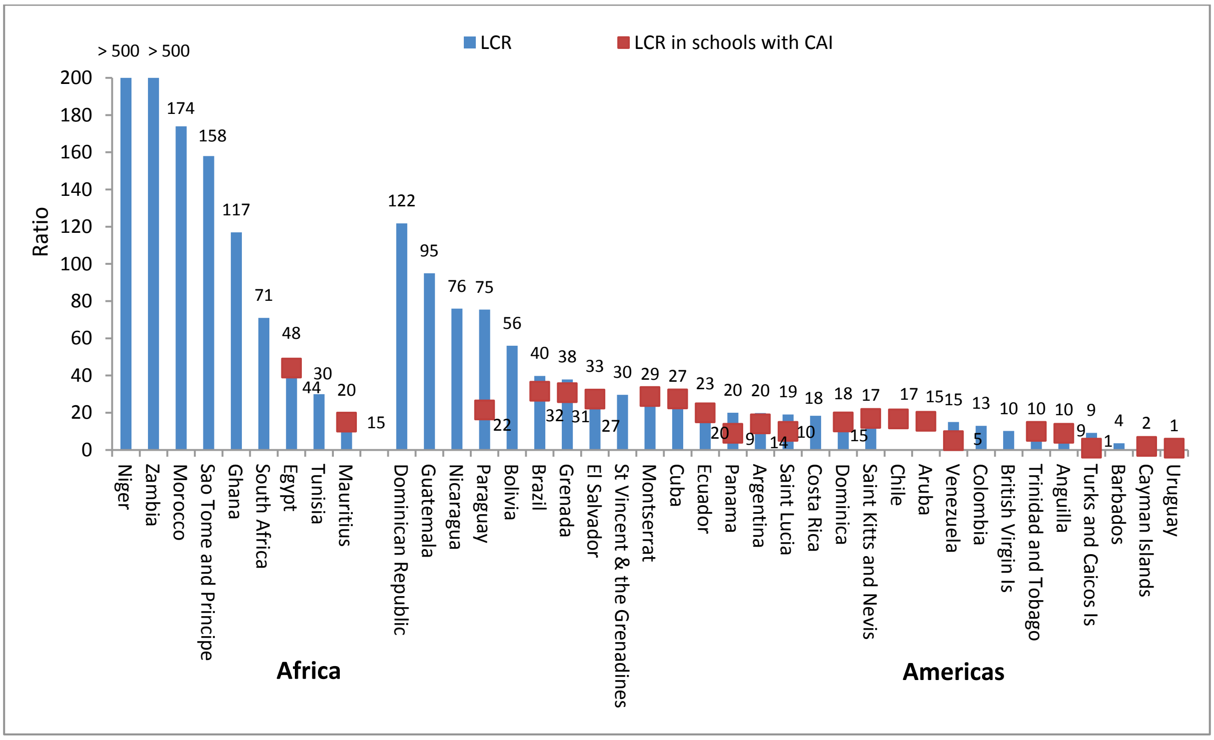
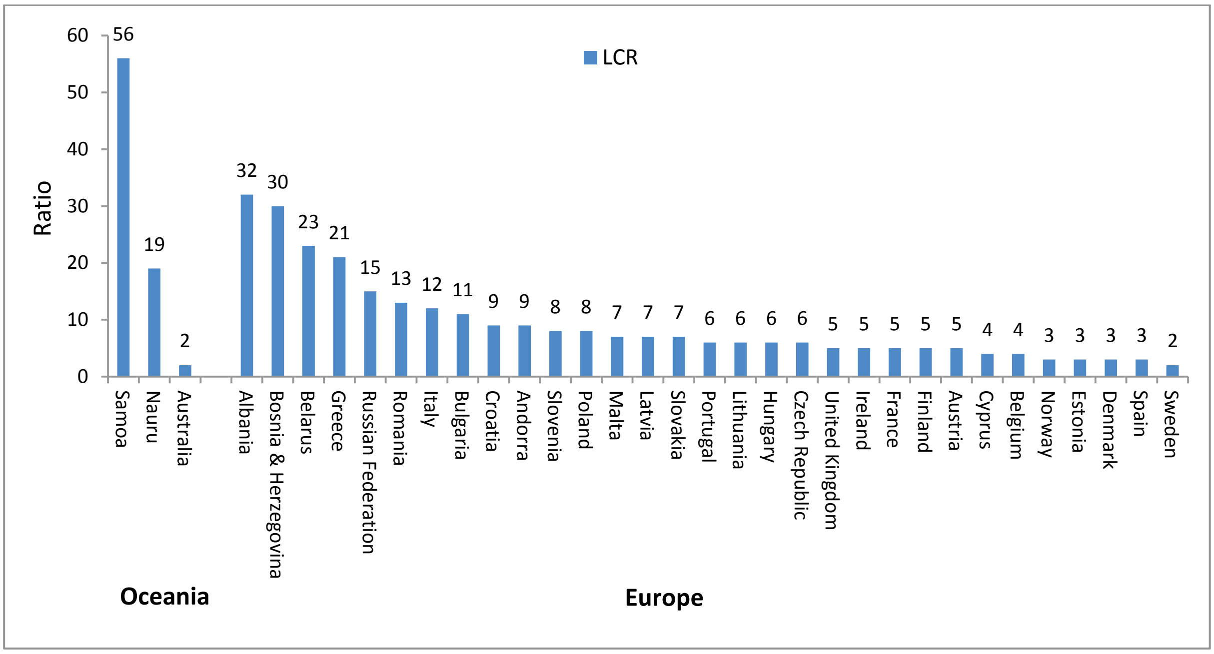


Chart 2.2: Learner-to-computer ratios, national aggregate/schools with CAI, or LYA (cont.)





Source: UIS database, Partnership on Measuring ICT for Development WSIS Targets Questionnaire, 2013.

Notes:

1. Reference years range from 2007 to 2013 (2009 to 2013 for the Americas; 2008 to 2013 for Africa, Asia and Europe; and 2007 to 2012 for Oceania). Full details can be found on the UIS website, http://www.uis.unesco.org/Communication/Documents/wsis-tables-2014.pdf.
2. Data for Cambodia refer to secondary schools only. Secondary data for Nicaragua, China and Philippines do not include upper secondary. Data for Saint Lucia and Uruguay refer to primary schools only. Data for European countries refer to lower secondary. Data for India do not include independent secondary schools. Data for Morocco, Tunisia, Dominican Republic, Guatemala, Nicaragua, Montserrat, Saint Lucia, Trinidad and Tobago, Anguilla, Philippines, Sri Lanka, Kazakhstan, Malaysia, Qatar, Japan, Singapore, Belarus and Russian Federation refer to public schools. Data for Palestine refer to West Bank schools only.

Box 2.4: Progress towards increasing access to ICT in Colombia

In Colombia, ICT has amplified educational opportunities by:

- engendering new approaches to teaching and learning (Piscitelli, 2012)
- contributing to increasing student retention
- improving learning outcomes and the pursuit of higher education (Rodriguez *et al.*, 2011)
- allowing the acquisition of technological skills needed in the information society (Ananiadou and Claro, 2009)
- facilitating the inclusion of ethnic minority groups, people with disabilities and students of low academic achievement (Castellanos, 2012)
- opening doors to tertiary education, free of charge, to anyone connected to the Internet.

Acknowledging current challenges, the ICT Ministry of Colombia since 2000 has endorsed the *Computers for Education*, or *Computadores para Educar* programme (CPE), which comprises an association of public entities that helps realise development opportunities for children and youth by improving the quality of education through ICT. As the main state mechanism for bringing technology to educational institutions, CPE contributes to lowering the national LCR. In 2002, the programme supplied schools with approximately 11 000 units of computer equipment resulting in a ratio of 142:1. Having secured a supply of 70 000 computers for educational institutions four years later, the ratio decreased to 46:1 in 2006. Most recently, with total computer assets totalling 760 000 in 2013, a ratio of 13:1 has been achieved.

CPE is innovative in its approach to computer provision, taking into account trends towards mobility and versatility, the needs of students and school budgets. For example, desktop computers provided in 2002 were upgraded in 2006, while more recent computer deployments introduced laptops in 2009 and tablets in 2012.

Nevertheless, the implementation of CPE has met a number of challenges, including lacks in adequate financial resources to safely store equipment, poor electricity supply, and minimal teacher training on how to use ICT in the classroom. In order to deal with these challenges and ensure successful implementation of CPE, Colombia has:

- involved local communities, businesses and government to increase funding
- negotiated greater electrical supply from power plants and sought donations for solar panels
- negotiated flexible teaching schedules with educational administrators to allow teachers to meet the 150 hours of required training.

While results are preliminary, an internal impact assessment of the programme showed that dropout rates decreased by 4 per cent. There was also a 2 per cent improvement in the national examination, and a 5 per cent increased probability of pursuing higher education.

Source: Ministry of Information Technologies and Communications, 2014.

Box 2.5: Georgia improves access to digital technology – the Deer Leap programme

To counter a lack of ICT resources and Internet connectivity in schools, Georgia's Ministry of Education and Science launched an ambitious national programme in 2005, known as *Deer Leap*, for integrating ICT into teaching and learning in schools. The project had several aims including:

- providing every school with computers, Internet access, educational software and ICT support services
- upgrading the ICT skills of teachers and students
- integrating ICT into the curriculum through computer-assisted instruction in a wide range of subjects
- computerization of the Education Management Information System (EMIS) at school, local and national levels.

With Estonia's assistance, the programme was provided with a total budget of just over USD 14 million (GRID, 2014).

The four-year program (2005–2009) was modelled on the Estonian *Tiger Leap* programme and was managed by a board consisting of representatives of government, Parliament, civil society, business associations, university academics and teachers. The task of the programme was especially challenging, given that in 2004 before the program started, the LCR in schools was over 200:1 and Internet connections in schools were rare (as well as slow and costly). While Internet Informatics was a compulsory subject in all secondary schools, the content of this subject – which was programming – was frequently taught without computers. Moreover, ICT was rarely used in other subjects or in school management.

By the end of 2008, the Deer Leap programme had resulted in increased ICT infrastructure in schools, including more than 26 520 new computers. The LCR had decreased from 250:1 in 2004 to 22:1. All computers were equipped with the Linux operating system and a set of open-source software applications. Internet connectivity was provided to more than 300 schools, so that 60 per cent of all primary and secondary pupils could have access to Internet at school. A web-based collaboration environment for educational projects was also developed and integrated with a portal to support authoring and sharing learning objects, including participation in international projects and collaborative learning between Georgian and Estonian schools. Finally, administrative support in the form of IT managers hired in most schools and the training of teachers, helped to support the ongoing modernization and computerization of the Georgian education system.

The goal of integrating at least one computer in each school by 2008 was not achieved. However, Georgia reaffirmed its commitment through the *Georgia without Poverty Programme* (2008–2012) and pledged to modernize all public schools and implement the *Deer Leap* programme successfully. By 2012, Georgia had met its target of having at least one computer in all schools, with a LCR for combined primary and secondary schools of 7:1. Internet connectivity was also installed in all Georgian schools, one third (29 per cent) of which had a fixed broadband connection by 2012.

Source: UIS research.

Proportion of schools with Internet access

The proportion of schools with Internet access is measured by Indicator 2.4. It is central to understanding connectivity at the primary and secondary level – and hence to assessing Target 2. The indicator measures the overall level of access to Internet in schools, not the intensity of use nor the actual amount of time that learners spend on the Internet for educational purposes. Access may be through any wired or wireless device (PCs, laptops, PDAs, tablets, smartphones etc.) using fixed broadband, fixed narrowband or mobile broadband connections. Private Internet connectivity within schools via mobile phone networks is excluded.

At the most basic level, electrification is a key concern for countries where many schools may not be connected to a reliable source. However, even where there is an electricity supply, ministries of education in some countries often have little or no control over Internet connectivity in schools, which depends on the national telecommunications infrastructure (World Bank, 2010). In some countries, Internet service providers (ISPs) are unwilling to operate in difficult geographic terrain or in rural areas with low population density (ADB, 2012).

Given the vital importance of broadband access, connectivity is also measured according to the type of Internet connection. The proportion of schools with fixed broadband Internet access provides a good indicator of the quality of Internet connections and the potential to use ICTs for educational purposes.[11]

Fixed broadband Internet refers to high-speed connectivity for public use of at least 256 Kbit/s in one or both directions (downloading and uploading). It includes cable modem Internet connections, DSL Internet connections of at least 256 Kbit/s, fibre and other fixed broadband technology connections (such as satellite broadband Internet, Ethernet LANs, fixed-wireless access, Wireless Local Area Network and WiMAX).[12]

Recognizing the importance of broadband Internet to effectively access online resources, the Broadband Commission for Digital Development, whose membership includes UNESCO, ITU and private industry, recently adopted the goal of *Broadband for All*, particularly for women, girls and marginalized groups. By defining practical ways in which countries, at all stages of development, can achieve broadband connectivity in cooperation with the private sector, the Broadband Commission for Digital Development promotes the importance of universal broadband on the international policy agenda to accelerate progress towards achieving the MDGs by 2015 (Broadband Commission for Digital Development, 2013).

Information on the type of Internet access can inform policies and decisions to expand and/or upgrade Internet connections in schools. Data to monitor the availability of general Internet and fixed broadband access in schools exist for a reasonable number of developed and developing countries. Chart 2.3 shows that, by 2012, the vast majority of schools in developed countries were connected to the Internet. In fact, many developed countries had stopped tracking some aspects of ICT infrastructure in schools, because connectivity (usually fixed broadband) was approaching 100 per cent. For instance, according to a report released by the European Union in 2006, the vast majority of schools in Europe already had Internet access. Similarly, all public schools in the United States were connected to the Internet as of 2006 and 97 per cent had a broadband connection, while in Canada, 97 per cent of schools were connected to the Internet as early as 2004.

Chart 2.3 demonstrates that in the majority of European countries with data (that is, in 20 out of 23 countries), more than 95 per cent of schools have an Internet connection. In contrast, 81 per cent of schools in Poland had Internet in 2012, while the Russian Federation and Belarus had 80 per cent and 61 per cent of schools, respectively, with Internet connectivity in 2008. According to Chart 2.3, fixed broadband was already universally available in Andorra, Croatia, Czech Republic, Malta and the United Kingdom in 2009, and in Sweden and Bosnia and Herzegovina in 2008. In contrast, it was available in about two thirds of schools in Slovakia (66 per cent) in 2009, less than half of schools in the Russian Federation (43 per cent) and only 7 per cent of schools in Belarus in 2008.

By comparison, the proportion of schools with Internet connectivity is relatively low in most countries in Latin America and the Caribbean. In fact, the proportion of schools with Internet connectivity was less than 15 per cent in a number of South and Central American countries, including Dominican Republic (12 per cent) in 2013, Guyana (4 per cent), Nicaragua (6 per cent) and Paraguay (9 per cent) in 2010 and Suriname (6 per cent) in 2009. Some countries that had low levels of school connectivity appear to be 'leapfrogging' directly to broadband Internet connectivity and bypassing the use of narrowband. For example, in Nicaragua and El Salvador where approximately 6 per cent and 24 per cent of schools had Internet connections, respectively, all were via fixed broadband.

There is an advanced state of Internet connectivity in a number of Caribbean island countries where 100 per cent of schools in Anguilla, Aruba, Barbados, British Virgin Islands, Saint Kitts and Nevis, Saint Lucia and Sint Maarten were connected to the Internet by 2010 – all using fixed broadband. Opposing the trend, Saint Vincent and the Grenadines demonstrates the coexistence of broadband and other types of Internet connection. For example, of the 68 per cent of schools with Internet, half (34 per cent) had fixed broadband.

Fixed broadband connectivity in schools presents a challenge for several large South American countries, with a substantial urban-rural divide. Brazil and Argentina, for example, show that both fixed broadband and other types of connectivity coexist. For example, while 46 per cent and 36 per cent of schools were connected to the Internet in Brazil and Argentina, respectively in 2010, 38 per cent and 22 per cent were connected via fixed broadband. Bandwidth constraint is particularly challenging in Colombia where only 8 per cent of a total of 71 per cent of connected schools had a broadband connection in 2011.

Uruguay, on the other hand, with its ambitious country driven *El Ceibal* project, provides an example of a middle income country that has been able to achieve a relatively high level of connectivity in schools. By 2009, it was able to provide fixed broadband to 96 per cent of schools, including both urban and rural subregions. Yet, while Uruguay demonstrates substantial progress, central authorities have reported that for 70 per cent of primary schools, school Internet connections were such that only half of all laptop computers could be online at the same time. Meanwhile, Chile’s *Enlaces* initiative, which partners with the private sector, has also been very effective in improving connectivity rates among schools. The result is that 78 per cent of schools were connected to the Internet in 2013, compared to just 44 per cent in 2009 (see Box 2.6).

A number of economies in Eastern Asia and South Eastern Asia display high levels of school connectivity, with all or most schools having fixed broadband Internet access in Brunei Darussalam; China, Hong Kong; the Republic of Korea; Singapore and Thailand. Other Asian countries with high levels of Internet connectivity included Kazakhstan (97 per cent) in Central Asia, and Armenia, Georgia and Bahrain in Western Asia (100 per cent) in 2012. While fixed broadband Internet was universal in Bahrain, about one third (29 per cent) and half (50 per cent) of all schools in Georgia and Kazakhstan, respectively, were connected via fixed broadband. Having invested heavily in e-materials, there is an ongoing recognition in Kazakhstan of a lack of efficiency resulting from problems in bandwidth, particularly in rural areas (ADB, 2012). Oman provides an example of a country that has shown significant progress in connecting its schools to the Internet, increasing from 62 per cent in 2008 to 90 per cent in 2013.

Mongolia, a country with one of the lowest population densities in Asia, has also made considerable efforts and has connected 91 per cent of its primary and secondary schools to the Internet – with 40 per cent having a fixed broadband connection in 2012. In addition to school connections, Mongolia also provides Internet access to pupils through fixed and mobile community centres (ADB, 2012). Yet despite this positive trend, some schools in Mongolia have terminated Internet access voluntarily due to high costs. To resolve this situation, Mongolia’s Ministry of Education, Culture and Science has attempted to meet schools' Internet costs from central budget funds to ensure continued connectivity.

Internet connectivity in schools has been particularly scarce in a number of developing countries across Asia. In 2011, it was available in less than 10 per cent of schools in Nepal (5 per cent); while in 2012, Internet connectivity was also scarce in Kyrgyzstan (6 per cent), Cambodia (7 per cent), and in Bangladesh (5 per cent). Unfortunately, data on Internet connectivity in schools are lacking for India and China, the two most populated nations in Asia.

Internet data are unavailable for most countries in Oceania. In Australia, where almost all schools had achieved full Internet connectivity by 2003 and 97 per cent had fixed broadband by 2010, the National Broadband Network is building a national fibre-optic data network that will connect 90 per cent of schools with speeds up to 100 Mbit/s.[13]

Data on Internet connectivity are also reasonably scarce in Africa and the data that do exist suggest that there is much room for improvement. For example, 10 per cent or fewer schools were connected in Ethiopia (2 per cent), Morocco (3 per cent) and Senegal (5 per cent) in 2008, Lesotho (10 per cent) in 2009, and Sudan (4 per cent) in 2013. In contrast, the proportion rises to 81 per cent and 85 per cent of schools in Tunisia and Mauritius, respectively, in 2008. Data on fixed broadband Internet for Africa are scarce; Chart 2.3 shows that 2 per cent of schools were connected via fixed broadband in Morocco in 2008, compared to 75 per cent of schools in Mauritius. In Botswana, where about one quarter of schools had an Internet connection (23 per cent) by 2009, all connections were via fixed broadband.

Chart 2.3: Schools with total and fixed broadband Internet, 2012 or LYA[8]

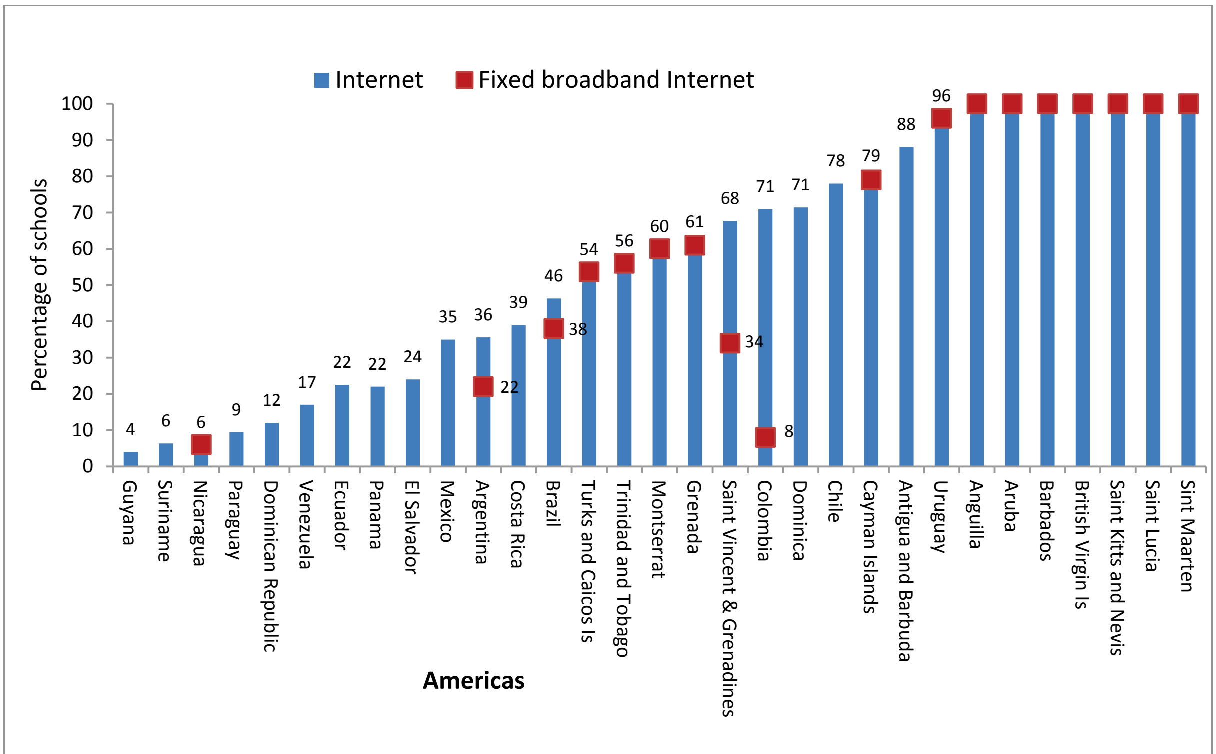
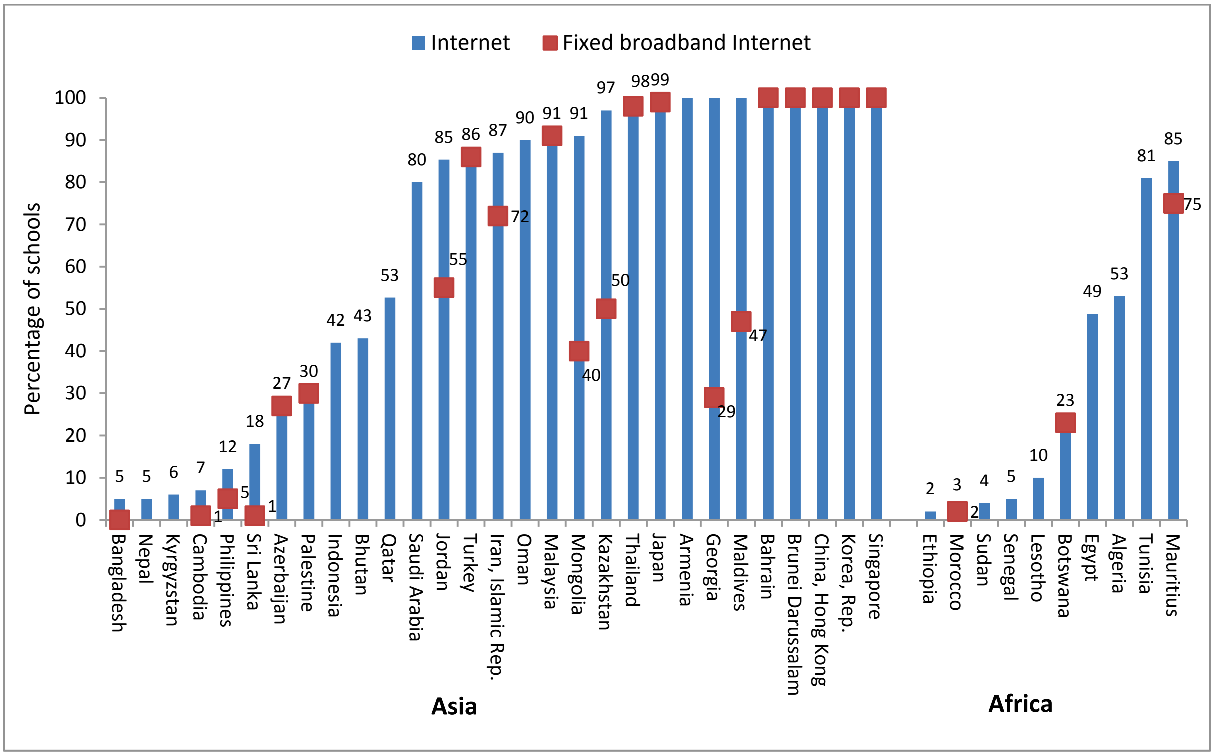
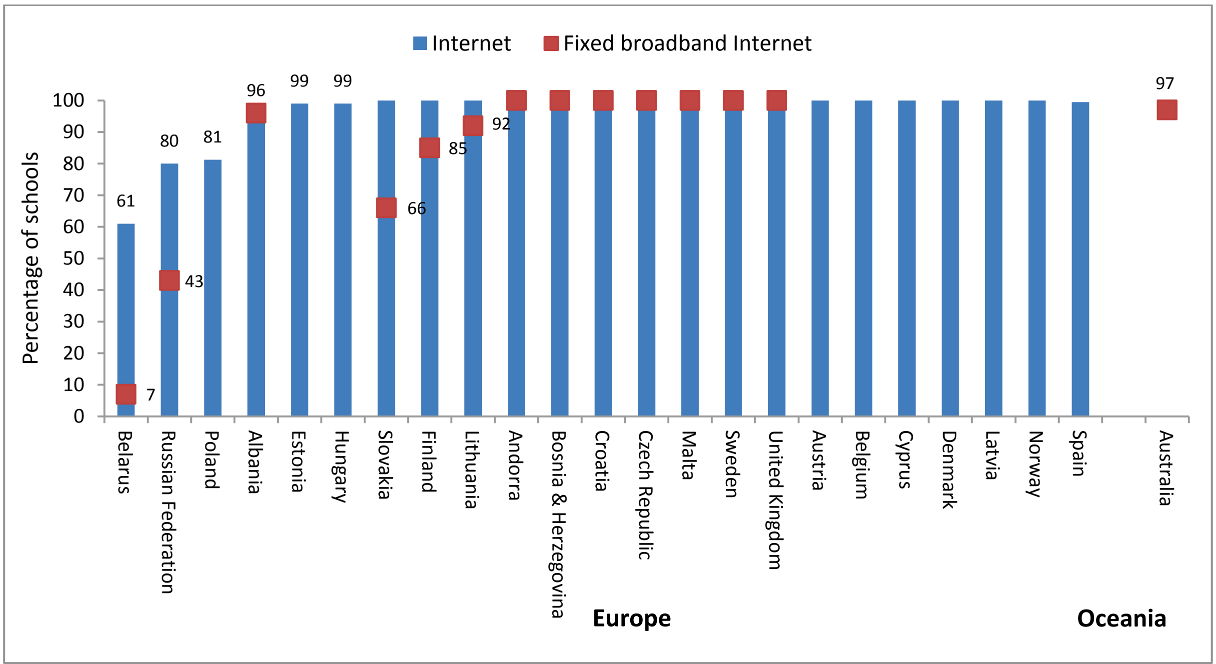


Chart 2.3: Schools with total and fixed broadband Internet, 2012 or LYA (cont.)





Source: UIS database, Partnership on Measuring ICT for Development WSIS Targets Questionnaire, 2013.

Notes:

1. Reference years range from 2008 to 2013 (2009 to 2013 for the Americas; 2008 to 2013 for Africa, Asia and Europe; and 2010 for Australia). Full details can be found on the UIS website, http://www.uis.unesco.org/Communication/Documents/wsis-tables-2014.pdf.
2. Data for Nicaragua, Philippines and Indonesia do not include upper secondary. Data for Jamaica refer to upper secondary only. Data for Costa Rica and Mexico refer to lower secondary. Data for Guyana, Nicaragua and Indonesia refer to primary and lower secondary. Data for Cambodia include pre-primary schools. Data for Anguilla, Barbados, Chile, Colombia, Dominican Republic, Guyana, Jamaica, Mexico, Montserrat, Nicaragua, Sint Maarten, Trinidad and Tobago, Azerbaijan, Bangladesh, Bhutan, Cambodia, Kazakhstan, Malaysia, Maldives, Morocco, Philippines, Sri Lanka, Singapore, Tunisia, Belarus and Russian Federation refer to public schools. Data for Palestine refer to West Bank schools only.

Box 2.6: Partnering to connect schools in Chile: The Enlaces initiative

In the early 1990s, Chile initiated educational reform of its primary and secondary system to adjust to the information society, by incorporating ICTs into schools. The initial vision for the reform was built around the construction of a National Educational Network, also known as *Enlaces*, through which teachers and students could develop professional and pedagogical communities.

Like many national ICT in education programmes, Enlaces began as a connectivity pilot project. However, unlike other programmes, Enlaces established strong links with universities from the outset to help ensure the inclusion of components that focus on teacher professional development and digital content. This contrasts with many other middle income countries where the focus was on the technology itself and the importance of maintaining a holistic perspective was not appreciated.

The education system in Chile is decentralized between public schools, which are managed by municipal governments, and private schools. Each sector is responsible for most of its own administrative and financing aspects. Enlaces only applies to municipal subsidized schools; however, the size of the private sector is large, accounting for 43 per cent of primary and secondary students.[14] With the support of Enlaces, Chile extended Internet connectivity to about three quarters (75 per cent) of primary and secondary schools under the Enlaces banner by 2009, resulting in a connection rate of approximately 55 per cent of all schools in Chile. However, since then, the proportion of schools (public and private) with an Internet connection increased to 70 per cent by 2012 and 78 per cent by 2013.

From the point of view of middle income countries, implementing a national connectivity initiative of this magnitude can be costly. A crucial step in the development of Enlaces was the agreement that the Ministry of Education negotiated with one of the largest telephone companies in the country – Telefonica CTC Chile. The company agreed to provide telephone lines, e-mail accounts and dialup Internet at no cost for a period of ten years to all the schools in the regions where the company had a telephone network (this covered the majority of the Chilean Schools). Moreover, a focus from an early stage was on connecting rural schools. For example, it was decided to begin the rural Enlaces component with a focus on the pedagogical use of technology inside the classroom – even if the schools did not yet have Internet access. In parallel, there was a task team designing a national solution for providing sustainable Internet access to all the rural schools – and communities – in the following years.

As part of its efforts to promote broadband connectivity, since 2004 Enlaces has attempted to reach agreements with multiple operators to offer preferential fees to educational facilities. Enlaces also established a fund through which schools could apply for a subsidy equal to 50–100 per cent of the broadband connection fee. More recently, Enlaces has worked with the Fondo de Desarrollo de Telecomunicaciones, the country's universal service fund, to roll out fibre optic cable to Chile's largest schools (Ministerio de Educación, 2008).

The success of the Enlaces pilot led to its formal acknowledgement as the national education technology programme for Chile. A decade later it was officially absorbed within the Ministry of Education. This evolution – from pilot to national programme to becoming part of the MOE – established a model that was realized later in many other middle income and developing countries.

Source: UIS research.

Conclusions and recommendations

Evidence suggests that in a number of countries progress is being made towards the achievement of Target 2. Yet, despite this, it is still not possible to provide a comprehensive review. For example, while data have been collected for an increasing number of countries since the launch of the UIS international data collection on ICT in education (that is, 118 countries by the year 2014), data are still missing for many developing countries, particularly in Asia, Africa and Oceania. Moreover, demonstrating progress is further complicated by a lack of time series data for the majority of countries, thus preventing reliable measurements of change over time. However, the situation should improve as the UIS is currently conducting statistical capacity-building activities in Africa, to be followed by data collections. More generally, the UIS is moving towards conducting a biennial global data collection on ICT in education beginning in 2015.

Setting targets and measuring progress in the area of ICTs in education involves a balancing act between identifying quantifiable information to monitor international goals and taking into account the diversity of circumstances among countries in terms of stage of development, infrastructure, income and socio-economic factors. The four indicators identified to monitor Target 2 attempt to reconcile these two conflicting aspects by monitoring both old and new technologies, which may be found to varying degrees in both developing and developed countries.

However, it is possible to draw some conclusions in respect of both developed and developing countries and regions, especially in terms of LCRs and Internet access in schools – the two indicators that are currently tracked by the greatest number of countries. Existing data on the LCR show that there are sizeable variations between countries, with relatively high levels of computer access in most developed and high-income economies and lower ratios in the developing world, particularly in low income countries. While in general it must be seen as advantageous to have more computers for fewer students, it is not clear what the ideal ratio might be. This will depend a lot on national circumstances and on how computers are used; it is suggested that more research be conducted in respect of this indicator.

Since time series data are scarce, interpreting change requires caution. Nevertheless, evidence shows that LCRs are generally decreasing across many countries, while school Internet rates are increasing – both generally and for fixed broadband specifically. However, change is not uniform and occurs at different rates in different countries. Typically, countries that have strong policies and set targets for ICT in education with high-level government and sector-wide support show the most rapid change. This is true for a number of countries including Colombia, Chile and especially Uruguay in Latin America, as well as for Oman, Jordan, Thailand and Georgia in Asia.

The data presented in this chapter also highlight that schools in developed countries, especially in Europe and in high income countries in East Asia and the Caribbean, are almost universally connected, typically to high-speed broadband networks, and have relatively low LCRs. While countries will differ on policy related to LCR targets, given the ubiquity of ICT in education in these countries, little further progress can be expected based on the current indicators.

At the opposite end of the continuum, while some progress has been made in a number of developing countries, LCRs frequently remain too high and school Internet connectivity rates too low to provide pupils with access to advanced forms of ICT in education. This is true of some countries in Latin America and the Caribbean, and especially so for many countries in Asia and Africa, where the minority of schools have Internet connections and where LCRs are too high to provide pupils with meaningful learning opportunities. Since LCRs can mask disparities between those schools with many computers, those with few, and those with none, it is difficult to shed light on the extent of disparity within countries.

Only relatively few countries collect data on the proportion of schools with older ICTs, namely radios and televisions. Penetration levels vary between developed and developing countries, but also among countries within each category, suggesting that national policies and objectives vary. While some countries may try to achieve full penetration for both older and newer ICTs, others may see broadcasting technologies, or ad hoc use of radios and televisions, as a relevant alternative only if newer technologies are not available or affordable. Bringing radios and TVs into schools could therefore be understood as a short- to medium-term target that should be complemented, or replaced by, Internet access in the long term. There is some evidence for a small number of countries that the use of radios and televisions for education is decreasing, while for others it is increasing. Given the enormous potential for radio and television in some of the world's least developed countries, monitoring these indicators in conjunction with the LCR and Internet connectivity is the most reasonable way forward.

As stated in the mid-term report (ITU, 2010), to make Target 2 as concrete and measurable as possible, it was suggested that the word “all” be included in order to seek to connect 100 per cent of schools to either old or to new ICTs (or both) depending on national circumstances. Given that universal connectivity remains elusive for many middle and low income countries, it is recommended that Target 2 retains its current form for the post-2015 monitoring period.

Based on current analysis, and considering the rapidly evolving ICT landscape, some additional indicators may be important for effectively monitoring Target 2 during the post-2015 agenda. The 'Learner-to-computer ratio in schools with computer-assisted instruction', which is also a core *Partnership* ICT in education indicator, would shed additional light on the actual level of computer access available in schools and would be particularly useful for developing countries, where many schools do not yet have computers and other similar devices.

Additionally, the 'Learner-to-computer connected to the Internet ratio' (LCCIR), would provide additional information on the degree of school connectivity by shedding light on capacity to interface with the Internet and the multitude of educational resources available online. Previous analysis has indicated that while countries may have some success in building a computer infrastructure, connecting schools to the Internet may lag behind. While these data have been somewhat more challenging to obtain, particularly in developing countries, the LCCIR would nevertheless shed additional light on the relative connectivity of schools since indicators 2.3 (LCR) and 2.4 (proportion of schools with Internet access) do not capture the full extent to which all computers in schools are connected.

The UIS regularly collects the relevant data to calculate both these additional indicators. While data will not be universally available in the post-2015 environment, increased capacity building in countries will contribute to improvements of ICT in education statistics over time.

Several recommendations are made concerning actions that governments can take to improve ICT connectivity in schools. They are:

- Strengthen existing electrical infrastructure. A lack of electricity is arguably the biggest barrier to extending access to ICTs, including the Internet.
- Recognise the potential of fixed broadband, WiMax, and mobile broadband (3G and 4G) Internet, and aim to equip all schools (including in rural areas) with high-speed Internet.
- In countries with difficult terrain (for example, mountainous), consider building a combination of wireless and satellite-based telecommunications with low-cost Very Small Aperture Terminal (VSAT) apparatus for downlink of data and images.
- Consider the use of both radios and televisions to connect schools in situations where more advanced forms of ICT are not feasible or available.

- Low cost computers are an effective strategy to rapidly increase the computer resources in a country, but this policy option should be weighed carefully against other educational priorities, including building schools and hiring and training teachers.
- Recognise the role of community media centres to play a role in extending the reach of ICT to pupils when ICTs are not available in schools. Negotiate schedules and form partnerships with public and private partners (for example, Internet cafés) in order to access ICTs.
- Establish partnerships with multiple levels of government and the private sector, particularly with telecommunications companies, to negotiate low cost access to Internet services.
- In countries where universal Internet service is not feasible, governments need to promote the installation of public Internet facilities in rural areas. These can be financed through universal access contributions or licence conditions.

List of references

Ananiadou, K. and Claro, Y.M. (2009), *21st Century Skills and Competences for New Millennium Learners in OECD Countries*, OECD Education Working Papers, No. 41.

ADB (Asian Development Bank) (2012), *ICT in Education in Central and West Asia*.

Balanskat, A., Bannister, D., Hertz, B., Sigillo, E. and Vuorikari R. (2013), *Overview and analysis of 1:1 learning initiatives in Europe*, European Union.

Broadband Commission for Digital Development (2013), *Technology, broadband and education: Advancing the Education for All Agenda*, A report by the Working Group on Education, http://www.broadbandcommission.org/work/working-groups/education.aspx.

Camfield, J., Kobulsky, A. and Paris, J. (2007), *A Report Card for One Laptop Per Child. Closing the Digital Divide via ICTs and Education: Successes and Failures*, IAFF 229: Multidisciplinary Seminar in Science Technology and Global Affairs. http://www.joncamfield.com/essays/Camfield_Report_Card_for_OLPC.pdf.

Castellanos, M. (2012), *La formación de los docentes en TIC, casos exitosos de Computadores para Educar*, Bogota: Ministerio de Tecnologías de la Información y las Comunicaciones, ISBN: 978-958-57617-0-4.

Cristia, J.P., Ibarraran, P., Cueto, S., Santiago, A. and Severin, E. (2012), *Technology and Child Development: Evidence from the One Laptop per Child Program*, Inter-American Development Bank.

Department of Broadband Communications and the Digital Economy (Australia) (2009), *Australia's Digital Economy: Future Directions*, http://www.archive.dbcde.gov.au/__data/assets/pdf_file/0006/117681/DIGITAL_ECONOMY_FUTURE_DIRECTIONS_FINAL_REPORT.pdf.

Department of Communications (South Africa) (2013), *South Africa Connect: Creating opportunities ensuring inclusion. South Africa's Broadband Policy*, http://www.doc.gov.za/documents-publications/broadband.html.

Department of School Education and Literacy Ministry of Human Resource Development (India) (2012), *National policy on information and communication technology (ICT) in school education*.

European Schoolnet (2013), *Survey of Schools: ICT in Education. Benchmarking access, use and attitudes to technology in Europe's schools*, European Union.

Fatih (2014), http://fatihprojesi.meb.gov.tr/tr/english.php.

GRID (Global Resource and Information Directory) (2014), *Georgia: Country Profile*, http://www.fosigrid.org/europe/georgia-europe.

Haddad, G., Trucano, M. and Wacholz, C. (2007), *ICT-in-Education Toolkit for policymakers, planners, and practitioners*, UNESCO and World Bank-InfoDev, http://www.ictinedtoolkit.org/usere/login.php.

Hinostroza, J. E. and Labbé, C. (2011), *Policies and practices for the use of information and communications technologies (ICTs) in education in Latin America and the Caribbean*, Santiago de Chile, Economic Commission for Latin America and the Caribbean.

IDB (Inter-American Development Bank) (2013), *IDB approves loan to increase coverage and quality of education in the state of Amazonas*, http://www.iadb.org/en/news/news-releases/2013-09-25/improved-education-in-brazils-state-of-amazonas,10585.html.

IDB (2014), *Interactive education using technology in Amazonas, Brazil: Expanding coverage of high quality education to remote areas*, EDU BBL's seminar, http://events.iadb.org/calendar/eventDetail.aspx?lang=En&id=4344.

ITU (International Telecommunication Union) (2005), *World Summit on the Information Society Outcome Documents: Geneva 2003 - Tunis 2005*, http://www.itu.int/wsis/outcome/booklet.pdf.

ITU (2010), *World Telecommunication/ICT Development Report 2010: Monitoring the WSIS Targets, A mid-term review*, http://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtdr2010.aspx.

Kraemer, K.L., Dedrick, J. and Sharma, P. (2009), *One laptop per child: Vision vs. reality*, Communications of the ACM, Vol. 52, No. 6.

Ministerio de Educación (Chile) (2008), 15 anos integrando tecnologías a la educación Chilena, http://www.enlaces.cl/tp_enlaces/portales/tpee371c23bs52/uploadImg/File/libro_enlaces.pdf.

Ministry of Education (Jordan) (2013), Country communication.

Ministry of Education (Thailand) (2013), *Teacher training and support on mobile learning: How Thai teachers can cope with the unknown terrain*, Office of the Education Council.

Ministry of Education and Science (Georgia) (2007), *Consolidated education strategy and action plan (2007-2011)*, Ministry of Education and Science.

Ministry of Information Technologies and Communications (Colombia) (2014), *WSIS 2014: Colombia country case study*, UIS.

OLPC News (2010), *Plan Ceibal: A Better Designed and Supported XO Laptop Implementation Program*, http://www.olpcnews.com/countries/uruguay/plan_ceibal_a_better_designed.html.

OLPC (2014), One laptop per child, http://laptop.org/en/children/countries/mideast.shtml.

OECD (Organisation for Economic Co-operation and Development) (2011), *PISA 2009 Results: Students On Line. Digital Technologies and Performance*.

Partnership on Measuring ICT for Development (2010), *Core ICT Indicators*, http://www.itu.int/en/ITU-D/Statistics/Pages/coreindicators/default.aspx.

Partnership on Measuring ICT for Development (2011), *Measuring the WSIS Targets: A statistical framework*, http://www.itu.int/en/ITU-D/Statistics/Pages/publications/wsistargets2011.aspx.

Partnership on Measuring ICT for Development (2013), *Partnership on Measuring ICT for Development WSIS Targets Questionnaire, 2013*, http://www.itu.int/en/ITU-D/Statistics/Pages/intlcoop/partnership/followup.aspx.

Piscitelli, A. (2012), *Retos y perspectivas de las TIC en la Educación*, En J.J. Briceño (Eds.), Formación de Docentes en TIC para el mejoramiento de la calidad educativa, Computadores para Educar, Colombia.

Reardon, J. (2010), *Venezuelan Government Begins Distribution of 350,000 Laptop Computers to School Children*, Venezuelanalysis.com, http://venezuelanalysis.com/news/5792.

Robertson, E. (2010), *New Study Says Venezuela is a World Leader in Increasing Internet Us*age, Venezuelanalysis.com, http://venezuelanalysis.com/news/7169.

Rodríguez, K., Sachez, F. and Maquez, J. (2011), *Impacto del Programa "Computadores para Educar" en la deserción estudiantil, el logro escolar y el ingreso a la educación superior*, Documento CEDE, 2011-15, ISSN 1657-5334.

Scheuermann, F., Pedró, F. and European Commission, Joint Research Centre (2009), *Assessing the effects of ICT in education: indicators, criteria and benchmarks for international comparisons*, Publications Office of the European Union; OECD.

Trucano, M. (2010), Interactive Radio Instruction: *A successful permanent pilot project?*, http://blogs.worldbank.org/edutech/iri.

Trucano, M. (2014), *Interactive Educational Television in the Amazon*, World Bank, http://blogs.worldbank.org/edutech/interactive-educational-television-amazon.

UNECLAC (UN Economic Commission for Latin America and the Caribbean) (2010), *Plan of Action for the Information and Knowledge Society in Latin America and the Caribbean (eLAC2015)*, Third Ministerial Conference on the Information Society in Latin America and the Caribbean, Santiago de Chile.

UNESCO-UIS (UNESCO Institute for Statistics) (1996*), International Standard Classification of Education ISCED 1997*, http://www.uis.unesco.org/Library/Documents/isced97-en.pdf.

UNESCO-UIS (2009a), *Guide to Measuring Information and Communication Technologies (ICT) in Education*, http://www.uis.unesco.org/Library/Pages/DocumentMorePage.aspx?docIdValue=460&docIdFld=ID.

UNESCO-UIS (2009b), *Pilot Questionnaire on Statistics of ICT in Education*.

UNESCO-UIS (2012), *ICT in education in Latin America and the Caribbean: A regional analysis of ICT integration and e-readiness*.

UNESCO-UIS (2013), *Information and communication technology (ICT) in education in five Arab states: A comparative analysis of ICT integration and e-readiness in schools in Egypt, Jordan, Oman, Palestine and Qatar*.

UNESCO-UIS (2014), *ICT in education in Asia: A regional analysis of ICT integration and e-readiness*.

World Bank (2010), *Information and Communication Technology for Education in India and South Asia*, Volume 1, Extended Summary, infoDev and Price Waterhouse Coopers.

Endnotes

[1] The original WSIS indicator was worded slightly differently "Connect universities, colleges, secondary schools and primary schools with ICTs".

[2] There are a number of examples of schools that provide access to the Internet for the general community after school hours. ITU's Connect a School, Connect a Community initiative (http://www.itu.int/ITU-D/connect/flagship_initiatives/connecting_children/index.html) is an example of an effort to benefit both students and the communities in which they live, by promoting broadband access in schools.

[3] This figure represents the number of countries for which data for any of the four indicators are available.

[4] The scope of all the indicators is ISCED levels 1–3, that is, public and private schools from primary to upper secondary education unless otherwise stated. The International Standard Classification of Education (ISCED) is a classification system for education statistics. The data collected for this report refer to ISCED97 whereby ISCED 1, ISCED 2 and ISCED 3 refer to primary, lower secondary and upper secondary education levels, respectively.

[5] See GRID: http://www.fosigrid.org/europe/georgia-europe.

[6] The use of televisions is negligible in primary and upper secondary institutions, compared to 57 per cent of lower secondary institutions that use televisions for educational purposes.

[7] In Myanmar, data for radios only cover secondary schools.

[8] Latest year available. Notes on reference years are under the chart.

[9] These refer to computer and Internet use for educational purposes respectively (indicators 7.3 and 7.4 in Target 7).

[10] LCR values in Cambodia reflect secondary education only. Data to calculate the primary LCR are unavailable.

[11] Note that the original indicator 2.4 included other forms of Internet access, such as narrowband and mobile broadband.

[12] Fixed broadband is considered to be the most effective method for connecting to the Internet. UIS data have focused on general ('any') Internet access as well as fixed broadband Internet access. The definitions used differ somewhat from those in the WSIS framework document (Partnership, 2011). That document distinguished i) broadband Internet, which included both fixed (wired) and wireless broadband (for example, satellite, terrestrial fixed wireless, fixed WIMAX, terrestrial mobile wireless access) and ii) fixed narrowband.

[13] See Joint Media Release by the Prime Minister, the Treasurer, and the Ministers for Finance and for Broadband, 7 April 2009, Canberra, http://www.minister.dbcde.gov.au/media/media_releases/2009/022.

[14] See http://www.chile-usa.org/education.html.