Practical Guide to Implement Surveys on ICT Use in Primary and Secondary Schools

Regional Center for Studies on the Development of the Information Society (Cetic.br)
UNESCO Institute for Statistics (UIS)

United Nations Educational, Scientific and Cultural Organization
UNESCO INSTITUTE FOR STATISTICS
United Nations Educational, Scientific and Cultural Organization
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Regional Center for Studies on the Development of the Information Society under the auspices of UNESCO
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Brazilian Network information Center
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Brazilian Internet Steering Committee

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** at the date of the meeting.*

Cetic.br

The Regional Center for Studies on the Development of the Information Society (Cetic.br) is a department of the Brazilian Network Information Center (NIC.br), linked to the Brazilian Internet Steering Committee (CGI.br). Cetic.br is committed to the production of ICT statistics that contribute to inform policymaking. As a regional center under the auspices of UNESCO, it collaborates technically with Latin American and African lusophone countries undertaking ICT surveys.

Cetic.br conducts regular surveys on ICT to produce statistics on access to and use of information and communication technologies (ICT) along different social sectors.

The center actively participates in international forums on the definition of methodologies and indicators for ICT measurement, mainly in the areas of health, education, households, enterprises, digital economy and media literacy.

Cetic.br works in four main lines of action:

- Knowledge center: information and knowledge production and dissemination, specifically ICT surveys, indicators, analyses and specialized publications.
- Capacity-building: on survey methodology and the use of statistics for policymaking and research.
- Laboratory of ideas: exploring emerging topics related to the social impacts of ICT through debates, lectures and discussion panels with specialists and stakeholders.
- Culture and ethics on the Internet: investigating the intersection of culture, ethics and the Internet, as well as the social implications of the Internet.

UNESCO

The constitution of the United Nations Education, Scientific and Cultural Organization (UNESCO) was adopted by 20 countries at the London conference in November 1945 and entered into effect on November 4th 1946. The Organization currently has 193 Member States and 11 Associate Members.

The main objective of UNESCO is to contribute to peace and security in the world by promoting collaboration among nations through education, science, culture and communication to foster universal respect for justice, the rule of law, human rights and fundamental freedoms that are affirmed for the peoples of the world, without distinction of race, sex, language or religion, by the Charter of the United Nations.

To fulfill its mandate, UNESCO performs five principal functions: 1) prospective studies on education, science, culture and communication for tomorrow's world; 2) the advancement, transfer and sharing of knowledge through research, training and teaching activities; 3) standard-setting actions for the preparation and adoption of internal instruments and statutory recommendations; 4) expertise through technical cooperation with Member States for the development of policies and projects; and 5) the exchange of specialized information.

UNESCO Institute for Statistics

The UNESCO Institute for Statistics (UIS) is the official statistical office of UNESCO and the UN depository for global statistics in the fields of education, science, culture and communication. The UIS is the custodian agency for data used to monitor progress towards the Sustainable Development Goal on education and provides data on key targets related to science, culture, communication and gender equality. While developing the methodologies and standards needed to produce cross-nationally comparable data, the UIS works directly with national statistical offices, line ministries and other organizations to help countries produce and use high-quality data.

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INTRODUCTION

This *Practical Guide to Implement Surveys on ICT Use in Primary and Secondary Schools* is a step-by-step methodological reference. It presents the critical steps to plan, design and implement a survey to collect data on information and communication technologies (ICT) use in education to ultimately produce relevant, robust and reliable indicators that inform policymaking. This *Practical Guide* does not elaborate on statistical or academic matters – although it provides additional references and sources for further review. Instead, it offers practical guidelines to plan and conduct large scale surveys on ICT in education that will serve to improve policy decision-making.

The purpose of this guide is to serve as a useful reference for government agencies interested in measuring ICT use in education as well as for researchers and key stakeholders in the education field.

There are multiple efforts to generate national data on ICT access and use of digital technologies in education, mainly statistics related to access and infrastructure. However, at the international level, there is little production of comparable data on use, appropriation, skills, opportunities and barriers experienced by children and teachers – especially in developing countries. The importance of this issue has been discussed at the international and national levels but, in practice, there is still a lack of systematic, reliable and comparable statistics on these topics.

Thus, Cetic.br and the UNESCO Institute for Statistics (UIS) have undertaken efforts to develop a guide to produce quality data on ICT in education in developing countries, which then enables international comparability and local relevance at the same time. The guide will serve as a methodological reference for the design and implementation of ICT surveys in schools. While addressing the access and skills dimensions, this guide focuses on how to develop and implement a survey on ICT use in primary and secondary education (ISCED levels 1, 2 and 3) at the national level. The guide helps develop surveys with the capacity to address the most relevant demands in the field of ICT in education today.

Given that ICT access indicators have a longer history of development and implementation and considering that they can be measured through administrative data as well, the focus and specific contribution of this guide will instead be on indicators of ICT use. Moreover, a specific contribution of this guide lies in its methodological choice to focus on the school setting and place an emphasis on the final implementers of ICT in education policies: teachers and principals – with an acknowledgment of students' perceptions. Good quality research guides to measure ICT use by individuals or in households abound while guides that focus on schools carry their own specificities and challenges, and are scarcer. Both the methodological and institutional challenges of approaching schools are covered in this guide along with plenty of examples and lessons learned from the long-term implementation of school surveys. A third relevant dimension linked to access and use, is digital skills development. As it will be explained in section 4.3.3, measuring digital skills entails a complexity that exceeds the scope of this guide. The thorough coverage of both conceptual references and methodological alternatives to measure digital skills would merit its own specific guide.

This guide is divided into three sections. The first section discusses the relevance of relying on survey data on ICT use in schools to inform policymaking and introduces the key concepts involved. Defining relevant concepts is fundamental to informing decisions on what information to collect; understanding how the elements relate to each other; providing keys to interpret the results; and determining how policymaking can more effectively generate expected outcomes (Hogarty, Lang, & Kromrey, 2003; Mainguet & Baye, 2006). This section closes with a proposed list of indicators to be included in the survey.

The second section focuses on the methodology and steps to successfully conduct a comprehensive and representative survey on ICT use in primary and secondary schools. It covers the planning phase, fieldwork, data processing, reporting and dissemination.

The third section presents the technical datasheets of each indicator proposed in the first section. These datasheets provide a thorough description of the indicators proposed, including model questions for each indicator (note: these are not full questionnaires, which should be designed and adapted by each country with their own choice of questions). Throughout the text, the reader will find examples, further readings and resources.

I. WHY IMPLEMENT SURVEYS ON ICT USE IN EDUCATION?

On the one hand, the role of education in the development of society is undeniable. The document *Sustainable Development Begins with Education* (UNESCO, 2015) reaffirms this message by analyzing how education permeates and contributes to progress in all the 2030 Agenda Goals. According to this document, education plays a key role in building sustainable, inclusive and resilient societies. Education can also provide information on health and nutrition to families; promote economic development through better training and preparation for the labor market; and serve as an important tool to foster a culture of sustainability and stewardship of the planet. Thus, as SDG 4 suggests, it is necessary to offer inclusive, equitable and quality education for all.

The use of ICT – conceived of in this context mainly as digital technologies comprised of yet not limited to computers, cellphones, robotics equipment, software, educational applications and the Internet along with the capacity to meaningfully use them – is now one of the factors that drives education quality. The availability of ICT in schools combined with their critical use by teachers and students has the potential to enhance the benefits already associated with education, such as facilitating access to knowledge and expanding opportunities for social, cultural and economic participation and engagement.

Robust data is needed to understand the factors that influence equal opportunities for access and use of technologies by the school community (comprised of teachers, principals, other school staff, students and their families) – especially for students and teachers. The availability of this data is essential to support policy decisions. Evidence-based policymaking and the analysis of indicators to monitor policy and program implementation are also important.

In terms of ICT in education policies, the Declaration of Qingdao (2015) calls for international commitment to develop evaluation and monitoring systems to produce data on the use and impact of ICT in this sector. The data will help inform policies on the integration of technologies into education and shed light on the fundamental role that ICT can play in building knowledge and developing skills.

Robust national statistics on ICT in education should form a key component of any comprehensive information system. Measuring and understanding the role of ICT in education requires sound data based on solid research methodology and frameworks, which ultimately address the complexity and multidimensionality of the field.

1. Why is it important to have good quality data on ICT use in primary and secondary schools?

During the last decades, investment in ICT infrastructure in primary and secondary education has increased among developing countries.[1] In general, the initial goal of such policies has been to guarantee the availability of digital technologies and ICT skills development (i.e. Internet, digital devices, software, teachers' ICT training). They were also based on an equity rationale as many educational institutions did not have the infrastructure to use ICT to support learning and teaching processes, and there was a significant gap in household possession of such devices. In addition to the equity policy rationale, a pedagogic rationale also accompanied many such initiatives as learning gains were expected as a result of increased ICT access at schools. Other hypotheses on the pedagogical impact of ICT include personalization of the learning experience, ubiquitous access to learning materials and the possibility of counting on real-time assessments that may enable teachers to more closely follow each student's learning processes. Some national ICT policies, in turn, formulated their objectives mainly based on a socio-economic rationale: equipping the future workforce with the ICT skills was deemed fundamental to a successful integration into the labor market (Lugo & Toranzos, 2014).

However, the relationship between ICT and academic learning is far from linear. Evidence suggests that technology does not automatically impact the quality of education. For example, Enrique Hinostroza, Shafika Isaacs and Mohammed Bougroum (2014), among others, found that pedagogical practices, the administration of available resources and instructional methodologies employed in learning and teaching activities were found to have a bigger influence on learning than the

[1] In Latin America, for example, the budget for Colombia's project *Computadores para Educar* in 2015 was US$113,366,4 while the budget for Chile's projects *Yo Elijo Mi PC* and *Me Conecto Para Aprender* in 2018 was US$73,477,555.2 (exchange rate on January 2018) (Ministerio de Educación, 2018).

availability of digital devices. Other variables, such as school leadership, availability of both technical and pedagogical support, attitudes and beliefs toward ICT in education and the time dedicated by teachers to prepare their lessons also proved to be relevant factors.

In 2015, the OECD released its report *Students, Computers and Learning: Making the connection*. Using data on ICT use[2] and academic performance[3], this report found that the frequency of ICT use was not as important as how students used them. A limited amount of ICT use was associated with better results. Students that do not use ICT at all and those who use them above OECD's average level of use showed worse results according to outcomes from the Programme for International Student Assessment (PISA).

Some studies show evidence of improvement in student performance when using ICT in their learning practices – as long as their teachers seek to increase student awareness on ICT use and enhance their Internet critical use skills (Comi, Argentin, Gui, Origo, & Pagani, 2017; Wong & Li, 2008). For example, the impact evaluation of *Computadores para Educar,* the Colombian ICT in education policy, identified positive effects attributable to the policy in national standardized tests on chemistry, biology and language. Evidence suggests that its implementation reduced the likelihood of dropping out and increased the chances of some students pursuing higher education (Rodríguez Orgales, Sánchez Torres, & Márquez Zúñiga, 2011).

Beyond the effects of ICT use in academic learning, in recent years, there has been a growing interest in the ICT skills or digital skills of teachers and students (see **Box 1 and 2**). In other words, the purpose of identifying the relationship between ICT access and use in schools and the development of digital skills has gained ground in ICT policy evaluation designs. This point will be discussed further in the next section.

Consideration of the diverse factors that mediate the relationship between ICT use and learning outcomes – be it academic or in reference to digital skills – requires sound ICT statistics to inform such evaluation designs. In other words, more complex and policy-relevant analyses can be carried out if indicators are available for a set of relevant factors, such as the antecedents of availability of ICT in the country; the degree of integration of ICT into the school curriculum; the digital resources available (beyond computers and the Internet); and the pedagogical activities carried out by teachers involving ICT. All these variables, by their nature, cannot be captured by administrative records.

Some of the studies and policy conclusions summarized before involved national statistics on ICT and education. In some cases, such as in the referred PISA studies, specific learning tests were accompanied by a set of ICT-related questions within a survey to students. In other cases, such as the policy evaluations mentioned, nationally representative ICT statistics fed specific evaluation designs, complementing other sources of data.

In essence, the availability of secondary data sources is fundamental to conducting ICT policy evaluations. In addition, historical and contextual data series are usually of high relevance and are often required for evaluation designs as they form an integral part of policy design. In short, ICT policy evaluations usually work within the framework of broader information systems and take into account existing data on the education system, its functioning, its results and, as in the case at hand, also the availability of ICT.

One of the needs for countries, therefore, is to count on reliable and updated statistics for the calculation of national ICT in education indicators. While it is common for national statistical offices to collect data on the educational system (e.g. enrollment, number and distribution of teachers, etc.), information regarding ICT use in schools can be more challenging to obtain and update. Considering this need for specific information when performing a diagnostic evaluation, evaluating policy outcomes or to guarantee a sound time series to take into account in a given evaluation, it may be necessary for countries to implement ICT access and use surveys in schools.

The availability of indicators that are politically relevant, robust, timely, accurate and reliable allow policymakers to count on information either to diagnose baseline and desired scenarios; design and follow up on the development of ICT in education policies; or to combine such data with specific evaluations to account for policy outcomes and eventual improvements that may be needed.

Overall, the development of multi-stakeholder information ecosystems, integrating multiple sources of information, if used knowledgeably, holds the potential to improve educational policy design, implementation and follow-up at different levels. The main possible sources of such data will be described next, highlighting their main strengths and limitations. Once the big picture is defined, we will focus on the contribution of survey data and tackle the methodological specificities of obtaining data on ICT use in schools.

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[2] Weekly hours, use of computers in courses and availability of computers at home and at school.

[3] PISA scores on paper and digital reading, mathematics, language.

Box 1. How is ICT use in schools measured in Sub-Saharan Africa?

Having recognized the potential of ICTs in education, many countries in Sub-Saharan Africa have elaborated strategic plans or launched programs to promote ICT use in schools. For example, Senegal has formulated and adopted its Education Sector Plan, covering the period 2018-2030, which includes a specific objective on the use of ICT, stated as: "To integrate ICTs to increase equitable access, quality of teaching/learning and governance in the education and training ("Programme d'Amélioration de la Qualité, de l'Équité et de la Transparence-Education/Formation [PAQUET-EF], 2018-2030", Ministère de l'Éducation du Senegal et. al, 2018). However, in the monitoring and evaluation section of this sectoral plan, no indicators have been defined to measure the effective use of ICT in education.

This example reflects the situation of several other countries, where available data to measure the use of ICT in education is scarce. Of the set of indicators proposed in this practical guide, only two are being measured currently in the Sub-Saharan region: percentage of schools by Internet access location and percentage of schools by main Internet connection speed. Such data is usually collected via annual school censuses carried out in primary and secondary schools using paper questionnaires. The data processing is performed at decentralized or central levels, depending on the availability of IT facilities.

In conclusion, it is considered urgent for ministries of education to guarantee the integration of more indicators on the use of ICTs in primary and secondary education into monitoring and evaluation frameworks. There is also a need to set up a necessary collection mechanism (specific survey and annual census) to produce all the required data. These indicators will ultimately help to better inform the use of ICT.

Note: Text contributed by Ndeye Yacine Fall, UNESCO Office in Dakar.

Box 2. Activating EdTech: Agile decision-making at Jordan's Ministry of Education

Challenge: Previous attempts to implement educational technology (EdTech) in Jordan were largely ad-hoc, device-driven interventions led by local and international NGOs. The few nationwide interventions were carried out using donor funding and were over a decade old. Funds to maintain technology in schools were unavailable after the initial influx of donor money. Furthermore, EdTech was viewed within the Jordanian Ministry of Education (MoE) as a technology matter, separate from education. The ministry instead emphasized a tech-centric approach to EdTech and divorced it from traditional educational decision making processes.

Approach: To address this issue, the MoE partnered with the Queen Rania Foundation to design a new Agile approach to EdTech decision making. The approach consists of a series of small experiments with clear feedback loops to decision makers. These experiments will grow gradually until they reach scale. This effort is coupled with regular training interventions and materials, to ensure that the necessary skills exist within the MoE to maintain this new process.

Results: A cross-organisational team was formed: the Activating EdTech (AET) team. The team is made up of members from not only different MoE departments, but also other national and non-governmental organisations. The team is dedicated to designing and testing EdTech interventions within the MoE. It now determines which of the different interventions can move between the three different phases of experimentation: Alpha, Beta and National Trials, based on their success, sustainability and evidential rigour. After passing these phases successfully, interventions are then scaled and embedded within the MoE, constituting a strong case of evidence-driven policymaking where surveys play a key role.

Note: Text contributed by Abdullah Kalayleh, Queen Rania Foundation, Jordan.

2. What are the possible sources of data on ICT in education?

2.1 Administrative records

A relevant and very commonly used source of ICT in education data is administrative records, collected by official entities such as Ministries of Education and other official agencies. This source is, in general, reliable, readily available and not very expensive to obtain and update. However, it is very important to point out that it is only suitable to account for some ICT in education dimensions and variables.

Administrative records are best suited to provide information on ICT infrastructure and the systems in place in the schools, including student enrollment, teacher attendance and other variables that do not require direct intervention of the subjects in question. For example, the Ministry of Education in Rwanda produces annual education statistics that include the number of computers in primary and secondary schools, computer-learner ratios and computer-teacher ratios (Rwanda Ministry of Education, 2018: 28). Moreover, this type of data has the indisputable virtue of being able to provide that kind of information on every single unit of a school system – something that sample surveys, by their nature, cannot. This feature can be useful to help inform decisions on resource allocation, for instance.

However, existing administrative data has gaps in key pieces of information required to properly inform policymaking.[4] Most of these gaps refer to how educational actors interact with ICT, the activities that they perform and their opinions, perceptions and concerns (see Table 1).

2.2 Survey data

Surveys are a second source of data used to calculate indicators. As opposed to administrative records, surveys can address final users directly. Therefore, they are more suited to capture individual or organizational variations in use, attitudes and opinions, and to identify barriers and opportunities. Such dimensions are key to envisioning a picture of the functionality of any ICT in education policy. For example, while administrative records may state how many computers were deployed to a given set of schools, they will not tell you how many of those are being actually used for pedagogical purposes and, much less, the barriers that teachers are experiencing to enable this kind of use.

Table 1. Comparison between the use of administrative data and survey data to obtain ICT information

Aspect to consider	Administrative Data	Survey Data
Information	Suitable to describe current situation and track changes in infrastructure, enrollment, management and resources in general.	Since it enables us to obtain information from end users, it is suitable to cover topics related to individual behavior, opinions and attitudes.
Units covered	It enables us to obtain information on every unit for which there is an administrative record.	It enables us to obtain data on a representative sample of the population that then can be inferred for the whole population (yielding statistical data).
Purpose	The available data can usually be processed to monitor policies, programs or projects.	The data obtained enables us to answer a clear and explicit research question on virtually any topic of interest.
Information limitations	It is not suitable to build indicators on opinions, attitudes or practices of individuals (e.g. frequency of Internet use by students for homework).	Sensitive topics and highly technical information can be inaccurately reported by respondents (e.g. exact bandwidth available in a school).
Data collection	Non-intrusive. It is possible to get information on populations that may refuse to answer survey interviews.	Might be intrusive. The technique relies on the respondent´s willingness to answer a questionnaire.
Update	It is usually updated. If standards of the data are kept, it is possible to build panel data.	It is usually costly to update the data. A new process of data collection is required in each round.
Monetary cost	Relatively low cost. There is no need for survey design and data collection.	Usually higher cost. Survey design and data collection are needed.

Source: Adapted from Martinez-Restrepo, Ramos Jaimes, Maya Scarpetta, & Parra Rodríguez (2018).

[4] Readers interested to know more about the administrative databases available in Argentina, Chile, Colombia, Mexico, Peru and Uruguay can consult the *Guía metodológica para medir las TIC en educación* (Martinez-Restrepo et al., 2018). Specifically, "Tabla 3. Resumen de las bases de datos administrativos disponibles en países que han participado en la Red Regional".

Examples of national surveys on ICT use are the Kids Online Survey, implemented by a set of countries in Europe, Asia, Africa and Latin America[5] and the Brazilian ICT in Education survey, implemented by Cetic.br/NIC.br.[6]

Even though implementing nationally representative and comprehensive surveys may seem like an expensive option when administrative data is readily available to policymakers, it is important to fully grasp its specific contribution to decision-making to accurately weigh its costs against its value.

Finally, surveys are a complementary source of information to support education policymaking and management – along with administrative data, censuses and learning assessments. Survey data contribute to assembling education information systems, which involve operational processes to analyze, collect and use data in education (UNESCO, 2018). Such data inform policy decisions across the education system regarding administrative, managerial and programmatic topics.

Table 1 summarizes the main differences between these two data sources, including the potential and limitations of each in relation to different research objectives.

2.3. Big data and artificial intelligence (AI)

The increased use of digital learning management platforms in some countries is opening new paths for analysis. This is the case of learning analytics in the school setting, which involve collecting, analyzing and reporting data on learners and their contexts with the purpose of understanding and optimizing learning itself as well as learning environments. The bulk of data that students leave behind when they interact with online learning platforms together with the responses they explicitly provide holds enormous potential to gain insight into what resources work better for student learning and, specifically, for which profiles of students.

Ethical and privacy concerns are still very relevant issues to resolve in the domain of AI applied to learning and educational management (see **Box 3**). As of today, there are at least four challenges to overcome as Ferguson and Buckingham (2012) point out: (i) integrating experience from the learning sciences, (ii) working with a wider range of datasets, (iii) engaging with learner perspectives and (iv) developing ethical guidelines to manage and use students' personal and contextual data.

2.4. Qualitative data

Relevant data ecosystems also include qualitative studies, which, in the case of ICT in schools can provide relevant input on relevant issues affecting ICT use in schools. For instance, the actors' perceptions and barriers experienced or as a means to observe interactions between the school and the community.

Along with survey data, Global Kids Online also provides qualitative data based on interviews with children who talk in depth about their perceptions of online participation. This complements the quantitative approach. Another real-case example of qualitative data are the focus groups carried out by Uruguayan Plan Ceibal´s Monitoring and Evaluation office, targeting teachers, parents and students in an effort to monitor the implementation of its programs and projects.[7]

3. Back to surveys: summary of the process

In sum, a strong data ecosystem consists of various interconnected sources of data, each of which has characteristic strengths and weaknesses. Among all these relevant sources, this *Practical Guide* will focus on surveys to specifically provide a roadmap to accomplish the successful implementation of representative surveys on ICT in education.

Figure 1 offers a scheme of the different phases involved in survey planning and implementation, and the processes within each. Over the course of the next section, each of them will be explained and exemplified. As Figure 1 illustrates, the first step involves defining the main concepts that will inform the whole design. This will be the subject of the next section in this chapter.

[5] Find more information at http://globalkidsonline.net/

[6] Find more information at https://www.cetic.br/pesquisa/educacao/

[7] Reports avaiable at https://www.ceibal.edu.uy/es/articulo/monitoreo-y-evaluacion

Box 3. Artificial Intelligence in Education

According to UNESCO (2019), governments and educational institutions are rethinking educational programmes to prepare learners for the increasing presence of Artificial Intelligence (AI) within educational systems. There are significant challenges and policy implications associated with introducing AI in education. Both benefits and risks exist.

Among the main pathways identified through which the education sector can leverage and adapt to AI are: (1) using it to generate real-time insights to improve educational outcomes; and (2) redeveloping educational programmes to make them more responsive to changes brought about by AI. While some countries are taking advantage of the abundance of educational data derived from electronic systems (e.g. EMIS), harvesting insights from large masses of data to provide more personalised learning experiences, others are far behind in this respect. Such data usage, however, is plagued with unresolved ethical implications of collecting and mining data from learners. One challenge for education systems is to delimit how such data are used and to guarantee that it is based on learners' consent.

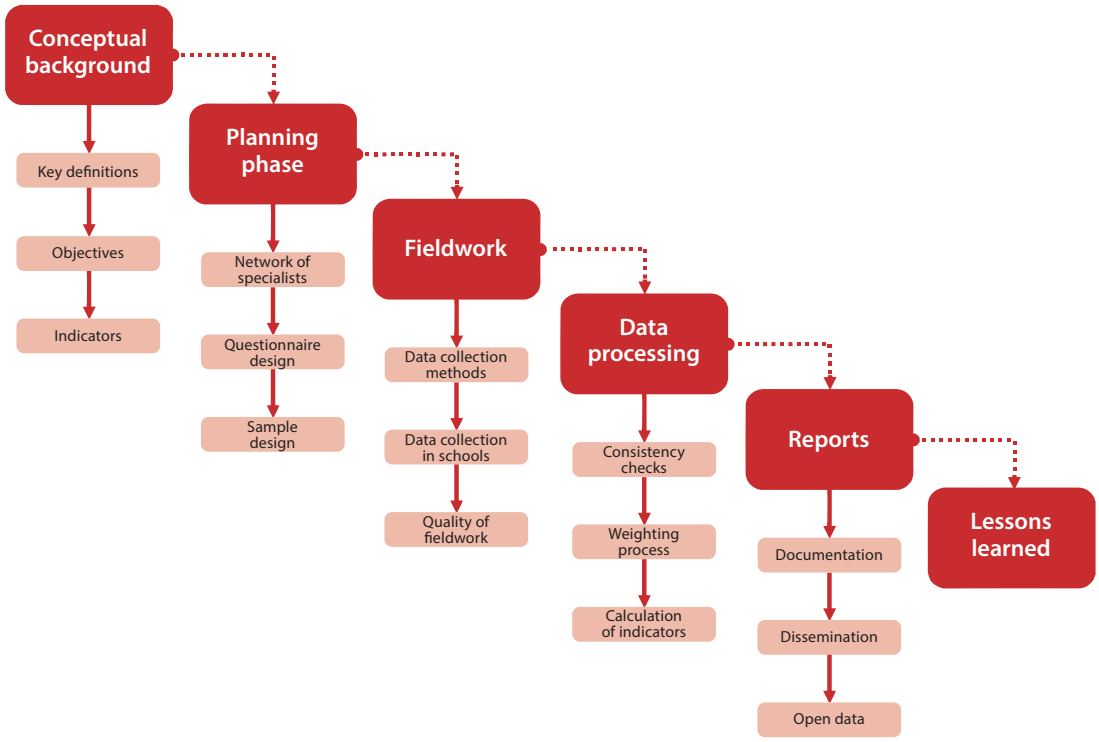
The main AI -based systems applied to education are Intelligent Tutoring Systems (ITS), which track and model student development, personalizing learning by offering content, pedagogical strategies and motivational triggers adapted to each learner and even step-by-step assistance to work on their difficulties. Another development based on AI enables the monitoring of learning based on the recognition of facial and voice expressions. Educational chatbots, in turn, use natural language processing to develop a dialogue with learners, providing guidance and feedback, and suggest available resources. Affective computing, for its part, uses AI to measure the affective states of learners and can act to keep or alter such states, as needed. Finally, pedagogical agents are autonomous computer systems that observe the environment through sensors and use their observations to plan and act on that environment so that students achieve and update their learning goals. Pedagogical agents are often represented by an avatar and can interact with the students, resorting to different roles and strategies. In general, learning analytics and data mining, both of which have grown significantly in recent years due to the massive use of online and hybrid learning environments, are core to most of these systems (Cieb, 2019).

There is a need for more information on how countries are moving forward in this shifting landscape. According to UNESCO (2019), a response to this need would be the creation of an Observatory of AI in education. Proposed as a platform for knowledge sharing and peer learning, this observatory would inform national strategies and guide the creation of a holistic policy framework for AI in education.

As it is apparent, the advent of AI in education poses opportunities and challenges for policymaking and, therefore, for quality, timely and ethical data production to inform such policies. Some of these challenges are addressed in this guide which, while focusing on ICT use surveys, calls for an integrated data ecosystem that makes use of a varied array of sources and the continued improvement of digital skills among teachers and students.

Sources: Pedró, F.; Subosa, M.; Rivas, A.; Valverde, P. (2019) Artificial intelligence in education: challenges and opportunities for sustainable development. UNESCO, Paris; Centro para a Inovação na Educação Brasileira – CIEB (2019). Notas Técnicas #16 Inteligência Artificial na Educação. São Paulo, CIEB.

Figure 1. Summary of the process to implement surveys on ICT use in primary and secondary schools



4. Objectives and key definitions to grasp ICT use in primary and secondary schools

Digital technologies have reached a ubiquitous presence around the world, permeating the economic, social, political and cultural spheres (Gere, 2008). Either people interact directly with digital technologies in their routine lives, or (if such technologies are not directly available) their lives are affected by them through tech-infused agriculture, genetics and transportation, for example.

As the digital world permeates different societal spheres, educational systems and institutions increasingly acknowledge the opportunities and demands posed by this new scenario and reform themselves to varying degrees to respond to the educational needs of new generations.[8]

In this sense, education is key to accomplish active citizen participation for it empowers people "to live healthier and more sustainable lives" and "break from the cycle of poverty" (UN, 2017). The United Nations' Sustainable Development Goal (SDG) 4 calls to "ensure inclusive and equitable education and promote life-long learning opportunities for all." One of the SDG 4 targets includes the promotion of ICT skills.

SDG targets are measurable objectives that contribute to reach one or more goals. In terms of education, ICT skills are framed as relevant skills for employment, decent work and entrepreneurship. ICT skills are technical and vocational skills to enable people to benefit from the potential of ICT (UIS, 2018). The SDG target 4.4 calls for an increase in the proportion of youth and adults with ICT skills.

There are different ways in which educational institutions and the digital world are closely intertwined. On the one hand, schools can deliver technological and digital resources to communities that have limited exposure to ICT, which potentially contributes to closing digital access gaps. Second, schools can contribute to the development of ICT skills essential in the labor market.[9] Moreover, schools present privileged spaces where critical thinking, safe,

[8] In 2016, the percentage of Internet users was 50% in Cape Verde, 18% in Mozambique, 24% in Equatorial Guinea, 61% in Brazil, 60% in Mexico, 46% in Peru and 66% in Chile (ITU, 2018).

[9] According to OECD.Stat, out of all the employed people, 59.14% regularly used a computer at work in Colombia in 2016, 30.5% in Mexico in 2012 and 50% in Brazil in 2015. In terms of companies, 47% out of the 30 top brands by market capitalization in 2013 were platform-oriented companies (Schwab, 2016).

responsible, active and creative use of technologies are promoted. Finally, schools can contribute to familiarizing education actors with the digital world at large. The digital culture not only influences traditional activities and pedagogical processes, but creates a language all its own (Cetic.br, 2016).

In this section we will present a selection of key concepts to understand ICT use in schools which, in turn, informs the indicator selection proposed for designing the survey.

4.1. Digital technologies

The digital refers to instant communication, global connectivity and omnipresent media that mark our existence (Gere, 2008). People usually interact with digital applications and devices, such as music, computer games, the Internet, online banking, e-government, digital telephony and digital television, among others.

Even if individuals do not interact directly with digital technology, it still affects their lives, through incorporation in agriculture, computerization of genetic information and e-banking models that define clients' profiles. However, exposure to digital applications and devices is an uneven process. Some population segments have more opportunities to interact with digital technologies than others, which has been researched under the concept of the "digital divide" (van Dijk, 2005; DiMaggio & Hargittai, 2001). Clear examples of this are the differences in Internet use between the lowest and highest income quintiles in Latin American countries (see **Table 2**).

Table 2. Internet use by income quintile among Latin American countries

Country	Year	Lowest income quintile	Highest income quintile
Bolivia	2015	20%	76%
Brazil	2015	44%	78%
Paraguay	2015	29%	78%
Peru	2015	28%	67%
Colombia	2016	39%	76%
Ecuador	2016	38%	75%
Honduras	2016	5%	52%
Uruguay	2016	48%	80%

Source: Based on Galperin (2017).

Lacking the opportunity to interact with digital technologies may limit active participation in society and learning opportunities (Schmidt-Hertha & Strobel-Dümer, 2014). However, it is important to bear in mind that interacting with digital technologies goes beyond using applications and devices – it is about the development of a way of thinking and of social practices (Cetic.br, 2016). Such ways of thinking center on "abstraction, codification, self-regulation, virtualization and programming" (Gere, 2008, p. 18).

4.2. ICT and education

As previously mentioned, SDG 4 includes the development of technical and vocational skills linked to ICT skills aimed at improving opportunities for employment (see **Box 4**). One of the policy challenges related to this, however, lies in integrating ICT in the teaching and learning practices across educational institutions.

Including ICT use in curricula may facilitate the implementation of teaching and learning practices that develop ICT skills in students (Taleb, 2012). Curricula are the systematized knowledge considered socially valid (Smith, 1995, p. 8). They represent how students are initiated into modes of making sense of their experiences and introduced to the norms, knowledge and skills required by a given society (Egan, 1978, p. 65).

However, ICT in curricula is not necessarily the inclusion of digital literacy courses. It refers to cross-cutting digital media into the curricular activities of different courses. A second challenge is that the benefits drawn from ICT infrastructure are conditional on its use (OECD, 2015). It is rather different to merely replace analogic teaching resources within traditional ones compared to actually fostering the development of skills and/or learning in different ways. Specifically, ICT integration enables students to seek information from different sources; establish the development of relationships between information; systematize knowledge acquired through life experiences; reconstruct knowledge represented by multiple languages and non-linear structures; and collaborate with peers and experts located in different places (CGI.br & UIS, 2016).

As ICT crosscuts culture, teachers are expected to be active and continuous users and creators of teaching and learning practices that involve ICT. Networks and communication between teachers, administrative personnel and principals are another example of ICT integration into school practices. For example, teachers can develop digital lesson plans, create, modify or integrate existing digital content, as well as share experiences and exchange materials with other colleagues.

Finally, to make policy decisions in this field, it is important to take into account the perceived barriers to using ICT, which are mainly the perceptions of the consequences of limitations in access conditions; attitudes towards technology in education; the expectations of all

Box 4. Mapping ICT-related indicators in SDG 4

The Regional Center for Studies on the Development of the Information Society (Cetic.br) conducted a systematic review of the presence of general, sectoral and thematic indicators among SDG targets and indicators to harmonize different sources, perspectives and approaches that show the cross-cutting contribution of ICT to the SDGs (UNESCO, 2019).

The descriptions of the 169 targets and 231 indicators were analysed to map references to the adoption of ICT, either explicit or indirect. Finally, the literature on socioeconomic impacts of ICT was reviewed to conceptually connect those targets and indicators that did not mention ICT at all, yielding three levels of ICT presence in the SDGs. The mentions of ICT in SDG 4 are presented below, organized in three levels:

1. SDG 4 indicators explicitly related to ICT

Target	Indicator
4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.	4.4.1 Proportion of youth and adults with **information and communication technology (ICT) skills**, by type of skill.
4.a By 2030, build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.	4.a.1 Proportion of schools with access to: (a) electricity; (b) the **Internet** for pedagogical purposes; (c) **computers** for pedagogical purposes; (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water; (f) single-sex basic sanitation facilities; and (g) basic handwashing facilities (as per the WASH indicator definitions).
4.b By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and **information and communications technology**, technical, engineering and scientific programmes, in developed countries and other developing countries.	4.b.1 Volume of official development assistance flows for scholarships by sector and type of study.

2. SDG 4 ICT-related indicators, by keywords

Target	Indicator
4.7. By 2030, ensure that all learners **acquire the knowledge and skills** needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.	4.7.1 Extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are mainstreamed at all levels in: (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment.

3. ICT-related indicators, based on literature review

Goal	ICT Review
4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.	OER, MOOC
4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy.	OER

Source: Prepared by Cetic.br with data from Cetic.br; ITU, OECD; UN DESA; WSIS and published in: Del Rio, O.; Martínez, P.; Martínez-Gómez, R.; Pérez, S. (2019). ICT for Sustainable Development. Recommendations for Public Policies that Guarantee Rights. UNESCO Policy Papers. UNESCO, Montevideo and Paris.

involved (teachers, principals, students and if possible, parents) for ICT use in education and their perceptions about impacts (both positive and negative).

4.3. Access, use and ICT skills development opportunities

The complex elements and dimensions that interact in the daily practice of teaching and learning processes makes it difficult to summarize and simplify the links between ICT and education. This is further complicated given that political, cultural and socioeconomic contexts differ. However, a conceptual guide serves to tell a story about ICT in education. A conceptual guide aims at identifying the most relevant information to capture in indicators, anticipating and showing possible relationships between dimensions and how they jointly generate a global effect (Mainguet & Baye, 2006, pp. 153–154).

One of the main reasons to invest in ICT in education is that these tools can promote student learning – either because ICT complements teaching practices, motivates students to engage with their learning processes, or reaches populations that otherwise would not have the opportunity to learn, among other explanations. The common goal is that students learn and enhance their academic performance.

Thus, measurement of ICT use at the school level requires delving into the description of educational practices once technology is present. The literature in general is in agreement that this process is composed of at least three dimensions: access, use and skills (as reviewed by Dodel, 2015).

Researchers and practitioners differ in the direction of the relation between the three dimensions, what conditions and mechanisms come into play while some consider that there are other areas and cross-cutting issues that are worth including. However, in this *Guide*, the adoption of these three dimensions facilitates the identification of how the relationship between learning, teaching practices and technology unfolds, starting from infrastructure and resources (access), how and with what purposes educational actors interact with those resources (use) and, finally, the school conditions to develop and reinforce the abilities related to ICT use (ICT skill development).

4.3.1. Access

Access refers to the effective availability of ICT resources and infrastructure at the school level. ICT resources and infrastructure cover locations, digital devices, software and Internet connection. Having access to ICT means that individuals and institutions have the option to use them. Another relevant dimension of access – in addition to effective availability – is the sustainability of digital access. It means that support services need to be put in place to ensure that digital technologies do not break down and interrupt access. It usually entails repairing and replacing devices at end of their life and responsibly disposing of them. In the educational context, ICT resources and infrastructure refer to school management, as well as teaching and learning resources at school, in the classroom and outside school.

Describing the conditions of access is particularly important in the case of schools. If indicators only register information like presence of computers or students per computer, they will poorly reflect the effective availability of ICT resources and infrastructure for students and the school community to use them (Selwyn, 2014). A good example of this are locked-up computer labs that no one is able to use. They will also tell little about whether the computers have effective chances of being used, such as having functioning software to meet user requirements.

Effective contributions come from indicators that describe the conditions under which access occurs. This requires indicators capable of capturing quality of access, accessibility and degrees of autonomy that people experience. For example, these indicators may include the number of working computers with Internet access at school, digital devices and software for students with disabilities and restrictions to access the Internet at school (see **Table 3**).

The importance of measuring access is due to the growing amount of information, data, opinions and learning resources transferred through digital means. Not having access to ICT at the school level is a sign of the reproduction of inequalities, lack of opportunities to develop technical and vocational skills, and limited chances of being an active actor of civil and societal life (Schmidt-Hertha & Strobel-Dümer, 2014).

4.3.2. Use

Individual data complement information about access at the school level with information to characterize what happens once educational actors interact with ICT in the school setting. As previously mentioned, administrative data is more suited to describing access than to delving into how individuals use ICT in learning and teaching activities.

Use refers to frequency, places of use, activities carried out and how much content individual educational actors generate and consume (Newby, Hite, Hite, & Mugimu, 2013). Given that the objective is student learning, it is necessary to understand how the school community and ICT relate at the individual level. Meaning that it is necessary to understand to what extent students make meaningful use of effective available ICT resources and infrastructure.

Table 3. List of core and optional indicators

Dimension	Indicator	
Access	Core	A1. Average of working digital devices with Internet access, available for pedagogical use at schools, by type of digital device
		A2. Percentage of schools by Internet access location
		A3. Percentage of schools by main Internet connection speed
		A4. Percentage of schools by restrictions in students' access to the school's Wi-Fi network
		A5. Percentage of schools with digital devices or software that meet the requirements of students with disabilities
	Optional	A6. Percentage of students/teachers/principals with access to digital devices at the household
		A7. Percentage of students/teachers/principals with Internet access at the household
		A8. Percentage of students/teachers/principals with access to mobile phones
Use	Core	U1. Percentage of students/teachers/principals who use the Internet, at any location
		U2. Percentage of students/teachers/principals who use the Internet, by location
		U3. Percentage of students/teachers/principals that frequently use the Internet at school
		U4. Percentage of schools that use digital devices and the Internet to perform administrative tasks
		U5. Percentage of teachers by activities performed when using the Internet at any location, by purpose
		U6. Percentage of teachers by learning and teaching activities performed with students when using digital devices and the Internet at any location
		U7. Percentage of teachers by activities with students to develop digital thinking
		U8. Percentage of teachers by actions to prepare teaching and learning activities using digital devices and the Internet at any location
		U9. Percentage of teachers, by type of resources obtained on the Internet to prepare teaching and learning activities
		U10. Percentage of students by activities performed when using the Internet at any location
		U11. Percentage of students by learning activities using the Internet at any location
ICT skills development	Core	ICT1. Percentage of schools by workshops, debates or courses on safe and responsible use of ICT
		ICT2. Percentage of schools by preparatory activities for ICT use
		ICT3. Percentage of teachers/principals by continued professional development training for ICT use in learning and teaching practices
		ICT4. Percentage of teachers/principals by perception of ICT impact on pedagogical practices
		ICT5. Percentage of teachers/principals by perceived barriers to ICT use at the school
	Optional	ICT6. Percentage of students by perception of ICT impact on their own learning
		ICT7. Percentage of students by ICT skills

Meaningful use of ICT in education is a means of promoting learning. Using ICT in a meaningful manner entails students carrying out learning activities that are intentional, collaborative, reflective and active (Lave & Wenger, 1991; Qureshi, 2013). These activities include discussing and analyzing situations in groups, as well as constructing knowledge – and not merely acquiring information. However, determining whether meaningful use is happening or not is challenging to measure.

There are a myriad of alternatives to describe use employing indicators.[10] This *Practical Guide* focuses on indicators of how use unfolds in schools. The proposed list of indicators encompasses the purpose of using ICT (administrative, pedagogical or personal ends), the location where individuals use ICT, frequency of ICT use, types of teaching and learning activities carried out and type of resources obtained from the Internet to prepare classes (see Table 3).

This selection of indicators does not constitute a normative list. Rather, it is based on experience, mainly that of Cetic.br/NIC.br in its ten years of measuring ICT access and use in schools. This means, on the one hand, that the indicators have been built considering international standards and cover the main issues in recent ICT and education agendas. On the other hand, it means that the model questions included in the methodological sheets have undergone design, validation through cognitive interviewing and use in implemented questionnaires. Even though there certainly are more issues and indicators of interest that measure ICT use, the list only includes those for which tested questions were available.

Therefore, indicators of ICT use do not only serve to identify whether individuals and educational institutions use these technologies. They provide a glimpse into the potential relationship that such use has with education quality and the effective opportunity to develop and reinforce ICT skills.

4.3.3. ICT skills development

ICT skills refer to those skills that allow individuals and communities to derive opportunities from ICT use. They refer to the capacity of using ICT for a particular purpose or to solve a relevant problem – for example, the skills required to boost employability (UIS, 2018). ICT skills consist of integrating and adopting processes related to the use of digital devices and applications within users' daily lives (Taleb, 2012). Relevant skills also entail understanding how technology works, how it is designed, programmed and how it relates to human decisions and needs.

There are two main methods to register students' ICT skills. It could be done through assessment, such as standardized tests (see **Box 5**), or resorting to self-reported information, which typically corresponds to surveys.

There is a vast literature focused on discussing the advantages and disadvantages of each of these methods, but, in summary, it should be noted that – in the second option, the cost of data collection on a massive scale is lower than in skills test implementation. This is the modality through which, for example, the well-known PISA study collects data on the use of ICT.

On the other hand, direct skills testing undoubtedly offers greater precision, but it also involves substantively higher implementation costs, since it requires the development, calibration and validation of a specific test; the development of a platform for students or teachers to use and, usually, it requires the presence of monitors during the test implementation.

As mentioned in the Introduction, the focus of this guide is on ICT use as digital skills measurement is a complex endeavour that may merit a separate survey or test and a specific methodological guide to adequately cover its design and implementation. Instead, the focus of this section will be the contextual factors surrounding digital skills, what we call digital skills development opportunities. They mainly encompass the perceptions of teachers, principals and students of digital skills and the initiatives carried out by schools to facilitate the development of those skills.

Measuring ICT skills through surveys encompasses capturing perceptions of the effect of ICT in learning, opinions, barriers as well as activities performed and self-perception on the ability to perform them. Surveys may also enquire about the conditions that facilitate ICT use, including simplicity of use and users' perceptions on its usefulness as well as user satisfaction. Thus, acquiring ICT skills means to use and adopt ICT in a significant and useful manner for individual, community, or organizational concerns (Selwyn, 2004).

However, in implementing a survey, by definition, it is not possible to check the accuracy of information on performance when using ICT. Self-confidence is a major source of bias in answers related to self-perception. Underrepresented social groups tend to show less confidence when assessing their own abilities, such as women and black students (Holland, 2008; UIS, 2018).

[10] Martinez-Restrepo et al. (2018) performed a thorough review of international indicators on ICT in education in a set of Latin American countries. In particular, indicators on use range from students using the computer lab for their regular classes, teachers who had used virtual platforms for pedagogical purposes and students who had used search engines, to students who had worked in collaborative activities using ICT resources.

Box 5. Measuring ICT skills with standardized tests

A standardized test is an assessment where all takers answer the same questions in the same way and are scored in a standardized manner to compare their performance (Popham, 1999). There have been relevant efforts to develop standardized tests to measure ICT skills, such as The International Computer and Information Literacy Study (ICILS) of the International Association for the Evaluation of Educational Achievement (ICILS 2018, IEA website), PISA tests (PISA Test – PISA, OECD website), ATC21S (Griffin & Care, 2015) and HTPA (Habilidades TIC para el aprendizaje – Enlaces website).

Digital skills for learning: Argentina, Chile, Mexico and Uruguay

In 2017 Enlaces from Chile, @prende.mx from Mexico, Plan Ceibal from Uruguay, Aprender Conectad@s from Argentina and the UN Economic Commission for Latin America and the Caribbean (ECLAC) made an agreement to share HTPA (*Habilidades TIC para el aprendizaje*). The tool was developed by Enlaces to measure digital skills and the project is supported by ECLAC. The short-term objective is to measure and analyze digital skills. The long-term objective is to promote the development of digital skills and other skills linked to ICT in education.

The test is designed to evaluate the skills mentioned in the following table:

Dimension	Sub-dimension	Skill
Information	Information as a source	Access to information
		Evaluation of information
		Organization of information
	Information as a product	Synthesis of information
		Creation of a new information product
Communication	Effective communication	Presentation of information with a purpose to a specific audience
Digital connivance	Ethics and self-care	Knowledge of the rights and application of strategies for information protection in the digital environment
		Respect for intellectual property
Technology		Master the most used digital applications

Despite ICT skills being the last dimension in this conceptual section, it does not mean that it is the last step in a linear progression. Counting on the conditions and characteristics to develop ICT skills fosters, in turn, greater use. For example, meaningful use can improve in the face of positive changes in perception of the effect that ICT has on learning processes.

Moreover, adopting ICT in users' daily lives means that the development of ICT skills also takes place outside the school. At educational institutions, students practice what they have learned, explore with accompaniment, and in the most traditional settings, they follow instructions. Whatever knowledge they have about ICT use most likely reflects the learning contexts in which they participate outside formal educational spaces. Thus, ICT skills are not only linked to educational processes, but to the possibilities that students have to actively participate in society.

For those interested in deepening their study of teacher skills, beyond the elements provided in this guide, a relevant reference to consider is the UNESCO Education Teacher Training Competency Framework, Version 3. This framework offers a conceptual basis to develop further questions on teacher digital competencies that can be included in the survey. The description of such competencies is organized into three levels. This thorough description can not only be used for teachers but also extrapolated to other stakeholders. Moreover, if applied within a longitudinal research design, this framework is useful for identifying the evolution of competence levels over time.

4.4. Objectives of a survey on ICT in education

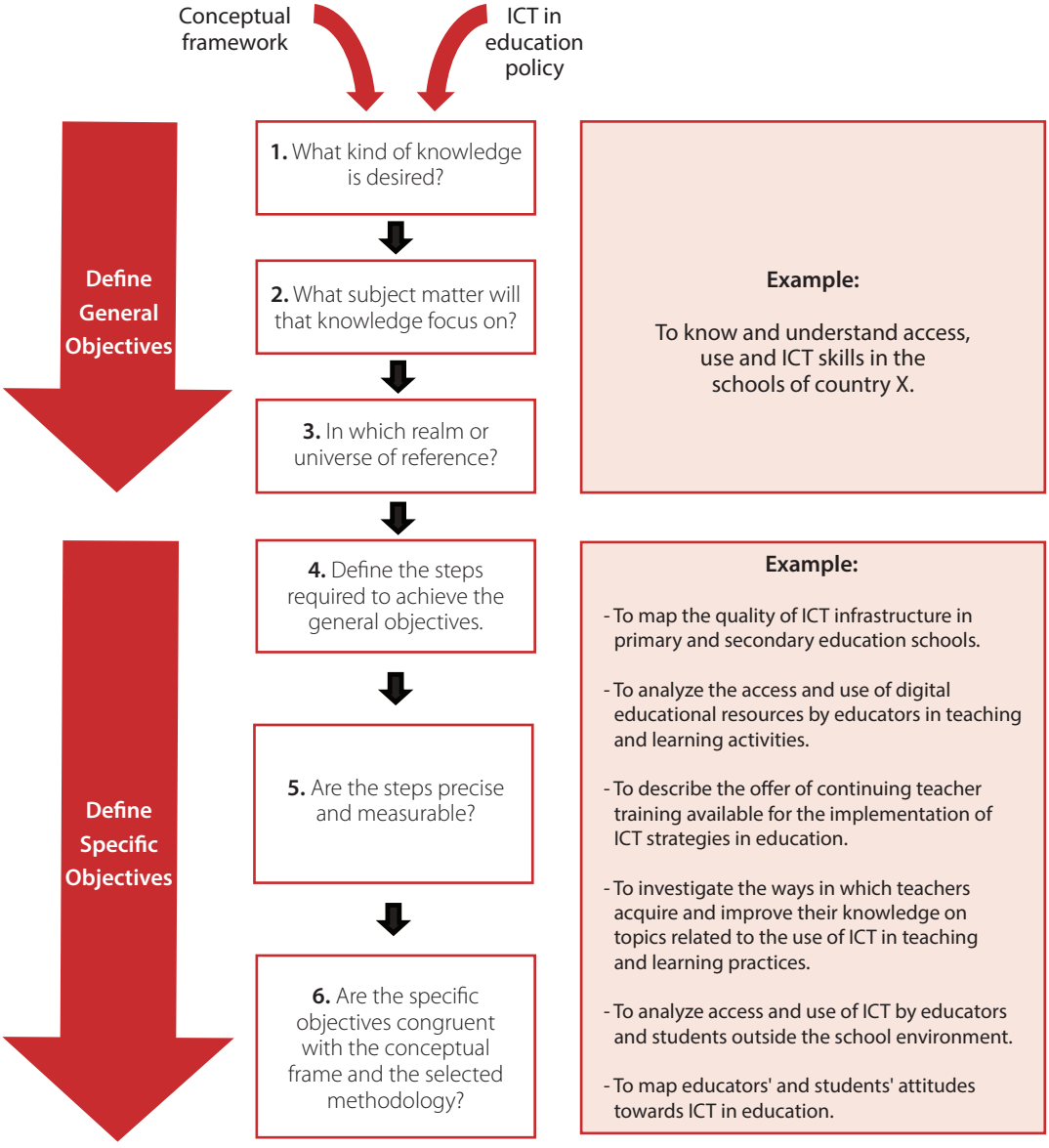
As the purpose is to implement a representative survey on ICT use in primary and secondary schools, it is necessary to turn the conceptual guidelines into survey objectives. Objectives are key to determine the boundaries of the questions to be included in the survey questionnaire. They also provide the operational definitions that delineate which population to interview, imperative content to include in the survey and how to further analyze the data (Statistics Canada, 2010).

It is necessary to define the survey objectives before designing the questionnaire, since objectives set the criteria to make decisions on planning, fieldwork, data processing and reports. Specifically, defining objectives facilitates decisions on what to ask in the questionnaire without losing sight of the concepts that support the indicators.

Both the conceptual guidelines and ICT in education policy of a given country are key inputs to define the objectives of the survey (see **Figure 2**). A way for the survey team to identify the main aspects of the policy on ICT in education is to work closely with stakeholders (see point 1.1, Network of specialists and stakeholders, in Section II of this guide). These stakeholders, such as government, academia and civil society organizations, represent the sectors that are interested in the topic, either because they are affected by ICT in education or because they affect it. Their engagement facilitates obtaining useful insight and provides legitimation and support for the survey as a whole. For example, stakeholders involved in the survey project can require the development of broader objectives to meet local needs and may pose specific data requirements for their decision-making.

General objectives state the survey's subject matter, kind of knowledge to be produced and universe of reference. These objectives should not exceed two. For example, the survey's general objective in this example is "to know and understand access, use and ICT skills in schools" (Figure 2).

Figure 2. The process to define general and specific objectives



Specific objectives are precise and concrete statements about tangible goals, which contribute to accomplishing the general ones (Figure 2). To fulfil the general objective, specific ones should be interconnected and congruent with both the conceptual frame and the ICT in education policy. They are expected to be formulated in such a way that they clearly enable their achievement to be tracked.

5. Indicators on ICT in education

The conceptual phase is completed once indicators are selected. Indicators work to measure the current state of affairs, changes and continuity of topics of interest (Mainguet & Baye, 2006; UIS, 2018).

This Practical Guide proposes a total of 26 indicators divided into the three dimensions of ICT in education (see Table 3), with suggested variables by which to disaggregate them. The indicators proposed are built on agreed-upon references on goals, usefulness, pertinence and validity. This means that the selection of indicators is a final step to engage theory and practice.

Indicators for ICT in education support monitoring and evaluation of educational systems, as well as provide warning signs that invite social and political actors to improve these systems (Mainguet & Baye, 2006). Indicators provide information at different levels and for different groups (**Box 6**). Some indicators inform on national, regional or local percentages or averages and some specialize in population segments that deserve special attention, such as students with disabilities or rural schools. It is also possible to have a main indicator with the option of further disaggregation.

Disaggregating indicators allows for the identification of digital gaps, namely where the differences are between population segments, which then allows for adjustments and changes as well as to promote lower administrative level engagement with the indicator systems (Scheerens, Luyten, & van Ravens, 2011). For example, disaggregated indicators show the difference in approaches that schools take to guarantee safe and responsible use of ICT between municipalities or regions within the same country.

Extensive research and studies have shown that information on access to ICT is more common among developing countries, although there are still significant informational gaps (Sunkel, Trucco, & Espejo, 2014; Martinez-Restrepo et al., 2018). Capturing information on ICT skills remains a major challenge for national governments and international institutions. There are ongoing debates on issues, including comparability, local relevance and methodologies to assess them. One important consensus is that while there are other ways to register information on ICT skills, surveys generally represent an option that works well. The main reason is that having self-reported information on skills seems to register self-confidence levels rather than actually measuring skills. Thus, surveys work to identify environmental conditions that have the potential to promote ICT skills development. The advantage of doing so is to avoid confounding skill levels with self-confidence.

This *Guide* proposes sets of core and optional indicators. Core indicators capture fundamental topics while optional indicators can be used if there are no other data sources. For example, some optional indicators correspond to information on the household, such as access to the Internet. These are optional in case there is a household survey that captured this information – so, it is not a priority to include variables about the household in the survey on education. Likewise, infrastructure information might be available through administrative data. Therefore, the suggestion is that indicators on ICT use are formulated as core indicators. This stage presents more information gaps, is more suitably measured through surveys and delves into the relation that educational actors build with ICT in teaching and learning activities in the school setting.

Box 6. Mapping existing indicators to determine knowledge gaps in South Africa

The table below uses the list of indicators provided to measure access, use and skills in ICT in primary and secondary schools and maps them to SDG indicators as well as country-level indicators that are equivalent to or closely resemble these indicators in South Africa. While it shows that there are already some indicators available that can support decision making for policy and practice, there are also many gaps. These can guide the development of instruments and research interventions that can help fill the gaps.

Indicator	SDG Target (Custodian Agency)	Respondent	Indicators & Sources in South Africa
A1 (Core). Average of working digital devices with Internet access, available for pedagogical use at schools, by type of digital device.	4.a.1 Proportion of schools with access to: (b) the Internet for pedagogical purposes; (c) computers for pedagogical purposes (UNESCO-UIS).	Principals (or other school staff knowledgeable about ICT infrastructure)	Not available
A2 (Core). Percentage of schools by Internet access location.			Percentage of schools by Internet Connectivity for Learning and Teaching, Per Province. Percentage of schools by Internet Connectivity for Administrative Purposes Per Province. *Source: National Education Infrastructure Management System (NEIMS), Department of Basic Education.*
A3 (Core). Percentage of schools by main Internet connection speed.			Not available
A4 (Core). Percentage of schools by restrictions in students' access to the school's Wi-Fi network.			Not available
A5 (Core). Percentage of schools with digital devices or software that meets the requirements of students with disabilities.			Not available
A6 (Optional). Percentage of students/ teachers/principals with access to digital devices at the household.	Not stated	Students Teachers Principals	Household ICT access by technology type. *Source: RIA After Access Survey 2017.*
A7 (Optional). Percentage of students/ teachers/principals with Internet access at the household.			Household access to the Internet. *Source: RIA After Access Survey 2019.*
A8 (Optional). Percentage of students/ teachers/principals with access to mobile phones.	5.b.1 Proportion of individuals who own a mobile telephone, by sex (ITU).		Proportion of individuals who own a mobile phone. *Source: RIA After Access Survey 2017.*
U1 (Core). Percentage of students/ teachers/principals who use the Internet, at any location.	Not stated	Students Teachers Principals	Not available
U2 (Core). Percentage of students/ teachers/principals who use the Internet, by location.			Not available
U3 (Core). Percentage of students/ teachers/principals that frequently use the Internet at school.	Not stated	Principals (or other school staff knowledgeable about ICT infrastructure	Not available
U4 (Core). Percentage of schools that use digital devices and the Internet to perform administrative tasks.			Percentage of schools by Internet Connectivity for Administrative Purposes. *Source: National Education Infrastructure Management System (NEIMS), Department of Basic Education.*

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Indicator	SDG Target (Custodian Agency)	Respondent	Indicators & Sources in South Africa
U5 (Core). Percentage of teachers by activities performed when using the Internet at any location, by purpose.	Not stated	Teachers	Not available
U6 (Core). Percentage of teachers by learning and teaching activities performed with students when using digital devices and the Internet at any location.			Not available
U7 (Core). Percentage of teachers by activities with students to develop digital thinking.			Not available
U8 (Core). Percentage of teachers by actions to prepare teaching and learning activities using digital devices and the Internet at any location.			Not available
U9 (Core). Percentage of teachers by type of resources obtained on the Internet to prepare teaching and learning activities.			Not available
U10 (Core). Percentage of students by activities performed when using the Internet at any location.		Students	When you use the Internet, how do you connect? *Source: UNICEF, South African Kids Online South Africa, 2015.*
U11 (Core). Percentage of students by learning activities using the Internet at any location.			Not available
ICT1 (Core). Percentage of schools by workshops, debates or courses on safe and responsible use of ICT.		Principals	Not available
ICT2 (Core). Percentage of schools by preparatory activities for ICT use.			Not available
ICT3 (Core). Percentage of teachers/ principals by continued professional development training for ICT use in learning and teaching practices.		Teachers Principals	Percentage of teachers for whom "use of ICT for teaching" has been included in their recent professional development activities. *Source: OECD TALIS South Africa Country Report 2019.*
ICT4 (Core). Percentage of teachers/ principals by perception of ICT impact on pedagogical practices.		Teachers Principals	Not available
ICT5 (Core). Percentage of teachers/ principals by perceived barriers to ICT use at the school.			Percentage of principals reporting a shortage or inadequacy of digital technology for instruction. *Source: OECD TALIS South Africa Country Report 2019.*
ICT6 (Optional). Percentage of students by perception of ICT impact on their own learning.		Students	Not available
ICT7 (Optional). Percentage of students by ICT skills.	4.4.1 Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill (UNESCO-UIS, ITU).		Not available

Note: Text contributed by Shafika Isaacs, independent digital learning consultant, South Africa.

II. SURVEY IMPLEMENTATION: COLLECTING REPRESENTATIVE DATA ON ICT USE IN EDUCATION

This *Practical Guide* focuses on survey methodology to collect comprehensive and relevant data on ICT use in schools. Survey methodology is defined by two main characteristics. It is applied to a quantitatively representative group of people or institutions, and it relies on a structured questionnaire to register answers from respondents. Surveys seek to obtain data that is representative of a given universe of study – namely, the data collected from a particular group of people or institutions (the sample) works to draw conclusions on attributes of the larger population to which said group of people belongs (the universe of study) (Groves et al., 2009).

Coupled with organizational dynamics, social and pedagogical processes, the introduction of ICT in the school setting constitutes a complex and relevant object of study. Thus, schools are the privileged unit of analysis. Collecting data in school settings allows us to capture the collective properties of the schools; individual experiences of students, teachers and other relevant staff members; as well as administration-related data. For a survey on ICT in educational institutions to be comprehensive, it is necessary to capture insights from a set of key actors. The institutional organization of schools involves students, teachers, principals, other relevant staff members and families. Each of the educational community actors provides information either on specific topics or that allows us to contrast information about the same topic from different perspectives (see Table 4).

Table 4. List of core and optional indicators and respondents

Dimension	Indicator		Respondent
Access	Core	A1. Average of working digital devices with Internet access, available for pedagogical use at schools, by type of digital device	Principals (or other school staff knowledgeable about ICT infrastructure)
		A2. Percentage of schools by Internet access location	
		A3. Percentage of schools by main Internet connection speed	
		A4. Percentage of schools by restrictions in students' access to the school's Wi-Fi network	
		A5. Percentage of schools with digital devices or software that meets the requirements of students with disabilities	
	Optional	A6. Percentage of students/teachers/principals with access to digital devices at the household	Students Teachers Principals
		A7. Percentage of students/teachers/principals with Internet access at the household	
		A8. Percentage of students/teachers/principals with access to mobile phones	
Use	Core	U1. Percentage of students/teachers/principals who use the Internet, at any location	Students Teachers Principals
		U2. Percentage of students/teachers/principals who use the Internet, by location	
		U3. Percentage of students/teachers/principals that frequently use the Internet at school	
		U4. Percentage of schools that use digital devices and the Internet to perform administrative tasks	Principals (or other school staff knowledgeable about ICT infrastructure)

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Dimension	Indicator		Respondent
Use	Core	U5. Percentage of teachers by activities performed when using the Internet at any location, by purpose	Teachers
		U6. Percentage of teachers by learning and teaching activities performed with students when using digital devices and the Internet at any location	
		U7. Percentage of teachers by activities with students to develop digital thinking	
		U8. Percentage of teachers by actions to prepare teaching and learning activities using digital devices and the Internet at any location	
		U9. Percentage of teachers, by type of resources obtained on the Internet to prepare teaching and learning activities	
		U10. Percentage of students by activities performed when using the Internet at any location	Students
		U11. Percentage of students by learning activities using the Internet at any location	
ICT skills	Core	ICT1. Percentage of schools by workshops, debates or courses on safe and responsible use of ICT	Principals
		ICT2. Percentage of schools by preparatory activities for ICT use	
		ICT3. Percentage of teachers/principals by continued professional development training for ICT use in learning and teaching practices	Teachers Principals
		ICT4. Percentage of teachers/principals by perception of ICT impact on pedagogical practices	
		ICT5. Percentage of teachers/principals by perceived barriers to ICT use at the school	
	Optional	ICT6. Percentage of students by perception of ICT impact on their own learning	Students
		ICT7. Percentage of students by ICT skills	

1. General planning activities

Implementing a survey involves taking care of aspects of a different nature:

- Political-institutional;
- Managerial, budgetary;
- Methodological.

In general, a survey is conducted through a set of several interconnected steps, summarized in Figure 1: choice of conceptual framework, survey planning and design; data collection; data processing; calculation of estimates and projections; data analysis; and dissemination to stakeholders. There are specificities about surveys in schools that differentiate approaches to the educational population compared to, for example, administering household surveys or questionnaires to enterprises.

Thus, this section is designed to provide practical guidance for organizing the activities related to planning, designing, implementing and communicating a survey on ICT access, use and skills in schools. It highlights the importance of sound survey sampling and describes the key principles and best practices for administering surveys in schools.

The guidelines presented in this methodological section align with good practices recommended by official statistics offices in terms of the methods required to build efficient and high-quality surveys. It is based on principles and concepts from internationally agreed-upon methodological frameworks to measure ICT in education. It also relies on the practical expertise of the team involved in its development, as well as on the expertise of the specialists from all continents in the Global South that were consulted to review the draft document. This section does not replace, however, theoretical and statistical expertise on survey methodologies.

Before getting into the specific methodological aspects of the planning phase, it is important to consider the general context of the survey to be produced. The first step is to know what other institutions have stakes or are potentially interested in either producing or using the data from the survey being planned. **Figure 3** shows a generic scheme of the parties usually involved in a national data production ecosystem related to ICT and Education.

Figure 3. ICT in education statistics ecosystem

1.1 Funding and budgets

Funding and budgeting are not trivial elements in policy planning and implementation. Counting on reliable survey data and specific evaluations is an integral part of the policy planning process, however, funding is frequently scarce for these activities. If this is the case, it is important to begin by sensitizing decision-makers and potential funders to the need for reliable data – be it for generating a baseline on ICT access and use before implementing a policy; to track advances or difficulties if an initiative has already been implemented; or to get a sense of where the country stands in context of similar countries in a given region.

The survey budget will depend largely on the data collection method chosen (web and telephone surveys being significantly cheaper than face-to-face interviews) and sample size (a consequence of the precision required). However, other factors also impact budget, such as geographical coverage (whether the survey covers big as well as small cities, rural as well as urban settings), geographical features of the country (size, geographical challenges such as mountainous territories) and it is also impacted by the presence or absence of judicious cost planning and control.

- **Consider multi-stakeholder funding:** early involvement of stakeholders, in addition to strengthening quality and legitimacy of the research, may also increase the likelihood of obtaining the necessary funding. There are multiple examples of successful multi-party funding experiences, such as the case of the Kids Online Uruguay Survey, where a multi-stakeholder group composed of UNICEF, a governmental agency called AGESIC, the agency in charge of the local ICT in education Policy (Plan Ceibal) and the UNESCO Regional office in Montevideo made it possible for the survey to be implemented.
- **Be creative and open:** a university may not be able to contribute monetarily but it may contribute with paid person-hours from some of its researchers who, in turn, may benefit from the use of the resulting data for their own research. A local NGO involved in ICT and education might end up being key to applying for external funding that may help make up for insufficient resources.

When budget planning, be mindful to:

- Estimate costs in as much detail as possible as every survey step exacts a cost. Planning costs using just broad categories (e.g. "personnel" or "travel") renders it difficult to visualize the real costs involved in each step of the survey.
- Avoid common budgeting errors, such as underestimating or omitting some of the costs
- Consider building in budget and human resource contingencies.

1.2 Timetables

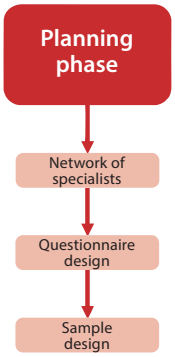
In addition to planning and allocating resources to cover costs, it is equally important to allocate realistic amounts of time to develop the different steps of the survey. If this is the first time that a team is coordinating a survey, the planning phase might be considerably longer. Subsequent implementations generally demand less time for completing most of the phases.

The time required to carry out each step of a survey may vary depending on the allocated resources, such as human resources available (mainly team size and experience), data collection method chosen (face-to-face interviewing typically takes far more time than telephone interviewing) and geographical challenges (if a face-to-face method was chosen), among other factors.

In **Box 7**, you will find an example of the time dedicated to carry out each phase of a real survey, the Brazilian ICT in Education survey.

2. Specific activities in the planning phase

Figure 4. Steps for the planning phase



The planning phase involves all the fundamental decisions to obtain representative and comprehensive data and produce quality indicators on the use of ICT in schools. It involves the selection of the guiding concepts and theoretical references (see *Key definitions to understand ICT use in primary and secondary education*); the definition of the general and specific objectives (see *Objectives of a survey on ICT in education*); the selection of core and optional indicators, questionnaire design; survey sampling; and the definition of data collection methods (see **Figure 4**). In this phase it is key to consider the most common contingencies that could hinder data collection and analysis.

Box 7. Example of time allocated to each survey phase, based on the Brazilian ICT in Education survey (Cetic.br/NIC.br)

Meetings with stakeholders	1 month
Planning	2 months
Questionnaire design	2 months
Questionnaire external review and inclusion of agreed suggestions	1 month
Draft interviewer's and supervisor's manuals	1 month
Carry out cognitive interviews	2 months
Plan and implement questionnaire pretest	1 month
Train interviewers and supervisors	1 week
Revise questionnaires and manuals (if needed)	1 week
Sample design (if first round)	1 month
Design and test data entry programme	1 month
Design and test data cleaning programme	1 month
Data collection (face-to-face interviews)	5 months
Building database	1 month
Design and test tabulation plan	1 month
Data cleaning (e.g. range and consistency checks)	2 weeks
Carry out the processing according to plan	1 month
Calculate sampling errors among other estimates	1 month
Analysis and report writing	1 month

A good first step when deciding to carry out a survey is to map out all the potentially interested actors involved. From that mapping, it is possible to visualize possible stakeholders to invite to participate in the process and identify associates, partners, or contractors. **Figure 4** illustrates a generic ecosystem of stakeholders for an ICT in education survey from which the actual map of actors can be drawn.

2.1 Network of specialists and stakeholders

Throughout the implementation process of policy-relevant surveys, it is appropriate to count on feedback and reviews from an independent network of specialists and stakeholders. Involving a group of professionals from different sectors and with ample knowledge and experience in ICT in education can provide input on what is important for the future use of the indicators, enabling for a user-centered design of the survey.

A network of specialists consists of a multi-stakeholder group whose purpose is to institutionally and methodologically support the implementation of the survey. They willingly participate with feedback and debates on the design of the study, the indicators selected and the survey questions along with their interpretation, validity and policy-related relevance.

The overall objective is to have a panorama of the most relevant aspects that affect the implementation of a representative survey on ICT and Education, including international perspectives, expertise from other regions, legal framework, socioeconomic context and ICT and Education policy (see **Box 8**). Ideally, the network should include specialists in social research whose profiles range from academics specialized in the field of ICT and education to practitioners and theorists that bring knowledge on national/local contexts of interest and a user-centered perspective. An appropriate network comprises a variety of standpoints: governmental institutions research centers and universities, non-governmental institutions and international organizations.

There are three main advantages of having a network of specialists and professionals on ICT and Education as advisors to the process. First, their insights and contributions to the planning and subsequent phases provide legitimacy to the process – thanks to the transparency of the methodological choices made. Second, the network is a means to disseminate methodological lessons and findings. Third, the network fosters dialogue between specialists and policymakers, which has the potential to articulate initiatives related to ICT and Education as well as to introduce these topics into political agendas.

Box 8. Good practices in survey design: Expert Group of the Brazilian ICT in Education survey

The Expert Group (EG) for the Brazilian ICT in Education survey is an institutionalized figure conceived as a regular consulting forum. It is composed of around 50 renowned specialists in the field of education and technology. Members encompass academic researchers, representatives from government agencies, international organizations and civil society organizations who participate on a voluntary basis. The EG contributes to the Brazilian ICT in Education survey before and after its implementation every year:

Before the Survey:

- Evaluation of strengths and weaknesses of changes made in the present round to validate both the indicators and methodology.

This instance enables the research center:

- To capture a diverse and multi-stakeholder array of points of view.
- To know first-hand the demands and needs of the sectors represented.

After the Survey:

Once the data is collected, results are critically discussed and analyzed, which provides input guidelines for data analysis and indicates potential weaknesses in data quality for a given indicator.

The collaboration of the EG is also essential to:

- identify new research lines
- improve methodological procedures
- ensure the validity and reliability of the data
- contribute to the dissemination, legitimation and adoption of the survey results within the fields in which each group member acts

2.2 Questionnaire design

The questionnaire aligns with the conceptual references, general and specific objectives and selected optional and core indicators. Specifically, survey questions collect data to further calculate and validate the indicators – i.e. which question and answer options will register the appropriate data to calculate the selected indicators of the study.

A well-done questionnaire that complies with quality standards guarantees that data collected will lead to accurate information. A poorly designed questionnaire will lead to inadequate data, which constitutes a waste of resources. There are experts that know how to develop the content of a questionnaire and what the criteria are to define the variables, questions, answer options, format and instructions either for interviewers or self-administered questionnaires. Thus, it is crucial to assemble a highly qualified team to take charge of designing the questionnaire.

This section presents key aspects and clues to take into account when designing a questionnaire. First, the design of the questionnaire depends on "setting the stage" for respondents to answer the survey in a reliable and valid manner. Second, the process not only entails design or adapting a set of questions as cognitive interviews and piloting (or pretesting the questionnaire) represent important phases to implement before reaching the final version. Cognitive interviews enable us to explore meanings and respondents' interpretations, along with checking the effectiveness of criteria to cross-nationally adapt questionnaires. Feedback and review from the network of specialists and professionals will crosscut each of these elements.

For the main cognitive processes involved in questionnaire answering (see **Figure 5**), since that stage involves taking care of specific aspects to assure questionnaire quality, it is worth considering the respondent´s:

- **Comprehension:** Understanding and interpretation of questions;
- **Recall:** Retrieving relevant information from memory;
- **Judgement:** Judging the retrieved information;
- **Response:** Communicating the final response, reporting this judgment by translating it to the offered answer options.

The design of a questionnaire not only includes the questions themselves, but also carefully planning on how the survey is introduced to the respondents, mainly to reduce bias in the answers and to avoid decreasing the respondent´s motivation. Answers can be affected by numerous contextual factors, such as question wording, item order and quantity of answer options, among other factors.

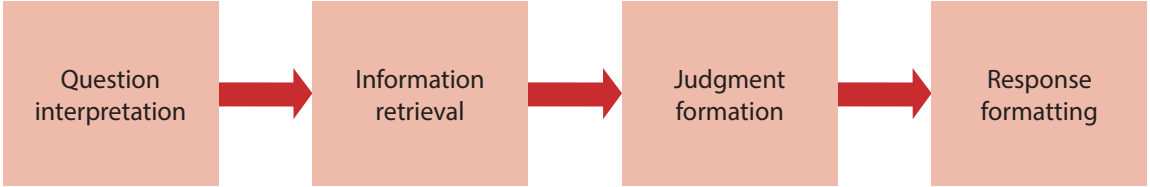
The introduction to a survey in general and in educational settings in particular, should both guarantee confidentiality to the respondent and foster accuracy and honesty in the answers. The guarantee of confidentiality should be made explicit to assure respondents that they will not be identified by anyone external to the survey. For principals, teachers and parents it may help to mention the national norms regarding data protection that the study follows.

Making confidentiality explicit is particularly relevant in the case of students. It is advisable to mention that their teachers, principals and parents will not have access to their answers. It is likely that children are embedded in a relationship of power with their teachers, principals, coordinators and guardians. If children believe that any of these authority figures may access their answers, they are likely to answer the survey to meet the expectations of such figures.

According to UNICEF (2014), a good practice regarding children is to directly ask them for their consent to participate in the survey, regardless of whether the local or national regulations require it or not. Doing so shows respect and acknowledges children's personhood, because genuine participation reaffirms their freedom to express their views in matters that affect them. It also promotes engagement and interest in their answers (see **Box 9**).

After clarifying that no one in their circle of influence will have access to their individual answers and personal information, it is necessary to foster accuracy and honesty by pointing out the voluntary nature of both the participation in the survey and of answering each particular question. The fact that someone consents to participate in the survey does not imply that they are compelled to answer each and every question in the questionnaire. However, it is central to overtly recognize the value and importance of each respondent´s answers, according to their role at schools: principals,

Figure 5. Basic stages involved in responding to a survey question



Source: Adapted from Sudman, S., Bradburn, N. M., & Schwarz, N. (1996).

Box 9. The special case of interviewing children

Even though less is known about interviewing children than adults, there has been methodological research on the topic and many agencies have proposed guidelines for the design of questionnaires that accommodate children as respondents. In this section, we will summarize the main points to take into account, based on the publication *Children as respondents: developing, evaluating and testing questionnaires for children* by Edith de Leeuw, Natacha Borgers and Astrid Strijbos-Smiths (2002), which portrays an integrative summary of recent research findings on children and surveys.

How young can a child be to be able to answer a survey? When are they old enough to answer the same type of questions an adult can?

Due to cognitive and social development reasons, age seven is generally considered the minimum age for a child to be able to validly answer a survey.

Children younger than age 7 years can be involved in research, however, the survey needs to resort to other methods to capture information, such as drawing, commenting on images or puzzle completion. Alternatively, research data on very young children can be obtained with mediation by their caretakers. However, it is not considered good practice to use proxies**,** such as in the case where caretakers report on children´s activities for children over an age in which they are able to answer for themselves.

Once children are seven years or above, they can answer a complete survey, as long as it is well designed and implemented with special care. Children aged 16 to 18 can typically answer the same questionnaire an adult can.

If a wide range of ages is included in the survey, it is advisable to design adapted versions of the same questionnaire according to age. As a rule of thumb, child questionnaires can be adapted for versions that target age groups 7-10 years, 11-15 years and 16-18 years.

Some developmental considerations influencing judgment: information integration and evaluation by children answering questionnaires.

In questionnaires for adults, attention must be paid to the influence on judgment stemming from social desirability. In the case of children, this presents an even more delicate issue. On one hand, up to age eight, children might assume that the adult "knows everything" and additionally, they might be afraid to provide a "wrong" answer. It is very important to make sure that the questionnaire does not conjure a school test scenario. The introduction of the questions should make it clear that there is no "right or wrong answer."

When it comes to early adolescence, an additional challenge should be considered. Children at this age are already capable of intentionally deceiving others. This is reflected both in non-response to certain items and in a tendency to answer what they believe is the socially expected option. There is evidence that more private data collecting techniques (such as CASI) in adolescents results in lower non-response to sensitive questions and fewer socially desired answers than other data collection methods.

Clues on design to facilitate reporting: child comprehension and selection of response options.

For adults, a maximum of five to seven response options are generally recommended (Krosnick & Fabrigar, 1997, as quoted in Leeuw, Borgers, & Strijbos-Smiths, 2002). For children, no more than two or three categories is adequate for those aged 7-10 years, and no more than four to five in late middle childhood and early adolescence. For late adolescents (16 years and older), one can use the adult number of categories. An exception is when using graphical rather than verbal response options. For example, sad to happy faces. Using graphic support allows for the slight amplification of the number of response options available while maintaining both motivation and understanding of the different options.

Labelling of response categories.

Clear labels improve the reliability of answers from adult respondents (Krosnick & Fabrigar, 1997), but they are more crucial for children for whom the logical and systematic thought necessary for interpolation of labels is still developing. Any ambiguity in labelling will negatively impact the data quality with a stronger impact seen on younger children.

teachers, students and families all have different stakes and opinions on ICT use in and schools. For example, principals may see ICT as part of an institutional strategy, while teachers may understand it as a tool for pedagogical activities and both may perceive different obstacles to achieve meaningful use.

Bear in mind that:

- In countries with more than one official language, a version of the questionnaire should be provided for each one.
- A portion of the population, which varies from country to country, will have difficulty in reading, writing, and/or hearing. Consider data collection options and resources to guarantee the participation of those individuals.

2.2.1. Cognitive interview and pilot

Since the survey's technique does not allow researchers to modify its content once the fieldwork stage has begun, checking the quality of the questionnaire beforehand in different socioeconomic settings significantly increases the likelihood that the questionnaire works once implemented.

In countries with large socioeconomic gaps such as Colombia, Brazil or Mozambique, some segments of the population are at the basic levels of their relation with ICT, while others have reached more complex ones. For example, in Brazil in 2015, Internet connectivity levels in the highest and lowest income quintiles were 78% and 44% respectively. In Colombia in 2016, Internet connectivity levels in the highest and lowest income quintile were 76% and 39% respectively (Galperín, 2017). It is crucial that question and answer options consider digital gaps.

A sound strategy to ascertain that the questionnaire captures the conditions of the various segments of the population is by identifying the respondents' interpretations of questions through cognitive interviews. Cognitive interviewing is a qualitative technique to help unravel the cognitive paths respondents use to answer the questionnaire and how they understand the concepts of the study (see Box 10).

Since its conception in the 80s, cognitive interviews have been useful to assess new questions and identify possible sources of error before administering questionnaires. They identify sensitivities to specific issues and ensure that questions are appropriate for the targeted population. Results of these interviews serve as inputs to review the questionnaire for

Box 10. Cognitive Interviews in the Regional Center of Studies for the Development of the Information Society (Cetic.br) in Brazil

Since 2009, Cetic.br has carried out cognitive interviews on ICT in households, ICT in education, ICT in health facilities, ICT Kids Online, ICT in Non-Profit Organizations and ICT Electronic Government questionnaires. Due to Brazil's vast social, economic and cultural diversity, cognitive interviews play an important role to ascertain that data collection tools apply nationally. Cetic.br has implemented four methods and six practical steps as general guidelines for cognitive interviews:

Methods:

1. **Concurrent or retrospective "think-aloud" interviews:** the respondent speaks their thoughts while answering questions or recalls their thoughts directly afterwards.
2. **Probing:** asking a follow-up question after each question or group of questions.
3. **Paraphrasing:** the respondent rephrases the question in his or her own terms.
4. **Definitions:** asking the respondent to explain key terms.

Practical steps:

1. Carry out at least 20 interviews for each questionnaire to ensure diversity of respondents.
2. Use controlled environments (e.g. mirrored room) as this has yielded good results.
3. Implement the interviews in two different phases, allowing different aspects to be evaluated in each phase and for a revised version of the questionnaire to be tested.
4. Use audio and video recording for further analysis.
5. Hire interviewers with experience in qualitative analysis. A psychology background is desirable.
6. Develop a sound process of documentation, including reports on each phase.

adequacy, clarity and comprehensibility of its content in particular social settings (Statistics Canada, 2010).

Once the final draft of the questionnaire is reached and right before confirming that it is the final version, it is crucial to run pilots simulating as many realistic implementation conditions as possible. Pilots test the flow of the questionnaire, assess its complexity and help register the time required for its completion. It is important to measure the average time respondents take to complete it to identify whether people tend to drop out, get distracted or provide inaccurate answers to finish the survey quickly. Usually, schools have schedules that the implementation of a survey may interrupt. This is a silent drawback of surveys in schools in general. Programming the survey and calculating the time that educational actors will need to answer the survey is crucial to define fieldwork logistics.

2.3 Sample design

This section of the guide seeks to familiarize non-specialist readers with good methodological practices and basic knowledge involved in sampling decisions. It is important to emphasize that sample design should be undertaken by statisticians with specific experience. However, any team carrying out a survey should be able to dialogue and understand the implications of the decisions to be made in order to participate as informed parties in the process of designing the sample.'

In general, sampling design refers to the selection and definition of the individuals that are going to answer the questionnaire. Doing so means defining the 'target population' and selecting the 'sample.'

There are cases in which drawing a sample is not only unnecessary but also unadvisable. When the target population is reduced in number, implementing a census is a better option. A census involves planning to interview each and every unit. This can be the case for very small countries, or small to middle-sized countries that choose to include only one level of their educational system in the study. This said, this section will focus on the probabilistic sampling approach to surveys, which covers most cases.

2.3.1 Target population

The target population are the units of analysis that will provide information through the survey. In other words, it answers the question "who are we interested in?" Units of analysis may refer to businesses, households, people, institutions (e.g. schools and hospitals), geographical units, artefacts (e.g. books and pictures) and social interactions (e.g. divorces) (Statistics Canada, 2010; Trochim, 2006). A survey on ICT in education is about schools, which comprises principals, teachers and students.

There are two important criteria to selecting the educational actors to be included in the survey. First, the individual is expected to be able to provide information about the school – i.e. at the organizational level. This means that the person must have thorough knowledge of the school, its infrastructure, policies and projects, as well as the main ICT issues affecting the school community. Second, the end-implementer of ICT in learning and teaching processes must always be included (i.e. the teachers). The inclusion of other actors, such as families or coordinators, depends on national educational systems and available resources.

Each implementing team chooses the role that complements principals' and teachers' insights. In some Latin American countries, for example, an ICT project coordinator is used. In Mexico, the supervisor is a key actor. Families are important members of the school community as well and should be included in the survey if there are enough resources to do so.

2.3.2 The sample

A sample is a group of units of analysis representing the whole population to which they belong. The units of analysis are the part of the population from which information is going to be collected. The objective is to obtain measurements from the group of units to further draw conclusions about the population as a whole (Weiss, 1999).

There are two types of sampling methods, non-probability and probability sampling. It is strongly advised that sample selection adopts probability sampling. It is statistically accepted as it provides estimates of the sampling error and confidence intervals. Findings and results can be generalized only if probability sampling was implemented to select the units of analysis. Likewise, selecting the sample of the units of analysis involves four elements: survey frame, sampling method, sample size and sample allocation.

The survey frame allows for the identification and contact of respondents (Statistics Canada, 2010). It is a list of all units of the target population or a list of the clusters (i.e. schools) of the population units. This means that the survey frame either lists on a roster all schools, including the contact information of principals, teachers, students and, if included, students' parents; or it lists only schools without details on the principals and remaining educational actors.

Ministries of Education are the usual institutions that provide the official updated list of schools. Alternatively,

this can be provided by another national-level educational authority that updates such registers. Ministries of Education are usually in charge of keeping track of the educational institutions in the national territory with the objective of guaranteeing compliance with minimum quality levels, legal requirements and equity in access. It is crucial that countries commit to updating, taking care of the registry quality and publishing them. These rosters are a key prerequisite to developing sample frames and, hence, survey results with good statistical quality.

Despite the importance of having up-to-date national lists of schools and its key actors, it is possible to design a representative survey without them available. In these cases, it is necessary to combine the official information available along with alternative and reliable information to reconstruct the missing data. This process must guarantee that the entire target population has a positive probability of being selected in the sample. For example, one option to complement missing data is to list the schools at small administrative levels (municipalities, counties, etc.) that cover the entire target population of the survey. Still, the drawbacks of complementing official information with other sources include:

- High cost
- It will not be as legitimate as official lists
- There is high risk for the list not to be exhaustive or accurate

Although these drawbacks should be taken into account, ultimately, building a list of units of analysis is a valid and necessary solution when there is no official survey frame available.

The next step is to identify the sampling method to select the units of analysis. **Table 5** summarizes the advantages and disadvantages of four sampling methods: Simple Random Sampling (SRS), Cluster Sampling, Stratified Sampling and Multistage Stratified Cluster Sampling.

In particular, SRS is unusual in nationally representative surveys as it requires a survey frame that contains all units of the target population. As every unit is equally likely to be chosen, this method yields a highly spread sampling distribution, which increases fieldwork costs. Thus, in the field of research on education, the common method is multistage stratified cluster sampling, which combines both cluster and stratified sampling.

- Cluster sampling randomly selects clusters (i.e. schools) and then randomly selects individuals (i.e. principals, teachers and students) from each school. This facilitates putting together the survey frame. It is easier to have a complete list of schools rather than a complete roster of individuals; and it is only required to possess a list of principals, teachers and students of the already selected schools. Additionally, this process lowers fieldwork costs as it controls the distribution of the sample. Nonetheless, the units of analysis within the same cluster are likely to have similar characteristics, which increases sample error compared to the SRS method.
- Stratified sampling makes up for the sample error generated with cluster sampling. Stratified sampling takes into account the strata of interest within the universe of study – for instance, geographical regions in extensive countries, such as Brazil (see **Box 11**). This method ensures that the selection of the sample covers the strata of interest, so units of analysis are not as alike as in cluster sampling and the final sample is as representative as possible of the socioeconomic context.

Sample size is the third element to consider (see **Box 12**): how many principals, teachers and students should the survey reach so that it is representative of the universe of study? The answer depends on whether it is a sample with or without replacement,[11] what resources are available (financial, human, technical, operational and time) and the desired quality of estimates for key indicators to be produced by the survey.

Box 11. Strata (or domains) of interest for analysis and dissemination

Before the sample selection begins, it is crucial to define what strata or domains of interest are key to have a representative survey of a particular national context. These strata define the variables by which the results will be presented and, at the same time, they represent inputs that can be used to define sample size and design.

For example, Simce-TIC is a test that evaluates ICT skills for learning in second grade students in Chile and is stratified by region and administrative dependency. This stratification, ultimately, depends on the resources available to carry out the survey (Enlaces website).

[11] A sample with replacement means that it is possible for a unit of analysis to be selected more than once – i.e. the respondent answers the survey more than once. Regarding the aims of having precise results and operationally convenient samples, it is a better option to have sampling without replacement (Statistics Canada, 2010).

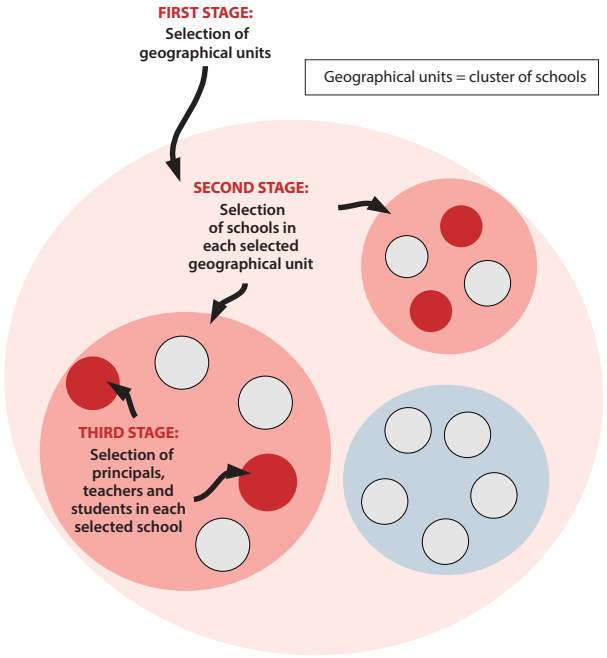
Table 5. Sampling methods: advantages and disadvantages

Sampling methods	Advantages	Disadvantages
Simple Random Sampling (SRS)	All units have the same probability of being selected. The survey frame (and contact information) is the only data required to draw the sample.	Does not use auxiliary information, which could lower the efficiency of the estimates. The sampling distribution tends to be large. It increases fieldwork costs. A complete list of the target population may not be available.
Cluster Sampling	Lowers data collection costs. More likely that there is a list of entities that group the target population, as in the case of schools.	Units inside a cluster have very similar characteristics, which increases sample error relative to SRS. It is hard to know the sample size in advance. Usually, there is no information on the size of the cluster before the survey.
Stratified Sampling	More efficient than SRS. Improves the quality of the estimates compared to cluster sampling as the units in various strata are more different. Restricts possible samples to ensure that particular population segments are represented in the sample.	Requires high-quality auxiliary information for all the units on the frame, which increases the costs. Its estimation is more complex than that of SRS.
Multistage Stratified Cluster Sampling	Combines stratification and cluster sampling. Lower cost than that of SRS. Does not require a list of all the units.	Usually less statistically efficient than SRS. The calculation of estimates and sampling variance can be complex. The planning of the survey can be complex.

Source: Adapted from Statistics Canada (2010).

Box 12. Sample selection stages in the Brazilian ICT in Education survey (Cetic.br)

The complexity of the Brazilian survey reflects the size of the country, its complex geographical characteristics, its socioeconomic disparities and the frames available. The ICT in Education survey sampling design uses three-stage stratified cluster sampling. The population target units are stratified into five geographical regions and the state capitals. The selection of the sample in each region is done in three stages.



Among the factors that impact sample size are:

- For a given sampling methodology, a greater level of detail in output requires a higher sample size. For example, if you need to present your data just on a national level, you will need a smaller sample size than if you need to present the data by each region or state in your country.
- Oversampling to compensate for non-response is commonly practiced. For example, if you need to reach 1,000 teachers, you may sample 1,100, taking into account that, most likely, you will not reach 100% of them.
- For a given sampling methodology, sample sizes need to be higher where a greater degree of reliability or confidence is required. For example, when calculating unemployment or price inflation rates, it is not feasible to present the data with a high margin of error. In other cases, such as the case of ICT in education data, the margin of error will most likely depend on the policy information requirements and the resources available.

There are equal and unequal probabilities. The former means that every unit of analysis has the same likelihood of participating in the survey. On the contrary, the latter considers particularities or additional criteria, such as resources available to reach units of analysis located in remote geographic areas, such as rural schools. It is important to consider the characteristics of all possible units of analysis. For instance, excluding remote schools yields non-representative samples. However, in the face of limited resources, one option is to assign a lower probability of being randomly selected to these schools.

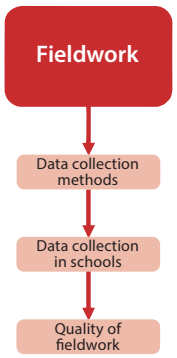
Finally, the desired quality of estimates for key indicators is determined by the sampling error. The larger the sample, the smaller we expect such errors to be. The more observations in the sample, the closer the estimation gets to the real mean of the target population.

The last element is sample allocation. In education, Multistage Stratified Cluster Sampling is recommended. It is, therefore, imperative to identify how the sample is distributed across strata of interest.

The sample size in each stratum must consider informational needs, costs and expected accuracy of estimates per stratum. In particular, when the goal is to produce national estimates, a feasible option is to allocate a sample proportionate to the number of schools. However, for ICT in education, national estimates alone are not enough to effectively inform policymaking. Thus, if the objective is to disaggregate the data by region or other stratum of interest, there are requirements that apply to ensure representation. To calculate the sample allocation, in this instance, each stratum should be viewed as a distinct population. This procedure of stratification is also better suited to represent less populated areas. Proportionate allocation typically renders samples too small to be representative of such areas, which hinders meeting the stratum-level accuracy requirements.

3. Fieldwork

Figure 6. Steps for fieldwork



3.1 Data collection methods

Data collection refers to the process of gathering information that will answer a research question (see **Figure 6**). The decision on how to collect the data (i.e. data collection method) is crucial in terms of budget constraints and data quality. The development of new data collection methods has largely been associated with the introduction of ICT into the survey process (Groves et al., 2009). Thus, the collection of survey data may widely vary. It may combine different methodological approaches as well as mixed designs to reduce costs and errors.

One of the main distinctions among data collection methods is between those that rely on an interviewer and those in which the respondent answers a questionnaire autonomously.

Among interviewer-assisted methods are paper-and-pencil personal interviewing (PAPI), computer-assisted personal interviewing (CAPI) and computer-assisted telephone interviewing (CATI). These methods usually render good response rates, but involve elevated costs. Among the self-administered methods (i.e. no interaction with interviewers to answer the questions) are computer-assisted self-interviewing (CASI), computer-assisted web interviewing (CAWI) and self-administered paper questionnaires (SAQ). These methods simplify the collection of sensitive data, but their response rates are typically lower than those of the interviewer-assisted ones and demand particular levels of literacy. **Table 6** summarizes the disadvantages and advantages of interviewer-assisted and self-administered data collection methods.

The device used to communicate with respondents and to register answers (paper-and-pencil, computers, tablets, telephone) shall be selected according to the socioeconomic characteristics of the population segments, budget and advantages and disadvantages of the specific methods.

According to such advantages and disadvantages, there are potential risks of biasing the estimators by privileging the participation of particular population segments. For example, data collection methods that require digital devices and Internet access tend to underrepresent schools with poor ICT infrastructure.

Also, when implementing surveys in schools, it is necessary to acknowledge that different population segments have different literacy rates. It is crucial to consider whether to rely on an interviewer who will read and may eventually re-read the questions, or if questionnaires are clear enough for respondents to answer them without assistance (see section 2.2.1). A third option is to use more than one method that facilitates reaching specific populations. Research has shown that data collection methods that include both visual cues and audio representation are useful to keep children's attention and overcome literacy-related issues (Borgers, de Leeuw, & Hox, 2000).

There is evidence that people strive for social desirability when answering surveys because they tend to feel observed and judged. For example, a renowned policy on ICT and Education may pressure teachers to overestimate their use of digital devices, instead

Table 6. Data collection methods: advantages and disadvantages

<table>
<tr><th colspan="6">General Methods</th></tr>
<tr><th colspan="3">Interviewer-assisted Methods</th><th colspan="3">Self-administered Methods</th></tr>
<tr><td colspan="6">Disadvantages</td></tr>
<tr><td colspan="3">• Higher costs</td><td colspan="3">• Higher response errors and nonresponse.
• Require complete list of individuals to interview.
• More time needed for data collection.</td></tr>
<tr><td colspan="6">Advantages</td></tr>
<tr><td colspan="3">• Lower response errors and nonresponse.
• Less time needed for data collection.
• Able to reach populations with low literacy rates.</td><td colspan="3">• Lower costs.
• Anonymity: easier collection of sensitive data.</td></tr>
<tr><td colspan="6">Specific Methods</td></tr>
<tr><td>PAPI
Paper-and-pencil personal interviewing</td><td>CAPI
Computer-assisted personal interviewing</td><td>CATI
Computer-assisted telephone interviewing</td><td>CASI
Computer-assisted self-interviewing</td><td>CAWI
Computer-assisted web interviewing</td><td>SAQ
Self-administered paper questionnaires</td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Interviewers ask questions face-to-face using paper questionnaires</td><td>Interviewers ask questions face-to-face using digital devices</td><td>Interviewers ask questions by phone using digital devices</td><td>Respondents receive a digital device to fill the survey out on their own</td><td>Respondents use an Internet browser to fill the survey out on their own</td><td>Respondents receive paper questionnaires to fill them out on their own</td></tr>
<tr><td colspan="6">Disadvantages</td></tr>
<tr><td>Slower than CAPI</td><td>Costly</td><td>Lower response rate compared to PAPI and CAPI</td><td colspan="2">Not all respondents have access to the necessary equipment to answer the survey</td><td>High demand of manual work for data collection</td></tr>
<tr><td colspan="6">Advantages</td></tr>
<tr><td colspan="2">• Highest response rates.
• Does not require the complete list of individuals to interview.
• Best options if the literacy rate of the population is low or any language barriers are in place.
• Allows the use of additional material (graphics, diagrams) and observation of the respondent.</td><td colspan="2">• Easier quality control.
• Fastest data collection.
• Anonymity.
• Easier logistics than PAPI and CAPI.</td><td colspan="2">• Faster data capture and processing than SAQ.
• Better quality data than SAQ.</td><td>Lower costs than CASI and CAWI.</td></tr>
</table>

Source: Own elaboration based on Statistics Canada (2010).

of mentioning the difficulties they could have had integrating ICT in their teaching practices. Moreover, face-to-face interviews have proven unsuitable to collect data on sensitive topics, including illicit drug use, violence and abortion (Tourangeau & Ting, 2007). Thus, the presence of interviewers may likely hinder answers on sensitive topics.

One way to reduce "social desirability" bias is by increasing privacy. To do so, social researchers suggest the use of self-administered methods, such as CASI, CAWI (see **Box 13**) and SAQ instead of interviewer-assisted methods. However, it depends on the intent to collect sensitive data, whether or not it is part of the survey objectives.

Another aspect to consider in the school setting is the contact information survey frames contain. It is unlikely that these rosters include telephone numbers or any other individual-level contact information for teachers and students, which can rule out certain options. In this instance, CATI is ruled out as the main data collection method. In particular, principals are the most likely to be contacted by phone, but there are schools located in remote areas without access to telephone lines.

All the decisions mentioned here are, in turn, conditional on resource constraints. What are the best options according to the available resources? This decision is made, to a large extent, in relation to the available time frame and the fixed and variable costs of the data collection methods. In essence, this decision should take into consideration:

- The time frame of the survey, which allows for a limited maximum possible length for data collection. CATI and CAWI demand shorter periods than PAPI, due to PAPI's requirements for travel.
- Fixed costs that include developing, pre-testing and programming the questionnaire or the data entry templates.
- Variable costs that include contacting and interviewing all sample cases and retraining interviewers who exhibit poor performance during the implementation of the questionnaires.

Usually, PAPI methods show inflated variable costs. A great part of their costs encompass training, hiring and travel expenses of fieldwork staff (i.e. interviewers, coordinators, quality control personnel). In contrast, CAPI's fixed costs are elevated as these include programming the questionnaire (interface design, data exporting and validation) and the acquisition and maintenance of digital devices (see section 3.3.2).

3.1.2 Paper-based self-administered surveys in schools

Even though self-administered paper-based surveys may seem like a complicated and even outdated method when compared to any data collection method assisted by a computer, they can constitute an interesting and valid alternative in the specific context of schools. Even though sending paper questionnaires to households will most likely yield low response rates, sending them to schools with the legitimation of district or national educational authorities and the support from school principals, can be an effective way of collecting data on ICT use in schools.

Among the main advantages of this data collection method is the fact that schools in most countries are familiar with the procedure as they might have already participated in learning assessments and/or school censuses. Additionally, self-administered questionnaires can be completed in whatever fragments of time teachers and principal can spare throughout the school day. In the case of students, children are more likely to be familiar with writing on paper than with being interviewed by an unknown person and perhaps much less with filling a form on a computer. Finally, this method does not introduce bias originating from differing access to the Internet.

On the other hand, some of the disadvantages of self-administered paper-based questionnaires are that inconsistency in the answers and non-answered items are more likely than in other methods. This pitfall can be compensated for by grouping the respondents and providing a monitor who can help clear doubts and assist individuals with difficulty reading or writing. Once the form is complete, as in any paper-based questionnaire, a longer period of data entry is necessary. Costs associated with printing, sending and receiving questionnaires as well as the use of data editing and data entry personnel are also higher than in any method assisted by computers.

These advantages and disadvantages need to be weighed by the research teams considering each application context. It is worth mentioning that there are several examples of the use of this method for ICT in schools surveys in the Latin American region (e.g. in Argentina, Uruguay and Mexico).

3.1.3 Creating the database

Once the questionnaire is ready and the data collection method has been chosen, it will be time to decide how to turn the information from the survey into organized data. To organize and systematize the data, it is necessary to

Box 13. Web surveys

As seen in Table 6, when comparing data collection methods in, it can be very tempting to consider a web survey as this entails:

- Lower cost of implementation (mainly due to the need not to hire interviewers).
- The fastest fieldwork timeframe.
- Automated skipping.
- Automatic data entry (unless opting to offer the questionnaire as a pdf).
- The possibility of adding resources rich in visuals.

However, it is important to consider some common pitfalls to web surveys and how to compensate for them:

- Only those who can access the Internet will receive the questionnaire. This can be a source of considerable bias.
  - ♦ This can be compensated for by using other data collection methods to ensure the participation of those who cannot access the Internet.
    - *It is necessary to ensure that the sample is drawn from the whole target population.*
    - *Even though different data collection methods yield slightly different answers, this methodological challenge has to be weighed against the biggest problem – biased participation in the survey.*
- Web surveys tend to present lower response rates.
  - ♦ In the case of schools, however, it is possible to try to neutralize this pitfall using coping strategies, such as:
    - *Phone calling the schools to follow up on the answering process (this is more difficult to implement with households).*
    - *Getting support from the school district authorities or ministry of education, so that they advocate that schools participate in the survey.*
- Participants review a slightly altered questionnaire due to the use of different devices (desktop computer, cell phone, tablet, etc.), the use of different browsers, different colour settings, etc.
  - ♦ This discrepancy can be avoided by sending a pdf via email.
    - *Pdf -based surveys, however, do not allow for automated skipping and they also make it more difficult to automatically create a database.*

As it stands, any methodological decision entails weighing the benefits against the pitfalls in a given context. Every implementing team should consider these options while weighing them against informed knowledge of the local context and culture.

When is a web survey an optimal alternative?

It can be a very good option for countries with a strong ICT policy (i.e.: where there are school labs or laptops widely available and where Internet access is widespread). This is the case, for example, in some Latin American countries, such as Uruguay, Argentina, Chile and Costa Rica.

- ♦ Even in those cases, strong support from the authorities is needed to gain the support of school principals to ensure school participation in the survey.
- ♦ Additionally, it might be necessary, in these cases as well, to put in place follow-up mechanisms, such as a telephonic contact.
- ♦ An interesting option could be the presence of a person who may monitor the completion of a web questionnaire with students or teachers organized into groups within the same room, institutional conditions permitting.

enter data into a template in which each survey question relates to a variable and each survey answer translates to a code under the corresponding variable.

For paper-and-pencil data collection methods, there is a special group of interviewers who take charge of entering data into templates. They create the database that will be used to calculate the indicators. So, the chosen software should facilitate typing answers from paper to the computer. In contrast, when working with computer-assisted methods, when surveyors register answers the software automatically generates the dataset.

There are several options to develop data entry templates and databases. Epi Info™ (www.cdc.gov) and CSPro (www.census.gov) are two examples of free applications. It is desirable that the software includes the option of running automatic consistency checks of entered data. This serves to control for typos and answers that do not make sense (e.g. the system sends a notification if someone enters an age that is a three-number figure). Basic consistency checks involves filters of the survey itself (e.g. if a teacher registers not to implement ICT resources in her lessons, she should not answer questions on weekly hours of Internet use in her teaching activities).

3.2 Collecting data in schools

Collecting data in schools entails a series of particularities that need to be taken into consideration when preparing the survey implementation. Once all the content, research questions and design of the project are ready, an ethics committee is expected to approve the project. At this point of the implementation, fieldwork starts to get more concrete. The most important procedures are obtaining authorization to collect data from minors and negotiating with the schools for them to invest time to participate in an extracurricular activity (i.e. the survey).

As schools are responsible for the protection of minors, authorization to collect data from students involves a series of formal and official procedures. It encompasses three levels of authorizations.

First, it is necessary to approach the authorities in charge of overseeing educational institutions. Research teams must count on the support of an official institution. In Colombia, for example, it is a requisite to directly coordinate with the Secretaries of Education, even if the Ministry of Education has already supported the data collection exercise. Obtaining a recommendation or introduction letter for the project and the research team is one strategy to facilitate the entry into the schools.

Second, students' families, guardians or tutors should be notified and grant permission for the students to participate in the activity. Thus, fieldwork will encompass sending an official communication to students' families and awaiting their response. The notification is done depending on the official channels of communication between the educational authorities and guardians. There are some contexts where this is not necessary, according to the particular regulations.

Finally, it is indispensable to explicitly and directly ask for the consent of the respondents. Not only students, but teachers and principals are expected to express their will to participate and provide their personal information, experience and opinions. For ethical reasons, individuals have the liberty to refuse to participate in a research activity, even after already beginning to answer the questionnaire. Thus, researchers and fieldwork staff should be ready to answer any doubts that respondents have (see **Box 14**). In general, respondents refuse to participate due to a lack of awareness of the usefulness of the research, an overload of activities (i.e. too many surveys, qualitative interviews and participation in research at the school) or a lack of feedback from previous researchers and data collection exercises.

A typical obstacle when collecting data in schools is insufficient time due to the amount of school core activities. Usually, students are taking official tests, teachers are preparing special events and administrative staff is working on urgent and pressing tasks. Incorporating an additional activity that takes time away from teaching and learning activities must be well justified.

Before entering into the particularities of administering surveys in schools, raising awareness for the survey and its goals increases the likelihood of the school community participating in the data collection and helps to decrease nonresponse bias. Awareness of the survey could be delivered as trainings or campaigns with principals, teachers and parents, if included.

3.3 Quality of fieldwork

The following steps show the relevant decisions in terms of training to guarantee that all the conceptual and content-related definitions of the questionnaire translate to useful and accurate survey data. These steps encompass choosing the implementing partner, training fieldwork staff and monitoring the quality of the data collection process.

3.3.1 Implementing partners

Research teams have the option of directly carrying out fieldwork, contracting a survey firm or universities, or partnering with an office that may already carry out surveys within school settings. Each of these options has advantages and disadvantages (see **Table 7**).

Box 14. Example of ethical standards in research with children

There are 16 principles that the Society for Research in Child Development applies when performing research with children.

1. Non-harmful procedures

The investigator should use no research procedure that may harm the child either physically or psychologically. The investigator is also obligated at all times to use the least stressful research procedure whenever possible.

2. Informed consent

The investigator should inform the child of all features of the research that may affect his or her willingness to participate and should answer the child's questions in terms appropriate to the child's comprehension.

3. Parental consent

The informed consent of parents, legal guardians or those who act in loco parentis (e.g., teachers, superintendents of institutions) similarly should be obtained, preferably in writing.

4. Additional consent

The informed consent of any persons, such as schoolteachers for example, whose interaction with the child is the subject of the study should also be obtained.

5. Incentives

Incentives to participate in a research project must be fair and must not unduly exceed the range of incentives that the child normally experiences.

6. Deception

Whenever withholding information or deception is judged to be essential to the conduct of the study, the investigator should satisfy research colleagues that such judgment is correct.

7. Anonymity

Anonymity of the information should be preserved, and no information used other than that for which permission was obtained.

8. Mutual responsibilities

There should be clear agreement between the investigator and the parents, guardians or those who act in loco parentis and the child, when appropriate, that defines the responsibilities of each.

9. Jeopardy

When, in the course of research, information comes to the investigator's attention that may jeopardize the child's well-being, the investigator has a responsibility to discuss the information with the parents or guardians and with those expert in the field in order that they may arrange the necessary assistance for the child.

10. Unforeseen consequences

The investigator should immediately employ appropriate measures to correct these consequences.

11. Confidentiality

The investigator should keep in confidence all information obtained about research participants.

12. Informing participants

Immediately after the data are collected, the investigator should clarify for the research participant any misconceptions that may have arisen.

13. Reporting results

Because the investigator's words may carry unintended weight with parents and children, caution should be exercised in reporting results, making evaluative statements, or giving advice.

14. Implications of findings

Investigators should be mindful of the social, political and human implications of their research and should be especially careful in the presentation of findings from the research.

15. Scientific misconduct

The Society shall provide vigorous leadership in the pursuit of scientific investigation that is based on the integrity of the investigator and the honesty of research and will not tolerate the presence of scientific misconduct among its members.

16. Personal misconduct

Personal misconduct that results in a criminal conviction of a felony may be sufficient grounds for a member's expulsion from the Society.

Source: Adapted from the Society for Research in Child Development (2007).

Table 7. Advantages and disadvantages of outsourcing fieldwork

Advantages	Disadvantages
• Better for extensive data collections. • Data collection is faster than doing it directly. • Requires less work from the research office. • Ensures a qualified team for data collection. • Ensures neutrality and increases credibility of the results.	• Typically more expensive than doing the survey directly. • Requires supervision of the survey firm to ensure data quality. • The survey firm may not understand the research.

Source: Own elaboration based on (Hempel & Fiala, 2011).

When hiring a survey firm or a university, the research team needs to define its involvement in the fieldwork. This can range from defining and controlling the product's quality criteria, in which case the contracted institution takes charge of everything in the field, to actively participating and closely monitoring all the stages of the implementation.

Given the particular nature of administering surveys in educational institutions, the implementing team needs to demonstrate experience working with children, teenagers and school communities in general.

In the case of using computer-assisted data collection methods, the research team should also consider, along with the implementing partner, the conditions for the latter to deliver the datasets. In the case of using paper-and-pencil methods, the research team should define how data entry is going to be developed, whether through directly hiring interviewers or subcontracting a firm.

3.3.2 Interviewer training

This subsection relates to face-to-face or personal interviewing surveys. The main objective of interviewer training is to guarantee uniformity and understanding of survey concepts across interviewers, interviewees and supervisors (Statistics Canada, 2010). Thus, after choosing who will manage the survey implementation in the field, it will be time to set the guidelines, content and methodology to train fieldwork staff.

First, the definition of the interviewer guidelines must align with the ethical principles to perform research projects with minors (see Box 14) and the particularities of collecting data in schools (see section 2.3.2). For instance, when working in schools interviewers may face unexpected events that may interrupt survey administration.

Second, the definition of training methodology is done, which encompasses survey manuals, information to present during training and exercises for interviewers to practice. The training methodology includes the activities and methods for interviewers to familiarize themselves with the questionnaire, its concepts, the objective of the research and how to use the manual when they face doubts. Survey manuals are essential as they are the main source of reference and consultation for interviewers once they start working in the field. A vital component of training is to acknowledge the key role that interviewers hold in research. If they perform poorly, register wrong answers or do not follow guidelines to avoid non-responses, the data will yield inaccurate information. Finally, well-executed trainings always include practical exercises that encourage interviewers to read the questions out loud and clear any doubts in the moment.

Lastly, interviewer selection method entails the final decision on who will be going to the schools. There should be clear criteria to define what constitutes a good interviewer. For example, performance in quizzes on the content of the survey, body language during role-play exercises and appropriate language style to converse with educational actors (i.e. minors, teachers and administrative staff) should be carefully evaluated.

3.3.3 Quality control

As the survey team is collecting data, the research team accompanies and monitors this step. The degree of involvement is conditional on the agreements between the research team and the implementing partner. Quality control is an ongoing process that starts in the beginning of the fieldwork. Its main objective is to preserve the representativeness of the survey.

Quality control involves three main areas: accompaniment to surveyors, review of filled-in questionnaires and the periodical review of databases. Administering a survey is a learning process in which surveyors get used to the questionnaire content, skips and language. Personal accompaniment and feedback sessions after the first rounds of surveys are useful to help identify potential sources of error. These interventions help expedite the process so data are collected uniformly and efficiently.

Random checks of questionnaires with answers are vital for paper-and-pencil interviewing. Reading randomly chosen questionnaires helps the research team identify whether answers make sense and

follow the instructions. Lastly, the periodical review of databases enables the detection of missing values, inconsistencies, or biases in non-respondents, which will require immediate correction.

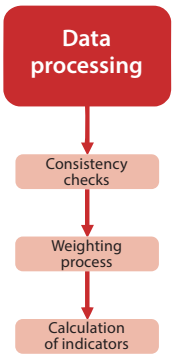
Identifying potential sources of error while collecting data guarantees both that the final product meets quality control criteria and that data are accurate and appropriate to calculate relevant and precise indicators.

4. Data processing

This third phase of survey implementation entails calculating selected core and optional indicators. Consistent datasets, correctly formatted data and quantitative representation of respondents are requirements to calculate indicators (see **Figure 7**). This means that before knowing what the survey reveals about access, use and ICT skills, it is necessary to perform consistency checks and the weighting process.

4.1 Consistency checks

Figure 7. Steps for data processing



Before the calculation of indicators, answers registered from all questionnaires require a consistency check. Once the dataset is ready, the first step is to identify the quality of the variables and whether or not they follow quality criteria. It is necessary to check if codes are consistent and if they follow the correct format.

This step entails carrying out data cleaning. Statisticians and data scientists take charge of carrying this out according to the specifications that the research team established. These specifications, in general, define the nature of the variables, the data format needed to calculate the indicators and the instructions that surveyors would have had to follow when filling out questionnaires.

Two important inconsistencies that could jeopardize the quality of the data are missing values and quantitative discrepancies. Missing values reduce the amount of available data and can lead to misleading conclusions. If missing values follow a pattern (e.g. some questions are systematically more likely to have missing values), it means that information could have been sensitive, or the question was incorrectly asked. Quantitative discrepancies refer to numbers that are not logical. For example, if there are more students than the ones registered in total by the schools.

4.2 Weighting process

The weighting process refers to assigning the number of units from the target population that the selected unit in the sample represents. Each sample unit has a value greater than one, which is the inverse of its inclusion probability (Statistics Canada, 2010).

After identifying the quality of the data and their missing values, there will be some sample units that partial or totally did not answer the questionnaire. These units either explicitly refused to provide information or the interviewers encountered obstacles to reaching the selected school to administer the survey – for instance, due to of out-to-date survey frames (see section 2.3.2). Therefore, there are non-responses that will render obtaining a representative sample of the target population difficult. To avoid eroding representativeness, it is necessary to make non-response adjustments considering that:

- Non-respondents are likely to be systematically different from respondents, which will probably bias estimations.
- Non-responses reduce the sample size, which means that the sampling variance will increase and with it, precision of the estimates will decrease.

Nonresponse weight adjustment usually entails assuming that the responding units represent both responding and nonresponding units of the survey, so the design weight of the latter is distributed amongst the former. For further details please refer to *Weight Adjustment for Nonresponse in Statistics Canada* (2010).

Finally, whenever possible, it is useful to calibrate the sampling weights to have sample estimates that match known values in the target population. These values (e.g. number of teachers by region) are available in administrative data sources – such as the survey frame.

4.3 Calculation of indicators

The calculation of indicators is the final stage in data processing. The quality of the decisions and implementation of conceptual guidelines, survey design and content and fieldwork determines the validity and reliability of the indicators. The final product of this stage are the estimates of how schools, principals, teachers and students interact with ICT. It involves the production of statistical tables that show the estimation of total values, proportions and error margins for each of the indicators selected from the conceptual guideline and that in turn were included in the questionnaires.

The construction of the statistical tables is based on the sample design of the survey. There are several statistical software that serve this purpose, such as SPSS, Stata, R and Epi Info. Typically, in the development of statistical

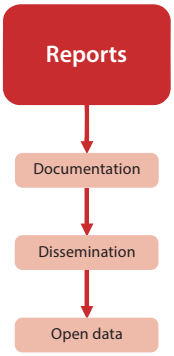
calculations, there is documentation of every step to estimate the indicators. According to the characteristics of the statistical software, data scientists produce logs of the estimation process.

5. Reports

5.1 Documentation

Good practice in research calls for thorough documentation of every survey step and phase (Statistics Canada, 2010) (see **Figure 8**). The purpose of this is to make the results available to the general and specialized public and enable feedback on findings and to guarantee the transparency and accountability of the research team. The documentation step includes policymakers, scholars, managers, data users, interviewers, methodologists and data analysts. The documentation of the survey consists of a set of technical documents clearly describing each phase of the survey process. It is advisable to have documentation on:

Figure 8. Steps to create the report



- **Methodology.** A methodological report contains concepts, definitions, description of the survey population, sample design and selection, design of data collection tools and data processing. In particular, regarding data processing, documentation is divided into three reports – one on consistency, one on the weighting process and another on the estimation of indicators.
- **Quality control.** This report focuses on presenting the results of the cognitive interviews and pilots that guarantee the quality of the questionnaire (i.e. its questions and answer options). This is also to document feedback and reviews from the network of specialists and to include fieldwork reports produced during the data collection phase. It is advisable to include survey manuals, reports on surveyors' performances in the field, the description of the survey project management, including activities and actions of supervisors, as well as specifications of applications, software and functionalities.
- **Data analysis.** This report contains coding, data file layout, description of the database (variables), tables, dictionary of the metadata and paradata. The Data Documentation Initiative (DDI) provides tools (codebooks, validators, software, among others) to standardize the description of the survey data.
- **Findings.** A survey report presents the main quantitative and qualitative findings, with corresponding tables and calculations.

5.2 Dissemination of results

Unlike academic research, the main objective of policy-related studies rests on the importance of its dissemination to inform decision making. The idea is for stakeholders and interested audiences to know the results and eventually, demand more of them.

The dissemination of results and findings legitimizes the study as well as any future attempts to repeat the exercise. According to good practices, the first audience to know what the research team found should be survey participants. Often, schools and their communities consider that researchers gather information from them, but do not return results and implications for their practices.

Preparing this stage of the survey implementation entails the research team discussing and validating interpretations of quantitative and methodological findings as well as the study's strengths and weaknesses before deciding what shall be published based on the robustness of findings (see **Table 8**). Including the network of specialists and professionals in discussions and decisions on dissemination, enriches messages and relevance of the content.

A key strategy to reach a wider audience is to form alliances with members of the network of specialists and professionals. As members include international participants as well, this network holds the potential to disseminate the survey findings to audiences that are interested in the study, but to whom the research team are not directly connected (see **Box 15**).

As this *Practical Guide* suggests across all the previous stages in the implementation process, it is necessary to identify the steps to carry out a high-quality dissemination of results. Section 5.3 on open data shows the most relevant questions that a research team needs to answer to plan the dissemination of results. The section includes three separate examples with survey participants, educational authorities that supported the study and scholars.

Table 8. Relevant questions to define the dissemination of results and findings of the study

What are the main audiences?	What are the suitable dissemination activities?	What are the main messages?	What is the appropriate language to use?	What is the main dissemination product?
Survey participants	Report for each school with aggregated results	How schools are doing in each of the indicators and what results were interesting	In terms of pedagogical matters	Report
Educational authorities that supported the study	Meeting between main researchers and institutional representatives	Policy implications and recommendations to improve the efficiency of policies, programs and investments	In terms of issues relevant to areas for current policies in ICT in education	Policy paper
Scholars	Academic conferences	Statistical significance and validity of quantitative results	Technical and conceptual terms	Academic article

Source: Cetic.br.

Box 15. Example of alliances to show survey results in Colombia

Fedesarrollo, a Colombian think tank, carried out a methodological study in 2015 and 2016 sponsored by the IDRC from Canada, whose results were presented in Santiago, Chile in 2016. The research team received an invitation from the members of the project's network of specialists from Enlaces (Ministry of Education of Chile) to participate in an international conference on ICT and Education. The presentation focused on the methodological findings regarding gender gaps in the use of ICT in 15 public schools in Colombia.

5.3 Open access data

The final step in terms of dissemination is to allow policy-makers, researchers and citizens in general to have open and free access to micro and metadata generated in the study. The data used to calculate indicators and draw conclusions from the surveys should be open, free and usable to guarantee methodological transparency. This also contributes to the production of knowledge and the generation of new data through consumer feedback.

In education, there are different kinds of data that will benefit many through open access. For example, data on topics that could enrich classroom activities, such as information on natural disasters and their consequences,[12] or data on teachers' performances to follow up teacher policies.[13] In the area of ICT, the UNESCO Institute for Statistics (UIS) and Cetic.br are examples of Open Data Sources (see **Box 16**).

According to the Open Knowledge Foundation Network (OKFN, 2019), there are four general tasks to make data open access. First, is to select the dataset that is intended to be open to the public. Second, to ensure both legal and technical openness. The former means to license all the intellectual property rights that exists in the data,[14] while the latter refers to bulk data and guarantees its format is machine-readable. Finally, people should be able to find the data. Thus, it is necessary to ensure that the data is easy to discover by publishing the dataset in catalogues such as DataHub. Thus, publishing open data entails a process or a data life cycle (see **Figure 9**). This refers to the steps to follow to publish an open dataset.

There is an ongoing debate on how to put into practice the process of publishing open data in terms of the characteristics and features involved. Consequently, there has been a process of standardization to improve communication between data producers and consumers that helps identify best practices (Corrales et al., 2018) (see **Table 9**).

[12] http://ourragingplanet.co.uk/

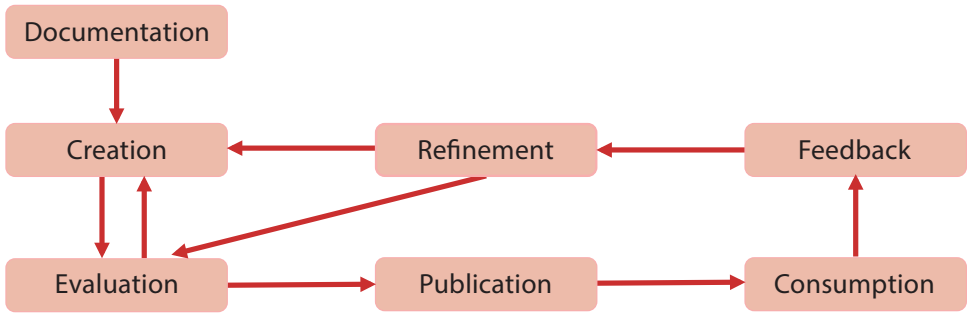
[13] http://siteresources.worldbank.org/EDUCATION/Resources/Vegasetal__Teacherpoliciesaroundtheworld.draft.pdf

[14] A list of licenses that can be used is posted at http://opendatahandbook.org/guide/en/how-to-open-up-data/

Box 16. Examples of open data sources on ICT in education

- UNESCO Institute for Statistics (UIS). Their open data base of statistics can be accessed at http://data.uis.unesco.org/
- Cetic.br´s open database can be accessed at http://data.cetic.br/cetic/explore?idPesquisa=TIC_EDU

Figure 9. Data life cycle



Preparation:	In this phase security, commercial sensitivity and personal data protection must be considered (Corrales, Burle, Macaya, & Jereissati, 2018).
Creation:	Data preparation for Web publication.
Evaluation:	Verification of the data that are going to be published. The result of this phase may send the team back to the 'creation' phase.
Publication:	This process can be done using data cataloging tools, such as the Comprehensive Knowledge Archive Network (CKAN) and Socrata or using an Application Programming Interface (APIs) (Corrales et al., 2018).
Consumption:	Consumers use the data available.
Feedback:	Consumers return comments on the data. This phase provides ways to improve on the available data and the opportunity to identify the necessity for new data.
Refinement:	Closes the circular data life cycle with maintenance, updating and new data generation.

Source: Adapted from Lóscio, Guimarães, Oliveira, & Calegari (2018).

6. Lessons learned

The last step to implement representative surveys on ICT use in Education refers to identifying how future versions of the same kind of survey either in the same place or in other locations could be improved based on the experience, results and processes of the current version of the study.

This is not only the task of the research team and fieldwork staff. It is key that the network of specialists and professionals participate in the review of results and methodology. Their critical assessment and reflections on potential items and elements to improve are vital for the research team to improve the quality of their implementation, the conceptual guidelines, questionnaires, indicators, training of the fieldwork staff and dissemination strategies.

Table 9. Best practices: publication and use of data on the Web

Dimension	Best practices
Metadata	Provide metadata
	Provide descriptive metadata
	Provide structural metadata
Data licenses	Provide data license information
Data provenance	Provide data provenance information
Data quality	Provide data quality information
Data versioning	Provide a version indicator
	Provide version history
Data identifiers	Use persistent URIs as identifiers of datasets
	Use persistent URIs as identifiers within datasets
	Assign URIs to dataset versions and series
Data formats	Use machine-readable standardized data formats
	Use locale-neutral data representations
	Provide data in multiple formats
Data vocabularies	Reuse vocabularies, preferably standardized ones
	Choose the right formalization level
Data access	Provide bulk download
	Provide subsets for large datasets
	Use content negotiation for data available in multiple formats
	Provide real-time access
	Provide up-to-date data
	Provide an explanation for data that is not available
	Make data available through an API
	Use Web Standards as the foundation of APIs
	Provide complete documentation for your API
	Avoid making changes to your API
Data preservation	Preserve identifiers
	Assess dataset coverage
Feedback	Gather feedback from data consumers
	Make feedback available
Data enrichment	Enrich data by generating new data
	Provide complementary presentations
Re-publication	Provide feedback to the original publisher
	Follow licensing terms
	Cite the original publication

Source: Adapted from Lóscio, Burle, & Calegari (2018).

III. INDICATORS: METHODOLOGICAL DATASHEETS

General remarks

The following technical datasheets contain the description of the access, use and ICT skills indicators. The description includes the indicator's name, definition, source, methodological clarifications and caveats, target population, time frame, disaggregation and classifications, calculation method and interpretation/ policy relevance.

Additionally, model questions and answer options are suggested for each indicator. The model questions presented have been put through cognitive interviews, pretested and are being used in existing questionnaires. However, it is important to bear in mind that they are model questions and do not constitute a questionnaire. Skips and filters between the questions as well as the addition of identification questions among other processes that yield a full applicable questionnaire are conditional to the process and questionnaire design, which needs to be developed by each implementing team.

Questions

The following technical datasheets describe each of the optional and core indicators proposed in the conceptual section of this *Practical Guide*.

- Every question includes the options "Does not know" and "Does not answer".
- Every question has the appropriate instructions to select the answer.
- Every question specifies the time frame of the information asked.
- Conditional on the type of answer options, some questions offer the option "Other. Please specify: _____" as the last choice.
  - In most cases, it is useful to include this option since the pre-established options rarely encompass all possible answers.
  - Offering this answer option is particularly important when a survey is being implemented for the first time in a given context, since it allows researchers to enrich the answer choices for the next round.

Operational definitions

- Digital device: it is a device that processes electronic signals (Bourgeois, 2014). Usually, digital devices refer to desktop computers, portable computers and tablets. In some cases, it also includes mobile phones.
- School's management and funding: indicate if the schools are managed by a public educational authority or government agency and the source of the funding (OECD, 2012).
- Socioeconomic Status (SES): categories that permit the grouping of individuals, households or organizations into groups according to their estimated level of socioeconomic wellbeing. SES can be calculated either based on internationally agreed or nationally defined criteria and it usually comprises the possession of a set of domestic goods and/or the educational level of key individuals and/or the occupation of the head of household. SES groups should at least be divided into high, medium and low SES.
- The Internet: it is a worldwide public computer network. It provides access to a number of communication services, including the World Wide Web and carries e-mail, news, entertainment and data files, irrespective of the device used. It is not assumed to be only via a computer as it may also be by mobile phone, tablet, DPA, game console, digital TV, etc.). Access can be via a fixed or mobile network, including wireless access at a Wi-Fi hotspot (ITU, 2014).
- Wi-Fi network: a technology that takes an Internet signal and converts it into radio waves. These radio waves can be picked up within a radius of approximately 65 feet by devices with a wireless adapter (Bourgeois, 2014).

A) Access indicators

CONTINUES ▶

A1. Average of working digital devices with Internet access, available for pedagogical use at schools, by type of digital device

Definition: The mean of working digital devices with Internet access available for effective use of the school community in pedagogical activities, i.e. activities directly or indirectly related to learning and teaching purposes. The number of digital devices available is disaggregated by type (desktop computers, portable computers and tablets).

Source: Cetic.br (2017)

Clarifications and methodological issues:

- This indicator excludes those devices that are out of order to avoid inflating data on access to digital devices.
- The respondent should answer questions Q1, Q2 and Q3 with the number of digital devices of each type (desktop computers, portable computers and tablets) available at school.
- The questions are related to each other. Q2 should be answered based on the answers to Q1 and Q3 on the answers to Q2.
- The main indicator calculates the average of working digital devices with Internet access available for pedagogical use. The proposed questions suppose having asked a previous question about whether the schools count on computers for pedagogical use at all, providing further detail about such availability.
- The complementary indicators calculate:
  - The average of working digital devices at schools.
  - The average of working digital devices with Internet access at schools.
- Once the data is collected through the three proposed questions, various different calculations can be made, depending on the complementary information available about the schools: either the indicator can be reported as a summary measure of the available devices in a country, or it can be related to the number of students enrolled in a given school shift, yielding the number of students per device. This measure, in turn, can be aggregated to subnational or national levels.

Target: Principals (or other school staff knowledgeable about ICT infrastructure).

Time frame: Date of the survey.

Model questions:

Question and answer options:

	Q1. How many _____ are currently working at this school?	Q2. Out of the _____ that are currently working, how many have Internet access at this school?	Q3. Out of the _____ that have Internet access, how many are available for students to use them in learning activities at this school?
a) Desktop computers.			
b) Portable computers.			
c) Tablets.			

Instructions: Write the number that corresponds to each type of digital device.

Disaggregation and classifications: Geographical region, school's management and funding and school size.

▶ CONTINUED

A1. Average of working digital devices with Internet access, available for pedagogical use at schools, by type of digital device

Calculation method:

Main indicator:

Using the answers of Q3:

$$A1_{DC} = \frac{\sum_{i \in S} AnsA_i}{S}$$

$$A1_{PC} = \frac{\sum_{i \in S} AnsB_i}{S}$$

$$A1_{T} = \frac{\sum_{i \in S} AnsC_i}{S}$$

i is the i^{th} school.

S is the total number of schools.

$AnsA_i$ is the answer of the i^{th} school to item a) of Question Q3. In other words, the number of working desktop computers with Internet access that are available for pedagogical use at the school.

$AnsB_i$ is the answer of the i^{th} school to item b) of Question Q3. In other words, the number of working portable computers with Internet access that are available for pedagogical use at the school.

$AnsC_i$ is the answer of the i^{th} school to item c) of Question Q3. In other words, the number of working tablets with Internet access that are available for pedagogical use at the school.

Complementary indicators:

Average of working digital devices at schools:

Using the answers of Q1:

$$A1Q1_{DC} = \frac{\sum_{i \in S} AnsA_i}{S}$$

$$A1Q1_{PC} = \frac{\sum_{i \in S} AnsB_i}{S}$$

$$A1Q1_{T} = \frac{\sum_{i \in S} AnsC_i}{S}$$

Where:

i is the i^{th} school.

S is the total number of schools.

$AnsA_i$ is the answer of the i^{th} school to item a) of Question Q1. In other words, the number of working desktop computers at the school.

$AnsB_i$ is the answer of the i^{th} school to item b) of Question Q1. In other words, the number of working portable computers at the school.

$AnsC_i$ is the answer of the i^{th} school to item c) of Question Q1. In other words, the number of working tablets at the school.

▶ CONTINUED

A1. Average of working digital devices with Internet access, available for pedagogical use at schools, by type of digital device

Average of working digital devices with Internet access at schools:

Using the answers of Q2:

$$A1Q2_{DC} = \frac{\sum_{i \in S} AnsA_i}{S}$$

$$A1Q2_{PC} = \frac{\sum_{i \in S} AnsB_i}{S}$$

$$A1Q2_{T} = \frac{\sum_{i \in S} AnsC_i}{S}$$

i is the i^{th} school.

S is the total number of schools.

$AnsA_i$ is the answer of the i^{th} school to item a) of Question Q2. In other words, the number of working desktop computers with Internet access at the school.

$AnsB_i$ is the answer of the i^{th} school to item b) of Question Q2. In other words, the number of working portable computers with Internet access at the school.

$AnsC_i$ is the answer of the i^{th} school to item c) of Question Q2. In other words, the number of working tablets with Internet access that are available for pedagogical use at the school.

Interpretation/policy relevance: This indicator provides information about the ICT infrastructure of schools, which constitutes fundamental baseline and follow-up information for any ICT policy decision-making. It can be calculated at the national, subnational and even school levels. It operationalizes the reference to ICT in SDG 4 and goes beyond, enabling as sophisticated calculations as the country data may allow for: if related to the number of schools in a given country, it provides a general idea of the national endowment of devices. If calculated in relation to the number of students, it provides a more accurate idea about the sufficiency of those resources for student use. In the latter case, this indicator measures progress in target 4.a of SDG 4, specified as learner-to-computer ratio for ISCED levels 1 – 3 (Partnership, 2019, p. 12). The suggested model questions are intended to be asked after a more general filter question about whether the school has computers for pedagogical use, which, in turn, accounts for target 4.a.1 of SDG 4.

A2. Percentage of schools by Internet access location

Definition: The proportion of schools that have Internet access in specific locations (e.g. computer lab, library, classrooms).

Source: Cetic.br (2017)

Clarifications and methodological issues: This question should be asked only to those schools that have answered "yes" to a previous filter question regarding whether the school has Internet connection for pedagogical purposes. The respondent should select all the locations where there is Internet access at school.

Target: Principals (or other school staff knowledgeable about ICT infrastructure).

Time frame: Date of the survey.

Model questions:

Question and answer options:

Please indicate in which of the following locations there is Internet access at this school (including administrative, pedagogical and any other type of use for administrative staff, teachers and students).

a) Computer lab.
b) Library or study room.
c) Classroom.
d) Teachers' room or meeting room.
e) Coordinator's or principal's office.
f) Other location. Specify: _____.

Instructions: Choose all the options that apply (multiple choice).

Disaggregation and classifications: Geographical region, school's management and funding and school size.

Calculation method:

$$A2_{OptA} = \frac{\sum_{i \in S} OptA_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

$OptA_i$ is the answer of the i^{th} school to the question. It is 1 if option a) is selected and 0 if it is not selected. In other words, if there is Internet access at the computer lab.

$$A2_{OptB} = \frac{\sum_{i \in S} OptB_i}{S} \times 100$$

i is the i^{th} school.

S is the total number of schools.

$OptB_i$ is the answer of the i^{th} school to the question. It is 1 if option b) is selected and 0 if other options are selected. In other words, if there is Internet access in the library or study room.

The same calculation must be done for answers c) through f).

Interpretation/policy relevance: This indicator provides relevant information for policymaking and specifies location of Internet access for those schools that count on Internet connection for pedagogical purposes, which constitutes a key indicator to track progress on target 4.a.1 of SDG 4 (Partnership, 2019, p. 12). Complementing that information, it is relevant to be able to differentiate the extent to which schools count on Internet connection in limited spaces (most frequently, the computer lab) versus those in which students and teachers can potentially access the Internet in a wide array of spaces, mainly, whether the connection is available in classrooms. Such spatial differences differentiate the policy options made and delimit the type of pedagogical uses that can be made of the Internet in the school setting.

CONTINUES ▶

A3. Percentage of schools by main Internet connection speed

Definition: The proportion of schools in each level of Internet connection download speed (low, medium or high). This indicator refers to the main Internet connection download speed, which is the one that provides Internet access to the highest number of users at the school.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- This question is applicable only to schools that have Internet connection.
- Internet connection speed is captured using an ordinal variable with 10 levels. The lowest is "up to 256 Kbps", which is the lowest speed provided by an Internet service provider.
- Not always can principals provide a precise answer about connection speed. The most accurate way of measuring connection speed is to do it directly – using equipment or software that tracks connection quality. This method should be used whenever feasible.
- Whenever the principal is unable to provide an accurate answer to this question, it is advisable to suggest that they consult other school staff, like the ICT teacher, if available. Alternatively, interviewers can be trained to identify this information themselves at the school.

Target: Principals (or other school staff knowledgeable about ICT infrastructure).

Time frame: Date of the survey.

Model question:

Question and answer options:

What is the download speed of the school's main Internet connection?

a) Up to 256 Kbps.
b) 257 Kbps to 999 Kbps.
c) 1 Mbps.
d) 2 Mbps.
e) 3 Mbps to 4 Mbps.
f) 5 Mbps to 8 Mbps.
g) 9 Mbps to 10 Mbps.
h) 11 Mbps to 20 Mbps.
i) 21 Mbps to 50 Mbps.
j) 51 Mbps or more.

Instructions: Choose only one choice out of the following options.

Disaggregation and classifications: Geographical region, school's management and funding, school size.

▶ CONTINUED

A3. Percentage of schools by main Internet connection speed

Calculation method:

$$A3_{LowSpeed} = \frac{\sum_{i \in S} LS_i}{S} \times 100$$

$$A3_{MediumSpeed} = \frac{\sum_{i \in S} MS_i}{S} \times 100$$

$$A3_{HighSpeed} = \frac{\sum_{i \in S} HS_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

LS_i is the answer of the i^{th} school to the question. It is 1 if options a), b), c) or d) are selected and 0 if other options are selected. In other words, it is 1 if the school's main Internet connection is up to 2 Mbps.

MS_i is the answer of the i^{th} school to the question. It is 1 if options e), f), g) or h) are selected and 0 if other options are selected. In other words, it is 1 if the school's main Internet connection is between 3 and 20 Mbps.

HS_i is the answer of the i^{th} school to the question. It is 1 if options i) or j) are selected and 0 if other options are selected. In other words, it is 1 if the school's main Internet connection is higher than 20 Mbps.

Interpretation/policy relevance: The Internet connection download speed constitutes relevant information about the quality of Internet connection available at the schools. The higher the Internet connection speed, the greater the number of devices that can be connected simultaneously and/or the more sophisticated the software and online activities that can be performed. When interpreting this figure, it is important to bear in mind possible information limitations of the respondent to provide an accurate answer. The ideal measurement of Internet speed is not through surveys but with direct measurements, performed with the aid of specific software. However, given the practical difficulties of carrying out direct measures, questioning an informed respondent within the school provides a reasonable approximation.

CONTINUES ▶

A4. Percentage of schools by restrictions in students' access to the school's Wi-Fi network

Definition: The proportion of schools where the students have unrestricted or restricted access to the school's Wi-Fi network and the type of restrictions in place (whether a password is required and, in that case, whether it is open and whether there are time, purpose or location restrictions to access).

Source: Cetic.br (2017)

Clarifications and methodological issues:

- This question is applicable only to those schools that have a Wi-Fi connection.
- The main indicator calculates the percentage of schools with unrestricted and restricted access.
- The complementary indicator calculates the percentage of schools with a certain type of restriction.

Target: Principals (or other school staff knowledgeable about ICT infrastructure).

Time frame: Date of the survey.

Model questions:

Question and answer options:

The Wi-Fi connection at this school is:

a) Of unrestricted access for students.

b) Of restricted access. It requires a password and it is provided to students.

c) Of restricted access. It requires a password and it is not provided to students.

d) Of restricted access. Students are allowed to use it for limited periods, for example, only in learning activities.

e) Of restricted access. Students are allowed to use it in specific locations of the school.

Instructions: Only schools with a Wi-Fi connection should answer this question. Choose only one choice out of the following options.

Disaggregation and classifications: Geographical region, school's management and funding and school size.

Calculation method:

Main indicator:

$$A4_{unrestricted\ access} = \frac{\sum_{i \in S} OptA_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

$OptA_i$ is the answer of the i^{th} school to the question. It is 1 if option a) is selected and 0 if other options are selected. In other words, it is 1 if the answer is "Of unrestricted access for students".

$$A4_{restricted\ access} = \frac{\sum_{i \in S} OptRest_i}{S} \times 100$$

i is the i^{th} school.

S is the total number of schools.

$OptB_i$ is the answer of the i^{th} school to the question. It is 1 if options b), c), d) or e) are selected and 0 if other options are selected. In other words, it is 1 if Wi-Fi connection at the school is of restricted access.

▶ CONTINUED

A4. Percentage of schools by restrictions in students' access to the school's Wi-Fi network

Complementary indicator:

$$A4_{type\ of\ restriction} = \frac{\sum_{i \in S} OptB_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

$OptB_i$ is the answer of the i^{th} school to the question. It is 1 if option b) is selected and 0 if other options are selected. In other words, it is 1 if the answer is "Of restricted access. It requires a password and it is provided to students".

$$A4_{type\ of\ restriction} = \frac{\sum_{i \in S} OptC_i}{S} \times 100$$

i is the i^{th} school.

S is the total number of schools.

$OptC_i$ is the answer of the i^{th} school to the question. It is 1 if option c) is selected and 0 if other options are selected. In other words, it is 1 if the answer is "Of restricted access. It requires a password and it is not provided to students".

The same calculation must be done for answers d) and e).

Interpretation/policy relevance: This indicator provides relevant information about the extent to which the Internet is effectively available to students at school. The indicator enables for overcoming the limitation of dichotomic measures of access to the Internet (that is, whether a school has Internet connection or not) considering that such connection can be available to some members of the school community while being restricted to others. The main indicator can be interpreted as the level to which access to the Wi-Fi network is effectively open to students. The complementary indicator provides information about how the schools are regulating Wi-Fi access. The value of this indicator may coincide, or not, with the policy recommendations in this respect in a given country.

A5. Percentage of schools with digital devices or software that meet the requirements of students with disabilities

Definition: The proportion of schools that have digital devices or software tailored to the needs of students with disabilities.

Source: Cetic.br (2018)

Clarifications and methodological issues:

"Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairment that, when interacting with diverse barriers, may hinder their full and effective participation in society on an equal basis with others. (Convention on the Rights of Persons with Disabilities. UN General Assembly, 2007)"

- This indicator excludes those devices that are out of order to avoid inflating data on access to digital devices.
- The denominator proposed for the calculation of the indicator is the total number of schools to avoid discrimination of potential students with disabilities that are not yet enrolled.

Target: Principals (or other school staff knowledgeable about ICT infrastructure).

Time frame: Date of the survey.

Model questions:

Question and answer options:

Does the school have at least one working digital device or software that meets the requirements of the student(s) with intellectual or physical disabilities?

a) No.

b) Yes, but the school falls short covering the full range of students' requirements.

c) Yes.

Instructions: Select only one answer option.

Disaggregation and classifications: Geographical region, school's management and funding and school size.

Calculation method:

$$A5 = \frac{\sum_{i \epsilon S} ByC_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

ByC_i is the answer of the i^{th} school. It is 1 if options b) or c) are selected and 0 if other options are selected. In other words, it is 1 if the school has at least one digital device or software that meets the requirements of the student(s) with disabilities.

Interpretation/policy relevance: This indicator provides information about ICT resources and infrastructure of schools with a specific focus on the needs of the population with disabilities, which is of policy relevance since the population of students with disabilities requires specific devices and/or software. Access indicators that are blind to these specificities limit both planning and advocacy for the exercise of this population´s rights to digital inclusion in the school setting. The proposed calculation is over the total number of schools, in order to provide a general view about to what extents a given level of the school system is prepared to include students with disabilities, from the ICT access point of view. A valid variation of this indicator would be to make the calculations considering only those schools attended by students with disabilities.

A6. Percentage of students/teachers/principals with access to digital devices at the household

Definition: The proportion of students, teachers and principals that have access to digital devices at their homes.

Source: Cetic.br (2017)

Clarifications and methodological issues: The calculation must be done separately for the group of students, the group of teachers and the group of principals. The indicator is optional, since other available surveys may cover digital inclusion at the household level for one or more of these populations.

Target: Students, teachers and principals.

Time frame: Date of the survey.

Model questions:

Question and answer options:

Do you have _____ at your home?

	Yes	No
a) Desktop computers.		
b) Portable computers.		
c) Tablets.		

Instructions: Select "yes" or "no" for every item.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

$$A6_{DC} = \frac{\sum_{i \in I} OptA_i}{I} \times 100$$

$$A6_{PC} = \frac{\sum_{i \in I} OptB_i}{I} \times 100$$

$$A6_{T} = \frac{\sum_{i \in I} OptC_i}{I} \times 100$$

Where:

i is the i^{th} individual (students, teachers or principals).

I is the total number of individuals (students, teachers or principals).

$OptA_i$ is the answer of the i^{th} individual to item a) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the individual has a desktop computer at home.

$OptB_i$ is the answer of the i^{th} individual to item b) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the individual has a portable computer at home.

$OptC_i$ is the answer of the i^{th} individual to item c) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the individual has a tablet at home.

Interpretation/policy relevance: Information about the level of access to digital devices in the domestic setting of teachers, students and principals is valuable information for policymakers in terms of the probable familiarity, or the lack thereof, with ICT for each of these populations. This indicator is also relevant for comparing levels of access at home and at school, providing a valuable measure for analysing to what extent digital policies implemented in the educational setting are reproducing or breaking patterns of inequality in access to digital devices by socioeconomic level and other variables of interest.

A7. Percentage of students/teachers/principals with Internet access at the household

Definition: The proportion of students, teachers and principals that usually have Internet access at their homes.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The calculation must be done separately for the group of students, the group of teachers and the group of principals. The indicator is optional, since other surveys may cover digital inclusion at the household level for one or more of these populations.
- Internet access at the household means that the Internet is usually (most days of the week) available for use at any time (ITU, 2014) in cooperation with national and international stakeholders, to develop statistical standards and relevant methodologies pertinent to ICT measurement. At its 38th session, held in 2007, the United Nations Statistical Commission endorsed a core list of ICT indicators. The core list, which was developed by the Partnership, included indicators on ICT infrastructure and access; ICT access and use by households and individuals; and ICT use by enterprises.

Target: Students, teachers and principals.

Time frame: Date of the survey.

Model questions:

Question and answer options:

Is Internet access available at your home?

a) Yes.

b) No.

c) Does not know/Does not answer.

Instructions: Select only one answer option.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

$$A7 = \frac{\sum_{i \in I} OptA_i}{I} \times 100$$

Where:

i is the i^{th} individual (students, teachers or principals).

I is the total number of individuals (students, teachers or principals).

$OptA_i$ is the answer of the i^{th} individual to the question. It is 1 if option a) is selected and 0 if other options are selected. In other words, it is 1 if the answer is "yes".

Interpretation/policy relevance: The policy relevance of this indicator is aligned with that mentioned for indicator A6: the information about the level of access to digital devices in the domestic setting of teachers, students and principals is valuable information for policymakers in terms of the probable familiarity, or the lack thereof, with ICT for each of these populations. This indicator is also relevant for comparing levels of access at home and at school, providing a valuable measure for analysing to what extent digital policies implemented in the educational setting are reproducing or breaking patterns of inequality in access to digital devices by socioeconomic level and other variables of interest.

CONTINUES ▶

A8. Percentage of students/teachers/principals with access to mobile phones

Definition: The proportion of students, teachers and principals that have access to mobile phones.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The calculation must be done separately for the group of students, the group of teachers and the group of principals.
- This indicator is proposed for students, teacher and principals. It can be used for a specific group (students, teachers or principals) based on the relevance for the research question.
- The main indicator calculates the percentage of individuals that use a mobile phone.

Target: Students, teachers and principals.

Time frame: Last three months.

Model questions:

Question and answer options:

Q1. During the last three months, did you use a mobile phone?

a) Yes.

b) No.

Q2. Did you use the Internet through a mobile phone?

a) Yes.

b) No.

Instructions: Ask the second question only if respondent gives an affirmative answer to the first question. Select only one answer option.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

Main indicator:

Using the answers of Q1:

$$A8_{access} = \frac{\sum_{i \in I} AnsQ1_i}{I} \times 100$$

Where:

i is the i^{th} individual (students, teachers or principals).

I is the total number of individuals (students, teachers or principals).

$AnsQ1_i$ is the answer of the i^{th} individual to Question 1. It is 1 if option a) is selected and 0 if option b) is selected. In other words, it is 1 if the answer is "yes".

▶ CONTINUED

A8. Percentage of students/teachers/principals with access to mobile phones

Complementary indicator:

Using the answers of Q2:

$$A8_{Internet\ access} = \frac{\sum_{i \in I} AnsQ2_i}{I} \times 100$$

Where:

i is the i^{th} individual (students, teachers or principals).

I is the total number of individuals (students, teachers or principals).

$AnsQ2_i$ is the answer of the i^{th} individual to Question 2. It is 1 if option a) is selected and 0 if option b) is selected. In other words, it is 1 if the answer is "yes".

Interpretation/policy relevance: Measuring access to mobile phones stands out as a relevant complement to the measure of access to computers (including desktops, notebooks and tablets) covered by other indicators of this set. The recommendation of international organizations such as ITU (2014) is to keep indicators of access to mobile phones separate from those that measure access to computers. Given the increasing importance of mobile phones in explaining the expansion of Internet access to wider sectors of the population worldwide, the relevance of knowing those levels of access for the members of the school community is evident. Complementarily, from a policy point of view, it can be considered as well that high penetration of cell phone in a given population can work as a facilitator of the use of other types of electronic devices.

B) Use indicators

U1. Percentage of students/teachers/principals who use the Internet, at any location

Definition: The proportion of students, teachers and principals who have used the Internet from any location within the last three months.

Source: Adapted from ITU (2014)

Clarifications and methodological issues:

- An individual is considered an Internet user if they have used the Internet at least once during the last three months.
- Country practices may vary but, ideally, reference periods should be aligned in order to obtain comparable data. Countries changing their reference period may wish to split it in order to obtain a comparable time series.
- The calculation must be done separately for the group of students, the group of teachers and the group of principals.
- This indicator can be used for a specific group (students, teachers or principals) based on the relevance for the research question.

Target: Students, teachers and principals.

Time frame: Last three months.

Model questions:

Questions and answer options:

Q1. Have you ever used the Internet from any location/place?

a) Yes.
b) No.

Q2. When was the last time you used the Internet?

a) Less than 3 months ago.
b) Between 3 and 12 months ago.
c) More than 12 months ago.

Instructions: Select only one answer option. Ask the second question only if respondent gives an affirmative answer to the first question.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

Using the answers of Q2:

$$U1 = \frac{\sum_{i \in I} OptA_i}{I} \times 100$$

Where:

i is the i^{th} individual (students, teachers or principals).

I is the total number of individuals (students, teachers or principals).

$OptA_i$ is the answer of the i^{th} individual to Question 2. It is 1 if option a) is selected and 0 if other options are selected. In other words, it is 1 if the answer is "Less than 3 months ago".

Interpretation/policy relevance:

Internet user uptake is a key indicator tracked by policymakers and analysts as an indication of improvement in terms of use. Disaggregation informs about the digital gap and thus, this indicator can contribute to the design of targeted policies. The proportion of Internet users is one of the Sustainable Development Goals indicators, along with others related to digital inclusion and education, including gender equality in broadband access. Focusing on specific populations of interest within the educational community, this indicator is aligned with the ICT Development Index as well (ITU, 2014), which makes it a key metric for the international benchmarking of ICT developments.

CONTINUES ▶

U2. Percentage of students/teachers/principals who use the Internet, by location

Definition: The proportion of students, teachers and principals who used the Internet in specific locations during the last three months.

Source: Adapted from ITU (2014)

Clarifications and methodological issues:

- ITU (2014) states that schools should be included in option b) "Community Internet access facility", however, this *Practical Guide* suggests that the category "school" should be included as a place of connection on its own.
- The calculation must be done separately for the population of students, teachers and principals.
- Clarifications for items d and e: Community Internet access facility refers to Internet use that is free of charge and available to the general public, such as in community facilities including public libraries, Internet kiosks and non-commercial telecentres. Commercial Internet access, on the other hand, refers to Internet use at publicly available commercial facilities such as cybercafés, hotels, airports, etc., where access is typically paid for. An alternative for simplification is not to differentiate items d) and e). This decision will depend on the research priorities and the countries' characteristics.
- Clarifications for item f: "while commuting, in transport or walking refers to Internet use while moving from one place to another. The emphasis is on the context of changing places, not on the device or the network used.
- Clarifications for item g: "in other locations" refers to places not mentioned in the main options, such as restaurants, shopping centers, churches and parks.

Target: Students, teachers and principals.

Time frame: Last three months.

Model questions:

Question and answer options:

Where did you use the Internet the most during the last three months?

a) Your own home.
b) Another person's home: the home of a friend, relative or neighbor.
c) At school.
d) Community Internet access facility (free of charge).
e) Commercial Internet access facility.
f) While commuting, in transport or walking.
g) In other locations.

Instructions: Select only one answer option.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

▶ CONTINUED

U2. Percentage of students/teachers/principals who use the Internet, by location

Calculation method:

$$U2_{OptA} = \frac{\sum_{i \in I} OptA_i}{I} \times 100$$

Where:

i is the i^{th} individual (students, teachers or principals).

I is the total number of individuals (students, teachers or principals).

$OptA_i$ is the answer of the i^{th} individual to the question. It is 1 if option a) is selected and 0 if it is not selected. In other words, it is 1 if the individual used the Internet the most at home during the last three months.

$$U2_{OptB} = \frac{\sum_{i \in I} OptB_i}{I} \times 100$$

i is the i^{th} individual (students, teachers or principals).

I is the total number of individuals (students, teachers or principals).

$OptB_i$ is the answer of the i^{th} individual to the question. It is 1 if option b) is selected and 0 if it is not selected. In other words, it is 1 if the individual used the Internet the most at another person's home during the last three months.

The same calculation must be done for answers c) through g).

Interpretation/policy relevance: As Internet access tends to spread, it is increasingly relevant for policymaking to count on information about the varying degrees of ubiquity of Internet use for teachers, principals and students. This indicator enables for comparisons of the proportions in which each segment uses the Internet in all or most locations, as opposed to those that use it only in one or a few of them, particularly when one of these locations is the school. Policy-relevant distinctions that can be made from this indicator include gaps between school and household Internet use, and, in general, population groups that rely on public Internet access facilities. Countries may also wish to track changes in the locations of Internet use in line with their access policy investments. The disaggregation variables provide relevant information to track the evolution of Internet access locations for men/women, children/adults and rural/urban areas and the different socio-economic groups.

U3. Percentage of students/teachers/principals that frequently use the Internet at school

Definition: This indicator measures how often principals, teachers and students used the Internet at school during the last three months. It indicates the proportion of individuals that are frequent Internet users at school. This indicator does not account for the purpose of use, neither for the source of the Internet service.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- A suggested methodological practice is to collect data that corresponds to an average time frame, excluding weekends and breaks from the routine, like holidays and vacations.
- An individual is considered a frequent user if their frequency of use is at least once a week.
- The calculation must be done separately for the group of students, the group of teachers and the group of principals.
- This indicator can be used for a specific group (students, teachers or principals) based on the relevance for the research question.

Target: Students, teachers and principals.

Time frame: Last three months.

Model question:

Question and answer options:

How often did you use the Internet at this school during the last three months?

a) At least once a day.

b) At least once a week, but not every day.

c) Less than once a week.

d) Never.

Instructions: Select only one answer option. This question must be answered excluding weekends and breaks from the routine (i.e. holidays and vacations).

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

$$U3_{frequent} = \frac{\sum_{i \in I} OptAyB_i}{I} \times 100$$

Where:

i is the i^{th} individual (students, teachers or principals).

I is the total number of individuals (students, teachers or principals).

$OptAyB_i$ is the answer of the i^{th} individual to the question. It is 1 if options a) or b) are selected and 0 if other options are selected. In other words, it is 1 if the individual used the Internet at school at least once a week during the last three months.

Interpretation/policy relevance: The indicator measures frequent Internet use within the school and, as such, a high value of the indicator suggests familiarity with Internet use within the school setting. As such, it can work as an indirect measure of the potential to include it in pedagogical practices. However, there are two main caveats for interpreting this indicator. On the one hand, U3 does not differentiate whether the connection was provided by the school or whether it belongs to the individual´s mobile network. Therefore, a high value of the indicator cannot be linearly interpreted as the result of an education Internet connection policy. Such interpretation may arise from the combination of different pieces of information provided by the set of indicators. On the other hand, considering that U3 does not retrieve information about the purpose of that use, a high value of the indicator cannot be linearly interpreted, either, as a high degree of integration of Internet use into specific school practices, which can be informed by complementary indicators. Finally, in the case of a low value for this indicator, a relevant complementary indicator is ICT5, which gathers information about barriers to ICT use that each school population experiences.

CONTINUES ▶

U4. Percentage of schools that use digital devices and the Internet to perform administrative tasks

Definition: Proportion of schools that use digital devices and the Internet for administrative purposes, excluding pedagogical and personal use.

Source: Adapted from Cieb (2017)

Clarifications and methodological issues:

- The questions are related to each other. Q2 should be answered based on the answers to Q1.
- The main indicator calculates the proportion of schools that use digital devices and the Internet for administrative purposes.
- The complementary indicator calculates the proportion of schools that use digital devices for administrative purposes.
- The respondent should select all the activities that involve the use of digital devices or the Internet or both.

Target: Principals (or other school staff knowledgeable about ICT infrastructure).

Time frame: Date of the survey.

Model questions:

Question and answer options:

	Q1. Do teachers and administrative staff use digital devices for any of the following administrative ends?	Q2. Of the administrative ends teachers and administrative staff use digital devices to perform, which ones are done using the Internet?
a) Enrollment or student registration process management.		
b) Gradebook.		
c) Financial-administrative management (for example, staff attendance, budget management, etc.).		
d) Specific school services management (library, transportation, logistics, stock, etc.).		
e) Communication with teachers, family or students.		

Instructions: Select all the options that apply (multiple choice).

Disaggregation and classifications: Geographical region, school's management and funding and school size.

▶ CONTINUED

U4. Percentage of schools that use digital devices and the Internet to perform administrative tasks

Calculation method:

Main indicator:

Using the answers of Q2:

$$U5_{OptA} = \frac{\sum_{i \in S} OptA_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

$OptA_i$ is the answer of the i^{th} school to Question 2. It is 1 if option a) is selected and 0 if it is not selected. In other words, it is 1 if the school uses digital devices and the Internet for the enrollment or student registration process management.

$$U5_{OptB} = \frac{\sum_{i \in S} OptB_i}{S} \times 100$$

i is the i^{th} school.

S is the total number of schools.

$OptB_i$ is the answer of the i^{th} school to Question 2. It is 1 if option b) is selected and 0 if it is not selected. In other words, it is 1 if the school uses digital devices and the Internet for the gradebook.

The same calculation must be done for answers c) through f).

Complementary indicator:

Using the answers of Q1:

$$U5dd_{OptA} = \frac{\sum_{i \in S} OptA_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

$OptA_i$ is the answer of the i^{th} school to Question 1. It is 1 if option a) is selected and 0 if it is not selected. In other words, it is 1 if the school uses digital devices for the enrollment or student registration process management.

$$U5dd_{OptB} = \frac{\sum_{i \in S} OptB_i}{S} \times 100$$

i is the i^{th} school.

S is the total number of schools.

$OptB_i$ is the answer of the i^{th} school to Question 1. It is 1 if option b) is selected and 0 if it is not selected. In other words, it is 1 if the school uses digital devices for the gradebook.

The same calculation must be done for answers c) through f).

Interpretation/policy relevance: The indicator provides information about ICT use in school's management and administrative processes which is, together with ICT use in teaching and learning processes, one of the main dimensions of ICT use in the educational setting. It covers the main school administrative areas and differentiates whether the Internet is involved in each, therefore providing relevant information for the policymaker.

CONTINUES ▶

U5. Percentage of teachers by activities performed when using the Internet at any location, by purpose

Definition: This indicator registers the activities that teachers performed when using the Internet during the last three months – not limited to learning and teaching processes at their schools – and the purpose of the activities. The objective of this indicator is to draw an Internet user profile, which can be compared to the activities performed by teachers at school.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The questions are related to each other. Q2 should be answered based on the answers to Q1.
- The location where the activities are performed is not relevant for this indicator.
- The main indicator is the user profile. Calculates the proportion of teachers that perform a certain activity using the Internet for a certain purpose (personal or professional).
- The complementary indicator calculates the proportion of teachers that perform a certain activity using the Internet for any purpose.
- The respondent should select between the given answers all the activities they perform using the Internet.

Target: Teachers.

Time frame: Last three months.

Model questions:

Question and answer options:

Q1. Have you _____, when using the Internet during the last three months?			Q2. What was the main purpose of the activity?	
	Yes	No	Personal	Professional
a) Sent e-mails.				
b) Sent instant messages.				
c) Participated in digital social networks.				
d) Searched for a job or sent resumes.				
e) Watched movies, videos or series online.				
f) Read online newspapers or magazines.				
g) Participated in online courses.				
h) Looked up information about undergraduate, graduate and extension courses.				
i) Posted texts, images or videos.				
j) Downloaded computer software, programs or applications.				
k) Played online games.				
l) Read a book or an e-book online.				
m) Took part in online discussion forums or groups.				

Instructions: Ask the second question only for those answer options where the respondent answered "yes" in the first question. Select all the options that apply (multiple choice). Consider that professional purpose refers to teaching and learning.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

▶ CONTINUED

U5. Percentage of teachers by activities performed when using the Internet at any location, by purpose

Calculation method:

Main indicator: user profile

Using the answers of Q2:

$$U6_{OptA\ personal} = \frac{\sum_{i \in T} OptA(personal)_i}{T} \times 100$$

$$U6_{OptA\ professional} = \frac{\sum_{i \in T} OptA(professional)_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA(personal)_i$ is the answer of the i^{th} teacher to item a) of Question 2. It is 1 if the answer "personal" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used the Internet to send emails for personal purposes in the last three months.

$OptA(professional)_i$ is the answer of the i^{th} teacher to item a) of Question 2. It is 1 if the answer "professional" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used the Internet to send emails for professional purposes in the last three months.

$$U6_{OptB\ personal} = \frac{\sum_{i \in T} OptB(personal)_i}{T} \times 100$$

$$U6_{OptB\ professional} = \frac{\sum_{i \in T} OptB(professional)_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptB(personal)_i$ is the answer of the i^{th} teacher to item a) of Question 2. It is 1 if the answer "personal" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used the Internet to send instant messages for personal purposes in the last three months.

$OptB(professional)_i$ is the answer of the i^{th} teacher to item a) of Question 2. It is 1 if the answer "professional" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used the Internet to send instant messages for professional purposes in the last three months.

The same calculation must be done for answers c) through m).

▶ CONTINUED

U5. Percentage of teachers by activities performed when using the Internet at any location, by purpose

Complementary indicator:

Using Q1:

$$U6_{OptA} = \frac{\sum_{i \in T} OptA_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA_i$ is the answer of the i^{th} teacher to item a) of Question 1. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used the Internet to send emails in the last three months.

$$U6_{OptB} = \frac{\sum_{i \in T} OptB_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptB_i$ is the answer of the i^{th} teacher to item b) of Question 1. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used the Internet to send instant messages in the last three months.

The same calculation must be done for answers c) through m).

Interpretation/policy relevance: This indicator provides information on the activities teachers perform online, which can be compared to the activities performed by teachers at schools and to the activities performed by students. The indicator is also a proxy for the presence of digital skills, since it measures activities that involve different levels of digital competencies.

CONTINUES ▶

U6. Percentage of teachers by learning and teaching activities performed with students when using digital devices and the Internet at any location

Definition: This indicator measures teaching and learning activities teachers perform with students, which involve the use of digital devices and the Internet.

Source: Cetic.br (2017), originally inspired in SITES 2006 (IEA)

Clarifications and methodological issues:

- The questions are related to each other. Q2 should be answered based on the answers to Q1.
- The respondent should select between the given answers all the activities they perform using digital devices and the Internet.
- The location where the activities are performed is not relevant for this indicator.
- The main indicator is the proportion of teachers that perform each of the activities using digital devices and the Internet.
- The complementary indicator is the proportion of teachers that perform each of the activities using digital devices.

Target: Teachers.

Time frame: Last three months.

Model questions:

Question and answer options:

	Q1. During the last three months and regardless of the location, have you used digital devices with students when you _____?		Q2. During the activities in which you used digital devices did you also use the Internet?	
	Yes	No	Yes	No
a) Requested texts, graphics or maps.				
b) Worked with educational games.				
c) Developed spreadsheets and graphs with the students.				
d) Conducted reading comprehension activities.				
e) Promoted debates or presentations.				
f) Searched in books and magazines with the students.				
g) Requested assignments (includes individual and group assignments).				
h) Created websites, web pages or blogs.				
i) Used computer educational programs or simulations.				
j) Created a computer game or application.				
k) Provided content on the Internet to students.				
l) Remotely answered questions from students.				
m) Received assignments made by the students.				
n) Developed projects with the students (scientific, artistic or social ones).				

Instructions: Select all the options that apply (multiple choice). This question should be answered taking into account the last three months.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

▶ CONTINUED

U6. Percentage of teachers by learning and teaching activities performed with students when using digital devices and the Internet at any location

Calculation method:

Main indicator:

Using Q2:

$$U7_{OptA} = \frac{\sum_{i \in T} OptA_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA_i$ is the answer of the i^{th} teacher to item a) of Question 2. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used digital devices and the Internet with students when they requested texts, graphics or maps during the last three months.

$$U7_{OptB} = \frac{\sum_{i \in T} OptB_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptB_i$ is the answer of the i^{th} teacher to item b) of Question 2. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the individual has used digital devices and the Internet with students when they worked with educational games during the last three months.

The same calculation must be done for answers c) through n).

Complementary indicator:

Using Q1:

$$U7dd_{OptA} = \frac{\sum_{i \in T} OptA_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA_i$ is the answer of the i^{th} teacher to item a) of Question 1. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used digital devices with students when they requested texts, graphics or maps during the last three months.

$$U7dd_{OptB} = \frac{\sum_{i \in T} OptB_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptB_i$ is the answer of the i^{th} teacher to item b) of Question 1. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the individual has used digital devices with students when they worked with educational games during the last three months.

The same calculation must be done for answers c) through n).

Interpretation/policy relevance: This indicator provides information about ICT use in teaching and learning processes with students. High values of this indicator show that the teachers are including digital devices and the Internet in pedagogical activities. It also provides information about the students' activities using ICT in the classes.

U7. Percentage of teachers by activities with students to develop computational thinking

Definition: The indicator measures learning activities teachers propose in class in order to develop computational skills and thinking.

Source: Adapted from Cieb (2017)

Clarifications and methodological issues:

- Digital thinking is related to the cognitive process required to understand, interact and design the artificial world (Dagan, Kuperman, & Mioduser, 2012).
- The answer permits multiple choices.

Target: Teachers.

Time frame: Last three months.

Model questions:

Question and answer options:

During the last three months, did you implement any of the following activities in class?

a) Robotic or sensor kit workshops.

b) Activities aimed at developing computational thinking, programming or coding (includes abstraction, logic, algorithms and flowcharts).

c) Problem-solving activities (planning and implementing solutions).

d) Activities aimed at understanding the functioning of technological artifacts (e.g. electric light, radio, telephone, etc.).

Instructions: Select all the options that apply (multiple choice). This question should be answered taking into account the last three months.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

$$U8_{OptA} = \frac{\sum_{i \in T} OptA_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA_i$ is the answer of the i^{th} teacher to the question. It is 1 if option a) is selected and 0 if it is not selected. In other words, it is 1 if the teacher has performed robotic or sensor kit workshops in class during the last three months.

$$U8_{OptB} = \frac{\sum_{i \in T} OptB_i}{T} \times 100$$

i is the i^{th} teacher.

T is the total number of teachers.

$OptB_i$ is the answer of the i^{th} teacher to the question. It is 1 if option b) is selected and 0 if it is not selected. In other words, it is 1 if the teacher has performed activities aimed at developing computational thinking, programming or coding in class during the last three months.

The same calculation must be done for answers c) through d).

Interpretation/policy relevance: This indicator provides information about a topic that is innovative in nature and which has been identified as relevant and forward-looking among ICT in education initiatives: computational thinking. It provides an idea about whether schools are introducing students to computational thinking and the development of related skills.

CONTINUES ▶

U8. Percentage of teachers by actions to prepare teaching and learning activities using digital devices and the Internet at any location

Definition: This indicator measures the activities done by teachers using digital devices and the Internet to prepare classes and other teaching and learning endeavors.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The questions are related to each other. Q2 should be answered based on the answers to Q1.
- The respondent should select between the given answers all the activities they perform using digital devices and the Internet.
- The location where the activities are performed is not relevant for this indicator.
- The main indicator is the proportion of teachers that perform each of the activities using digital devices and the Internet.
- The complementary indicator is the proportion of teachers that perform each of the activities using digital devices.

Target: Teachers.

Time frame: Last three months.

Model questions:

Question and answer options:

	Q1. During the last three months, when preparing teaching and learning endeavors have you used digital devices to ____?		Q2. During the activities in which you used digital devices did you also use the Internet?	
	Yes	No	Yes	No
a) Search for content to use in the classroom.				
b) Share educational content with other teachers.				
c) Access educational web portals.				
d) Search educational TV programs for the students.				
e) Participate in a project developed with other teachers and educators.				
f) Search for partnerships to develop projects.				
g) Develop or deepen knowledge about the use of teaching and learning technologies.				
h) Access information and services available on educational portals.				
i) Evaluate student performance.				

Instructions: Select all the options that apply (multiple choice). This question should be answered taking into account the last three months.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

▶ CONTINUED

U8. Percentage of teachers by actions to prepare teaching and learning activities using digital devices and the Internet at any location

Method of calculation:

Main indicator:

Using Q2:

$$U9_{OptA} = \frac{\sum_{i \in T} OptA_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA_i$ is the answer of the i^{th} teacher to item a) of Question 2. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used the Internet to prepare teaching and learning activities during the last three months.

$$U9_{OptB} = \frac{\sum_{i \in T} OptB_i}{T} \times 100$$

i is the i^{th} teacher.

T is the total number of teachers.

$OptB_i$ is the answer of the i^{th} teacher to item b) of Question 2. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used the Internet to prepare teaching and learning activities during the last three months.

The same calculation must be done for answers c) through i).

Complementary indicator:

Using Q1:

$$U9dd_{OptA} = \frac{\sum_{i \in T} OptA_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA_i$ is the answer of the i^{th} teacher to item a) of Question 1. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has used digital devices to prepare teaching and learning activities during the last three months.

$$U9dd_{OptB} = \frac{\sum_{i \in T} OptB_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptB_i$ is the answer of the i^{th} teacher to item b) of Question 1. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the individual has used digital devices to prepare teaching and learning activities during the last three months.

The same calculation must be done for answers c) through i).

Interpretation/policy relevance: This indicator provides information about ICT use in teaching and learning processes. High values of this indicator show that the teachers are including digital devices and the Internet in the preparation of pedagogical activities.

U9. Percentage of teachers, by type of resources obtained on the Internet to prepare teaching and learning activities

Definition: This indicator measures the variety of content that teachers find on the Internet to prepare pedagogical activities.

Source: Cetic.br (2017)

Clarifications and methodological issues: The respondent should select between the given answers all the resources taken from the Internet to prepare classes in the last three months.

Target: Teachers.

Time frame: Last three months.

Model questions:

Question and answer options:

In the last three months, what type of content have you obtained from the Internet to prepare your classes?

	Yes	No
a) Test or exam questions.		
b) Thematic texts.		
c) Images, figures, illustrations or photos.		
d) News.		
e) Films or animations.		
f) Lesson plans.		
g) Video-classes.		
h) Educational software.		
i) Games.		
j) Ready-made presentations.		
k) Podcasts.		

Instructions: Choose all the options that apply (multiple choice).

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Method of calculation:

$$U10_{OptA} = \frac{\sum_{i \in T} OptA_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA_i$ is the answer of the i^{th} teacher to item a) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has obtained test or exams questions from the Internet in the last three months.

$$U10_{OptB} = \frac{\sum_{i \in T} OptB_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptB_i$ is the answer of the i^{th} teacher to item b) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the teacher has obtained thematic texts from the Internet in the last three months.

The same calculation must be done for answers c) through k).

Interpretation/policy relevance: This indicator focuses on Internet use by teachers to obtain resources to prepare their classes and learning activities for the students. The suggested answer options for the model question cover a variety of resources that teachers may find online, from ready-made presentations to films and games. Therefore, the indicator can inform about the most searched resources, how diverse is the set of resources used by teachers, and to what extent innovative resources are present in that search. Research shows that teacher online searches for resources is, as a matter of fact, a prevalent use of the Internet by teachers, therefore worthwhile following up by ICT in education policymakers.

CONTINUES ▶

U10. Percentage of students by activities performed when using the Internet at any location

Definition: This indicator registers the activities performed by students when using the Internet during the last three months for any purpose. The objective of this indicator is to form an Internet user profile of the students.

Source: Adapted from Global Kids Online, Cetic.br (2017)

Clarifications and methodological issues:

- The location where the activities are performed is not relevant for this indicator.
- The indicator calculates the proportion of students that perform a given activity using the Internet for any purpose.
- The respondent should select between the given answers all the activities that they perform using the Internet.

Target: Students.

Time frame: Last three months.

Model question:

Question and answer options:

Q1. In the last three months, have you _____ on the Internet?

	Yes	No
a) Looked up information out of curiosity or personal desire.		
b) Watched video clips, shows, movies or a TV series.		
c) Shared texts, images or videos.		
d) Read or watched the news.		
e) Used instant messaging.		
f) Posted texts, images or videos you created.		
g) Used maps.		
h) Used social networks.		
i) Learned to do something that you did not know how to do.		
j) Taught other people to do something that they did not know how to do.		
k) Created a game, application or computer program.		
l) Read a book or an e-book.		

Instructions: Select all the options that apply (multiple choice).

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

▶ CONTINUED

U10. Percentage of students by activities performed when using the Internet at any location

Calculation method:

Using each answer to the question:

$$U11_{OptA} = \frac{\sum_{i \in ST} OptA_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptA_i$ is the answer of the i^{th} student to item a) of Question 1. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the student has looked up information on the Internet in the last three months.

$$U11_{OptB} = \frac{\sum_{i \in ST} OptB_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptB_i$ is the answer of the i^{th} student to item b) of Question 1. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the student has watched video clips, shows, movies or a TV series on the Internet in the last three months.

The same calculation must be done for answers c) through l).

Interpretation/policy relevance: This indicator allows policymakers to identify the students´ Internet user profile. It is a proxy for the presence of digital skills, since it measures the performance of activities that require different levels of digital competencies.

CONTINUES ▶

U11. Percentage of students by learning activities using the Internet at any location

Definition: This indicator registers learning activities that students have performed using the Internet during the last three months.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The respondent should select between the given answers all the activities performed using the Internet.
- The location where the activities are performed is not relevant for this indicator.

Target: Students.

Time frame: Last three months.

Model question:

Question and answer options:

In the last three months, have you _____ on the Internet?		
	Yes	No
a) Done assignments (individual or group).		
b) Done homework and exercises assigned by the teacher.		
c) Done school research.		
d) Done presentations to classmates.		
e) Played educational electronic games.		
f) Communicated with your teachers online.		
g) Taken part in online courses.		
h) Studied for a test.		
i) Researched on class topics.		
j) Shared school projects.		
k) Taken tests.		
l) Done school projects with classmates.		

Instructions: Mark "yes" or "no" for every item of the question.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

▶ CONTINUED

U11. Percentage of students by learning activities using the Internet at any location

Calculation method:

$$U12_{OptA} = \frac{\sum_{i \in ST} OptA_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptA_i$ is the answer of the i^{th} student to item a) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the student has done assignments on the Internet in the last three months.

$$U12_{OptB} = \frac{\sum_{i \in ST} OptB_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptB_i$ is the answer of the i^{th} student to item b) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the student has done homework and exercises assigned by the teacher on the Internet in the last three months.

The same calculation must be done for answers c) through l).

Interpretation/policy relevance: This indicator provides policymakers with an approximation to whether the Internet is being used within teaching and learning activities for analysing the complexity and innovative character of such activities.

C) ICT skills development opportunities

CONTINUES ▶

ICT1. Percentage of schools by workshops, debates or courses on safe and responsible ICT use

Definition: Proportion of schools that offer training, workshops, or any other spaces to discuss and learn about safe and responsible use of ICT.

Source: Cieb (2017)

Clarifications and methodological issues:

- The respondent should select between the given answers all the activities that the schools offer to discuss and learn about safe and responsible ICT use.
- The main indicator calculates the percentage of schools that offer any of the activities to discuss and learn about safe and responsible ICT use.
- The complementary indicator calculates the percentage of schools that offer each activity in the answer options.

Target: Principals.

Time frame: Last 12 months.

Model question:

Question and answer options:

Over the course of the last school year, did the school offer any training, workshop or organized debates among teachers/parents/students regarding any of the following topics?

a) Ethical sharing of contents, opinions, images or other media.

b) The potential of technology to develop creativity.

c) The use of Internet to develop political and social awareness.

d) The benefits of technology for people with disabilities.

e) Strategies for protecting children and teenagers in their Internet and social networks usage.

Instructions: Choose all the options that apply (multiple choice). This question should be answered taking into account the last 12 months.

Disaggregation and classifications: Geographical region, school's management and funding and school size.

▶ CONTINUED

ICT1. Percentage of schools by workshops, debates or courses on safe and responsible ICT use

Calculation Method:

Main indicator:

$$ICT1 = \frac{\sum_{i \in S} AnswerICT1_i}{S} \times 100$$

i is the i^{th} school.

S is the total number of school.

$AnswerICT1_i$ is the answer of the i^{th} school to the question. It is 1 if options a), b), c), d) or e) are selected and 0 if none of them is selected. In other words, it is 1 if the school has offered any training, workshop or organized debates on safe and responsible use of ICT during the last 12 months.

Complementary indicator:

$$ICT1_{OptA} = \frac{\sum_{i \in S} OptA_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

$OptA_i$ is the answer of the i^{th} school to the question. It is 1 if option a) is selected and 0 if it is not selected. In other words, it is 1 if the school has offered any training, workshop or organized debates regarding ethical sharing of contents, opinions, images or other media during the last 12 months.

$$ICT1_{OptB} = \frac{\sum_{i \in S} OptB_i}{S} \times 100$$

i is the i^{th} school.

S is the total number of schools.

$OptB_i$ is the answer of the i^{th} school to the question. It is 1 if option b) is selected and 0 if it is not selected. In other words, it is 1 if the school has offered any training, workshop or organized debates regarding the potential of technology to develop creativity during the last 12 months.

The same calculation must be done for answers c) though e).

Interpretation/policy relevance: Taking into account that digital inclusion involves technical skills but, above it all, critical use of the Internet, the school faces the challenge of addressing transversal competences that allow children and adolescents to exercise digital citizenship beyond specific pedagogical ICT use, or use focused on curricular learning. The relevance of knowing to what extent schools guide students in a context of increasing Internet access is relevant input for the development and monitoring of ICT in educational policies. It is also relevant to know to what extent schools are taking care of parental needs for information in this respect, particularly those of lower socioeconomic status. Finally, this indicator provides information about the efforts made by the school to develop safe and responsible ICT use.

ICT2. Percentage of schools by preparatory activities for ICT use

Definition: Proportion of schools that implemented specific activities to prepare the school community for the use of ICT in the last 12 months.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The respondent should select between the given answers all the activities that the schools offered during the last 12 months.

Target: Principals.

Time frame: Last 12 months.

Model question:

Question and answer options:

During the last 12 months, has any of the following ICT preparation activities taken place in this school?

	Yes	No
a) Discussing ICT use in teaching practices, with teachers.		
b) Consulting teachers on what changes they expect to happen at school as a result of ICT use.		
c) Carrying out discussions with students about changes in classroom activities.		
d) Classroom activities to develop critical Internet use.		
e) Classroom activities using the most common software.		
f) Carrying out discussions with parents about changes in classroom activities.		
g) Conducting any training for teachers on the use of digital devices and the Internet in teaching and learning practices.		

Instructions: Choose all the options that apply (multiple choice). This question should be answered considering the last 12 months.

Disaggregation and classifications: Geographical region, school's management and funding and school size.

Calculation method:

$$ICT2_{OptA} = \frac{\sum_{i \in S} OptA_i}{S} \times 100$$

Where:

i is the i^{th} school.

S is the total number of schools.

$OptA_i$ is the answer of the i^{th} school to item a) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if during the last 12 months, there have been discussions with teachers at school about ICT use in teaching practices.

$$ICT2_{OptB} = \frac{\sum_{i \in S} OptB_i}{S} \times 100$$

i is the i^{th} school.

S is the total number of schools.

$OptB_i$ is the answer of the i^{th} school to the question. It is 1 if option b) is selected and 0 if it is not selected. In other words, it is 1 if during the last 12 months the teachers have been consulted on their expectations for change at school.

The same calculation must be done for answers c) through g).

Interpretation/policy relevance: Both research on change management and ICT in education policy planning recommendations point to the fact that implementing preparatory activities involving the different school actors (teachers, parents, students) is key to the successful implementation of ICT-related innovations at the school level. Therefore, this indicator provides strategic information, particularly in the early implementation stages of an ICT in education policy.

CONTINUES ▶

ICT3. Percentage of teachers/principals by continued professional development training for ICT use in learning and teaching practices

Definition: This indicator measures the training received by teachers and principals for ICT use in learning and teaching practices during the last 12 months.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The calculation must be done separately for the group of teachers and the group of principals.
- The main indicator groups the principals and teachers in three categories (those who received formal training, those who received informal training and those who did not receive training) and calculates the proportion of teachers and principals in each category.
- The complementary indicator calculates the proportion of teachers and principals that participated in each specific type of training.
- For those countries interested in asking a specific question about teacher training on Open Educational Resources (OER), a complementary question can be added.
  UNESCO´s technical guide *Measuring Adoption and Impact of Open Educational Resources* (2019), proposes a series of indicators to track OER adoption, designed to be answered by school district administrators through annual school censuses or extracted from school records. However, one of those indicators can be adapted to be asked directly to teachers. OER 8 is defined as: "Proportion of educators (ISCED levels 1-8) that have been trained in OER through government-funded programs." The survey question suggested by the OER *Guide* is: "What proportion of educators (ISCED levels 1-8) in your country have been trained on OER through government-funded programmes (through national, or provincial/regional/state funding)?" (UNESCO, 2019, p. 32).
  An adaptation of that question so that it can be asked directly to teachers is suggested below (Question 2).
- Both teacher qualification training and continual professional education are considered government-funded programs for the purposes of this survey (UNESCO, 2019).

Target: Principals and teachers.

Time frame: Last 12 months.

Model questions:

Questions and answer options:

Q1. Over the last 12 months, did you participate in any professional development activities on ICT use in learning and teaching practices?

a) Yes. In training provided by the school.

b) Yes. In training provided by a governmental institution.

c) Yes. In self-financed training.

d) I participated in teacher or principal meetings where such practices were shared.

e) I informally shared practices involving ICT use with other colleagues.

f) I did not take any training on ICT use in teaching and pedagogical practices.

Q2. Over the last 12 months, have you participated in training on Open Educational Resources through government-funded programmes (through national, or provincial/regional/state funding)?

Instructions: Choose all the options that apply (multiple choice). This question should be answered taking into account the last 12 months.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

▶ CONTINUED

ICT3. Percentage of teachers/principals by continued professional development training for ICT use in learning and teaching practices

Calculation method:

Main indicator:

$$ICT3_{formal\ training} = \frac{\sum_{i \in I} OptA, ByC_i}{I} \times 100$$

$$ICT3_{informal\ training} = \frac{\sum_{i \in I} OptDyE_i}{I} \times 100$$

$$ICT3_{no\ training} = \frac{\sum_{i \in I} OptF_i}{I} \times 100$$

Where:

i is the i^{th} individual (teachers or principals).

I is the total number of individuals (teachers or principals).

$OptA_i$, ByC_i is the answer of the i^{th} individual to the question. It is 1 if the answers a), b) or c) are selected and 0 if they are not selected. In other words, it is 1 if the individual received formal training during the last 12 months.

$OptDyE_i$ is the answer of the i^{th} individual to the question. It is 1 if the answers d) or e) are selected and 0 if they are not selected. In other words, it is 1 if the individual received informal training during the last 12 months.

$OptF_i$ is the answer of the i^{th} individual to the question. It is 1 if the answer f) is selected and 0 if it is not selected. In other words, it is 1 if the individual did not receive training during the last 12 months.

Complementary indicator:

$$ICT3_{OptA} = \frac{\sum_{i \in I} OptA_i}{I} \times 100 \qquad ICT3_{OptB} = \frac{\sum_{i \in I} OptB_i}{I} \times 100$$

Where:

i is the i^{th} individual (teachers or principals).

I is the total number of individuals (teachers or principals).

$OptA_i$ is the answer of the i^{th} individual to the question. It is 1 if the answer a) is selected and 0 if it is not selected. In other words, it is 1 if the individual participated in training provided by the school during the last 12 months.

$OptB_i$ is the answer of the i^{th} individual to the question. It is 1 if the answer b) is selected and 0 if it is not selected. In other words, it is 1 if the individual participated in training provided by a governmental institution during the last 12 months.

The same calculation must be done for answers c) through f).

The formula associated with Question 2 is:

$$\frac{\sum_{h=1}^{8} TTO_h^t}{\sum_{h=1}^{8} T_h^t} * 100$$

Where:

$\sum_{h=1}^{8} TTO_h^t$ is the number of teachers at education level h in school-year t who are trained in OER through government-funded programs.

T_h^t is the number of teachers at education level h in school-year t.

Interpretation/policy relevance: Teacher training is a key dimension in any educational policy and, therefore, also in ICT in education policies. This indicator provides information on whether the school staff is participating in regular training that may enable them to integrate ICT in teaching and learning practices. It provides policy-relevant information about the proportion of teachers and principals accessing training by the different disaggregation relevant variables and about the sources of such training.

Regarding, the OER-focused, optional part of the indicator, according to UNESCO (2019): "A high value or percentage for this indicator can be interpreted as good progress in mainstreaming OER in the education system in terms of teachers being trained to use OER. When calculated by ISCED levels, education districts and for individual educational institutions and analysed in conjunction with other indicators regarding the availability of OER, this indicator can show discrepancies so that appropriate policy measures can be taken to implement OER programmes to better train untrained teachers" (UNESCO, 2019. p.32).

CONTINUES ▶

ICT4. Percentage of teachers/principals by perception of ICT impact on pedagogical practices

Definition: This is the teachers´ and principals' perceptions about a range of potential ICT impacts on their own practice, such as adopting new teaching methods, more personalized student assessment, increased access to quality teaching materials, broadened contact with external colleagues, saving time in administrative tasks, facilitated collaboration with colleagues and communication with students.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The calculation must be done separately for the group of teachers and the group of principals.
- This indicator is proposed for teachers and principals. It can be used for a specific group (teachers or principals) based on the relevance for the research question.

Target: Principals and teachers.

Time frame: Date of the survey.

Model questions:

Question and answer options:

For principals:

Thinking about your experience in this school using ICT for teaching and learning processes, do you disagree, neither disagree nor agree, or agree with the following statements?

	Disagree	Neutral	Agree
a) There were gains in student learning.			
b) You collaborated more with colleagues in the school.			
c) Your administrative tasks were facilitated.			
d) Your overall workload has decreased.			
e) There was a positive impact on student motivation.			

For teachers:

Thinking about your experience in this school using ICT for teaching and learning processes, do you disagree, neither disagree nor agree, or agree with the following statements?

	Disagree	Neutral	Agree
a) There were gains in student learning.			
b) Your administrative tasks were facilitated.			
c) You collaborated more with colleagues in the school.			
d) Your overall workload has decreased.			
e) There was a positive impact on student motivation.			
f) You gained access to more diverse or better-quality materials.			
g) You communicate more with other teachers and experts from outside the school.			
h) You resorted to new pedagogical strategies.			

Instructions: Choose "Disagree", "Neutral" or "Agree" for every item.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

Using the Question for principals:

$$ICT4(Principals)_{OptA} = \frac{\sum_{i \in P} OptA_i}{P} \times 100$$

▶ CONTINUED

ICT4. Percentage of teachers/principals by perception of ICT impact on pedagogical practices

Where:

i is the i^{th} principal.

P is the total number of principals.

$OptA_i$ is the answer of the i^{th} principal to item a) of the question for principals. It is 1 if the answer "agree" is selected and 0 if it is not selected. In other words, it is 1 if the principal agrees that there were gains in student learning as a result of using ICT for teaching and learning.

$$ICT4(Principals)_{OptB} = \frac{\sum_{i \in P} OptB_i}{P} \times 100$$

Where:

i is the i^{th} principal.

P is the total number of principals.

$OptB_i$ is the answer of the i^{th} principal to item b) of the question for principals. It is 1 if the answer "agree" is selected and 0 if it is not selected. In other words, it is 1 if the principal agrees he/she collaborated more with colleagues in the school as a result of using ICT for teaching and learning.

The same calculation must be done for answers c) through e).

Using the Question for teachers:

$$ICT4(Teachers)_{OptA} = \frac{\sum_{i \in T} OptA_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptA_i$ is the answer of the i^{th} teacher to item a) of the question for teachers. It is 1 if the answer "agree" is selected and 0 if it is not selected. In other words, it is 1 if the teacher agrees that there were gains in student learning as a result of using ICT for teaching and learning.

$$ICT4(Teachers)_{OptB} = \frac{\sum_{i \in T} OptB_i}{T} \times 100$$

Where:

i is the i^{th} teacher.

T is the total number of teachers.

$OptB_i$ is the answer of the i^{th} individual to item b) of the question for teachers. It is 1 if the answer "agree" is selected and 0 if it is not selected. In other words, it is 1 if the individual agrees that their administrative tasks were facilitated as a result of using ICT for teaching and learning.

The same calculation must be done for answers c) through h).

Interpretation/policy relevance: This indicator captures the perceptions of teachers and principals, key actors in the implementation of any ICT-related innovation policy at the school level. It covers a selection of impacts related to the main hypothesis about ICT school use impacts, comprising changes in teacher's workload, communication with colleagues, access to teaching materials, pedagogical innovation and students' motivation. These perceptions allow policymakers to understand what the main perceived benefits of ICT use are, which can be strategic information – for instance, to communication strategies or sensitization campaigns targeting teachers.

CONTINUES ▶

ICT5. Percentage of teachers/principals by perceived barriers to ICT use at the school

Definition: This indicator measures teachers' and principals' perceptions about school needs to integrate ICT use in teaching and learning practices. Answer options comprise limitation in hardware, Internet and technical support services.

Source: Cetic.br (2017)

Clarifications and methodological issues:

- The calculation must be done separately for the group of teachers and the group of principals.
- This indicator is proposed for teachers and principals. It can be used for a specific group (teachers or principals) based on the relevance for the research question.

Target: Principals and teachers.

Time frame: Date of the survey.

Model questions:

Question and answer options:

Thinking about your reality in this school and the integration of ICT for teaching and learning processes, do you disagree, neither disagree nor agree, or agree with the following statements?

	Disagree	Neutral	Agree
a) It is necessary to improve the technical skills and competencies of the school staff in ICT use.			
b) It is necessary to develop new teaching practices that involve ICT.			
c) It is necessary to increase the number of computers per student.			
d) It is necessary to update the digital devices at the school.			
e) It is necessary to increase the number of computers connected to the Internet.			
f) It is necessary to increase the Internet access speed.			
g) There is a need for better technical support or maintenance of digital devices.			
h) It is necessary to improve student technical skills and competencies in ICT use..			
i) It is necessary to improve ICT training for the school staff.			
j) It is necessary to lower the pressure on school staff to achieve performance standards.			
k) There is a need for pedagogical support for school staff to integrate ICT.			

Instructions: Choose "Disagree", "Neutral" or "Agree" for every item.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

▶ CONTINUED

ICT5. Percentage of teachers/principals by perceived barriers to ICT use at the school

Calculation method:

$$ICT5_{OptA} = \frac{\sum_{i \in I} OptA_i}{I} \times 100$$

Where:

i is the i^{th} individual (teacher or principal).

I is the total number of individuals (group of teachers or group of principals).

$OptA_i$ is the answer of the i^{th} individual to item a) of the question. It is 1 if the answer "agree" is selected and 0 if it is not selected. In other words, it is 1 if the individual agrees that it is necessary to improve the technical skills and competencies of the school staff in ICT use.

$$ICT5_{OptB} = \frac{\sum_{i \in I} OptB_i}{I} \times 100$$

Where:

i is the i^{th} individual (teacher or principal).

I is the total number of individuals (group of teachers or group of principals).

$OptB_i$ is the answer of the i^{th} individual to item b) of the question. It is 1 if the answer "agree" is selected and 0 if it is not selected. In other words, it is 1 if the individual agrees that it is necessary to develop new teaching practices that involve ICT.

The same calculation must be done for answers c) through k).

Interpretation/policy relevance: This indicator provides relevant information about the teachers´ and principals´ perceptions about barriers for ICT use at school. It is particularly relevant when low levels of ICT use is detected at the school, which is informed by other indicators proposed in this set, such as U3. Policymakers may take this input into account when deciding on resource allocation.

ICT6. Percentage of students by perception of ICT impact on their own learning

Definition: This is the students' perceptions about a range of potential ICT impacts on their own learning processes.

Source: Cetic.br (2018)

Clarifications and methodological issues: This indicator refers to the perception of the students about impacts of ICT use on their learning processes, either at home or at school.

Target: Students.

Time frame: Date of the survey.

Model question:

Question and answer options:

In your opinion, using digital devices (desktop computers, portable computers and tablets) and the Internet for learning at school or at home:

	Yes	No
a) Makes you feel more willing to learn new things.		
b) Distracts you from the actual school lesson or homework.		
c) Helps you find information or school materials that you would otherwise not access.		
d) Does not change your learning in any way.		

Instructions: Choose "yes" or "no" for every item.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

$$ICT6_{OptA} = \frac{\sum_{i \in ST} OptA_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptA_i$ is the answer of the i^{th} student to item a) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the student thinks that using digital devices and the Internet for learning makes them more willing to learn new things.

$$ICT6_{OptB} = \frac{\sum_{i \in ST} OptB_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptB_i$ is the answer of the i^{th} student to item b) of the question. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the student thinks that using digital devices and the Internet for learning distracts them from the actual school lesson or homework.

The same calculation must be done for answers c) and d).

Interpretation/policy relevance: This indicator shows the perception of students about the impact of ICT on their own learning processes. This indicator also allows policymakers and researchers to compare students' responses with those of teachers and principals on a key issue. Additionally, retrieving children´s own view on an issue that affects them is in line with the research recommendations that respects children´s rights.

CONTINUES ▶

ICT7. Percentage of students by ICT skills

Definition: This indicator measures the subjective perception of students about their own ICT skills using digital devices (desktop computers, portable computers and tables), the Internet and smartphones.

Source: Adapted from Global Kids Online (2016)

Clarifications and methodological issues:

- Given the high number of answer options, it is strongly recommended to hand in a visual support to the respondents.
- It would be best to ask these questions in a randomized order.

Target: Students.

Time frame: Date of the survey.

Model question:

Question and answer options:

Q1. Think about how you use digital devices and the Internet. How true are these statements for you?

	Not true for me	A bit true for me	Fairly true for me	Very true for me
a) I know how to save a photo that I find online.				
b) I know how to change my privacy settings (e.g. on a social network).				
c) I know how to use a programming language.				
d) I know how to open downloaded files.				
e) I know how to use shortcut keys (e.g. CTRL+C for copy, CTRL+S for save).				
f) I know how to open a new tab in a browser.				
g) I find it easy to check if the information I find online is true.				
h) I find it easy to choose the best keywords for online searches.				
i) I find it easy to find a website I have visited before.				
j) I find it easy to decide if a website can be trusted.				
k) Sometimes I end up on websites without knowing how I got there.				
l) I know which information I should and should not share online.				
m) I know how to remove people from my contact lists.				
n) I know how to post online videos or music that I have created myself.				
o) I know how to edit or make basic changes to online content that others have created.				
p) I know which different types of licenses apply to online content.				
q) I know how to create something new from videos or music that I found online.				
r) I know how to design a website.				
s) I know how to install apps on a mobile device (e.g. phone or tablet).				
t) I know how to keep track of the costs of mobile app use.				
u) I know how to make an in-app purchase.				

▶ CONTINUED

ICT7. Percentage of students by ICT skills

Model question:

Question and answer options:

Q2. Which of these things do you know how to do on a smartphone or tablet?

	Yes	No
a) Deactivate the function showing my geographical position (on Facebook, Google Maps, etc.).		
b) Connect to a Wi-Fi network.		
c) Block push notifications from different apps.		
d) Have the same documents, contacts or apps on all devices that I use (e.g. smartphone, tablet, PC).		
e) Block pop-ups which promote apps, games or services I have to pay for (unrequested windows that appear during web surfing).		
f) Protect a smartphone with a PIN or with a screen pattern.		
g) Update my status on the social network I use the most.		
h) Find information on how to use smartphones safely.		
i) Compare similar apps to choose the one that is most reliable.		
j) Take a picture or a video with my smartphone and post it onto social media.		

Instructions: For Question 1, select "Not true for me", "A bit true for me", "Fairly true for me" or "Very true for me". For Question 2, select "yes" or "no" for every item of the question.

Disaggregation and classifications:

- Individuals: Gender, age, SES, educational level.
- Schools: Geographical region, school's management and funding and school size.

Calculation method:

Digital devices and the Internet:

Using the answers of Q1:

$$ICT7(digital\ devices\ and\ the\ Internet)_{OptA} = \frac{\sum_{i \in ST} OptA_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptA_i$ is the answer of the i^{th} student to item a) of Question 1. It is 1 if the answer "Very true for me" is selected and 0 if it is not selected. In other words, it is 1 if the student knows how to save a photo found online.

$$ICT7(digital\ devices\ and\ the\ Internet)_{OptB} = \frac{\sum_{i \in ST} OptB_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptB_i$ is the answer of the i^{th} student to item b) of Question 1. It is 1 if the answer "Very true for me" is selected and 0 if it is not selected. In other words, it is 1 if the student knows how to change privacy settings.

The same calculation must be done for answers c) through u).

▶ CONTINUED

ICT7. Percentage of students by ICT skills

Smartphones or tablets:

Using the answers of Q2:

$$ICT7(smartphones\ or\ tablets)_{OptA} = \frac{\sum_{i \in ST} OptA_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptA_i$ is the answer of the i^{th} student to item a) of Question 2. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the student knows how to deactivate the function showing the geographical position (on Facebook, Google Maps, etc.).

$$ICT7(smartphones\ or\ tablets)_{OptB} = \frac{\sum_{i \in ST} OptB_i}{ST} \times 100$$

Where:

i is the i^{th} student.

ST is the total number of students.

$OptB_i$ is the answer of the i^{th} student to item b) of Question 2. It is 1 if the answer "yes" is selected and 0 if it is not selected. In other words, it is 1 if the student knows how to connect to a Wi-Fi network.

The same calculation must be done for answers c) through j).

Interpretation/policy relevance: This indicator measures the perceptions of students about their own ICT skills. It is important to interpret and, consequentially, to report the result as reported self-perceptions and not as actual skills. Limitations of measuring skills through self-perception notwithstanding, it is policy-relevant to count on a panorama about the students' perceived skills, particularly if disaggregated by gender, urban/rural residence and SES.

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This *Practical Guide to Implement Surveys on ICT Use in Primary and Secondary Schools* is a step-by-step methodological reference. It presents the critical steps to plan, design and implement a survey to collect data on the use of information and communication technologies (ICT) in education. This *Practical Guide* does not elaborate on statistical or academic matters – although it provides additional references and resources for further review. Instead, it offers practical guidance to plan and conduct large scale surveys on ICT in education that will serve to improve policy decision-making. The development of this *Guide* represents a joint effort by Cetic.br/NIC.br and the UNESCO Institute for Statistics (UIS) to support the production of relevant and robust quality data on ICT in education in developing countries, which will be both locally relevant and enable international comparability.

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