An indicator is a piece of information which communicates a certain state, trend, warning or progress to the audience.\footnote{Sander, 1997}

Core indicators are, simply put, the ways we come to understand the inputs and outcomes of a program or project that we may or may not be able to observe directly. In Chapter 1, we identify a variety of factors that can impact program outcomes. In this chapter, we concentrate on those indicators that are most relevant and immediate to ICT-supported educational programs and projects, what we term core indicators. In addition, we examine indicators of longer-term outcomes, the national context, and program costs. Specifically, we examine ways to measure or describe:

- **Input indicators**—including, for example, the type of ICT equipment and/or software and or organizational design features deployed in a classroom or setting.
- **Outcome indicators**—including, for example, student and teacher impacts (cognitive, affective and attitudinal).
- **National educational and socio-economic indicators**—including, for example, educational enrollment rates, gross domestic product, human development indicators (such as gender equity, literacy, etc.) that characterize and distinguish a country and enable and/or constrain a project or program.
- **Cost indicators**—including, for example, fixed, variable and recurrent costs.

We begin the chapter with a discussion of general issues related to the monitoring and evaluation as well as the selection and use of indicators. We then review various indicators that have been used in a variety of settings in various countries.

### 2.1 MONITORING AND EVALUATION: PROVIDING OPTIONS FOR DECISION-MAKERS

Monitoring and Evaluation (M&E) seems like (and often is) a technical exercise, designed by and used by technical experts and researchers. In fact, like all numerical data of this kind, the ultimate purpose of the M&E ‘exercise’ is to provide useful information to decision makers. This is not always obvious or easy to do, largely because engaging in an adequate M&E process may require a team of specialists who work on...
technical aspects that have only minor connection to broader policy questions. This can be as true in judging a matter of environmental impact as it is in educational impact using ICTs.

Thus, the purpose of M&E is to provide credible options based on the best information that can be gathered to support one or another decision. One of the first choices that must be made concerns the breadth and depth of the M&E task. Naturally, this is as least partly determined by the resources that can be made available (see Chapter 3). Yet, there are also conceptual issues in breadth and depth. For example, is a broad national representative sample necessary in order to justify the impact of a major ICT4E implementation of, say, computer labs in secondary schools? If a large (and perhaps debatable) investment has been made, then only a broad, large-scale study might convince policy makers that either more of the same is required, or that a change in policy is needed (say, if the PC’s were poorly utilized and understaffed). Alternatively, if an NGO set up a small number of very innovative Internet-enabled kiosks which provide health education information, it might be most appropriate to undertake an in-depth ethnographic case study of how the health information was used in real time, and whether it had impact on healthy behaviors.

Thus, M&E can take many forms when put into practice in specific contexts. However, the universe of M&E studies, while varied, can be straightforward if one understands the available options. For a quick sampling of M&E approaches, as related to both indicators and instruments, see Table 2.1. In this table, we can see that case studies, ethnographies, sample surveys, and direct assessment can all play meaningful roles in M&E, but the choice of tools will depend on both the questions asked and the resources available. A more detailed M&E planning methodology will be provided in Chapter 3.

2.2 INDICATOR SELECTION: PROBLEMS AND POSSIBILITIES

While indicators are easy to define, it is not always easy to select the right ones to study. For example, one can indicate the literacy level in a household by asking the head of household whether there are family members who are literate—this is termed an “indirect” measure of literacy because it does not directly assess the skill of the individual. As it happens, this is precisely how most literacy census data are still collected in developing countries. One might find it more relevant in some cases to ask for the mother’s literacy level, as that is an excellent “proxy” indicator of literacy skill of children in developing countries, and more directly predictive of positive social and economic outcomes. Of course, one could also measure literacy skills via a test for reading or writing skills on a variety of items—a “direct” measure of skill. Each of these indicators, and others, has been widely used to measure literacy in global education reports. Direct measurement tends to be more reliable, but also more expensive to implement. Indirect and proxy measures are less reliable but may also be less expensive.

Further, the designation of a particular factor as an “input” or an “outcome” is somewhat arbitrary, since each of these is often the intended impacts of ICT-supported educational programs or projects. For example, increases in the number of computers in schools or changes in pedagogical practices can be considered intended “outcomes” of some ICT-supported programs and they are

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Adapted from Wallman & Sanders.
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Another issue in selecting indicators is the tension between context sensitivity and change over time. There is a longstanding debate in the evaluation field, between context specificity and universality, and between adaptation to changing circumstance and the stability of measurement over time. We shall see in this chapter, as in the Handbook as a whole, that the dual dilemmas above are features that must co-exist with effective M&E.

The conceptual framework introduced in the Introduction identifies a variety of factors that can impact on ICT skills and student learning achievement. Some of these factors may appear somewhat removed from direct ICT intervention, such as the national economy, social development context, or the education reform context. Other context factors are more immediate, such as those related to ICT use in the home, amount of local school support, and the availability of digital education materials. However selected, every indicator need to relate to specific components of the ICT intervention and their implementation.

2.3 INPUT INDICATORS

2.3.1 Classroom ICT resources

It is important to specify the ICT inputs—amount, type, and location of ICT resources—when determining the role that ICT played in student knowledge, skills and attitudes. These need to be identified and described whether or not an increase in the number of these resources is an explicit part of the ICT-supported program. If increasing the amount of, and access to ICT is an overt goal, then ICT resources should be measured both as a baseline variable and later as an outcome. Of course, there are many ways to measure ICT resources or infrastructure, some of which are illustrated in Box 2.2.

2.3.2 Teacher training

Teacher quality is also a very important input (and potential outcome) of ICT for education programs and projects. Indeed, as shown in the review of Chapter 1, the level of qualification and training of teachers has been shown to be one of the key factors in the success of ICT for education programs. UNESCO7 has identified a number of training indicators that include percentage of teachers who received training, type of ICT training (basic or advanced), length of training, and percentage of teachers who use computers for teaching. The International Society for Technology in Education8 has also developed a set of standards for teacher, and these can be used as indicators for teacher training (shown in Box 2.3).

2.3.3 Classroom pedagogy

As we saw in Chapter 1, the way ICT is used in the classroom can make a big difference in the impact of an ICT-supported program or project.

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ICT use includes the extent to which ICT is integrated into the curriculum and the kinds of pedagogical strategies that are used in association with ICT use. In one international survey conducted primarily in OECD countries, principals identified a number of what were termed positive "emerging pedagogical practices" that were often supported by ICT use (see Box 2.4). In the World Links evaluation in several developing countries, Kosma and his colleagues surveyed students and teachers on the extent to which students engaged in various classroom practices using ICT (see Box 2.5). The data were not based on observations (i.e., direct measures) by others, but rather on individuals’ self-reports. However, the reliability of these reports was increased by collecting data from both teachers and administrators. Often they agreed that teachers were engaged in their ICT-supported classroom practices.

2.4 OUTCOME INDICATORS

2.4.1 Student knowledge of school subjects

Often the most important outcome targeted by ICT efforts is an increase in student knowledge. Some studies of ICT-supported programs have used self-report indicators, such as asking students, teachers, or administrators if students increased their knowledge of mathematics, science, language or school knowledge generally. These are indirect and typically unreliable measures of school learning; direct assessment of student learning is preferred where possible.

Generally, there are two broad types of direct measures of school learning that have been used in conjunction with ICT-based education projects: (1) national and international assessments, and (2) customized program- or project-specific assessments. In Chapter 1, we reviewed studies that used national and international assessments to measure the impact of ICT on student learning. Typically, these latter indicators do not effectively target the particular sample of students, grades, content subjects or specific uses of ICT being implemented. In this chapter, we focus therefore on the second category, customized designs. Of the various types of measures, customized assessments are the most likely to capture the learning that takes place in ICT-supported programs and projects. On the other hand, critics may claim that customized assessments are too narrowly focused on learning goals that are specific to a program and thus may be biased in favor of the ICT when comparing

BOX 2.4. Pedagogical practices of teachers

- Students developing abilities to undertake independent learning.
- Providing weaker students with additional support.
- Organizing the learning environment so that differences in learning rates are taken into account.
- Students learning to search for information, process data, and present information.
- Teachers being largely responsible for controlling their own learning progress.
- Students learning and/or working during lessons at their own pace.
- Students involved in cooperative and/or project-based learning.
- Combining parts of school subjects with one another.

Adapted from Pugel and Anderson (1999)

25 Core Indicators for Monitoring and Evaluation Studies in ICTs for Education.

BOX 2.5. Indicators of student practices in the ICT-supported classrooms

- Collaborate on a project with other students in the same class.
- Collaborate on a project with students from another school in the same country.
- Collaborate on a project with students from another country.
- Exchange information with students from another country.
- Gather and analyze resource materials on a problem or topic.
- Provide evidence to argue a position on an issue.
- Use graphics in a report.
- Critique information from another country or culture.
- Draw conclusions or make predictions using data gathered or obtained from resource materials.
- Communicate with parents or other members of the community about school activities.

Adapted from Kosma et al. (2004)
Monitoring and Evaluation of ICT in Education Projects

2.4.2 Student attitudes

In addition to the cognitive measures of learning, ICT is known to have effective consequences as well. These can include student motivation and attitudes about a particular school subject, about school or learning in general, or about other matters. Such indicators may be assessed through surveys, often self-reports. Reliability of these measures can be increased by using multiple information sources, such as by surveying students, their teachers, and school administrators. If all of these sources agree on an indirect measure, this increases the confidence that the outcome did indeed occur.

2.4.3 Student skills

There are potential student outcomes beyond attitudes and the knowledge of school subjects. Perhaps the most immediate expected outcome of ICT use is an increase in technological skill and confidence. ICT skills may not be part of the formal school curriculum and may not be assessed by national examinations. However, there are several commonly used indicators of technology skills.

UNESCO lists indicators that include: number of learners that demonstrate only basic ICT skills, number that demonstrate advanced skills, and the purposes for which they use ICT. The International Computer Driver’s License (ICDL) and variations of it, identify and measure skills related to basic computer concepts, using the computer, managing files, and using word-processing, spreadsheets, database, presentation, and communication software. The advantage of the ICDL is that it is a standard curriculum and assessment of ICT skills that leads to an internationally recognized certificate. This assessment is useful to evaluators as an indication of program success related ICT learning, and it provides the participants with a credential that is recognized by employers. However, the assessment is expensive, and is limited in its scope to skills in using ICT tools.

ISTE has also developed a set of indicators for students’ ICT skills that includes the application of both basic and more advanced ICT tools, such as research tools, decision tools, and problem-solving tools. Unlike the ICDL, ISTE has not developed an assessment. Rather, they have developed a set of standards that

BOX 2.6. Some guidelines for customized assessments

- Test complex knowledge, not just the memorization of facts or knowledge. Here’s should be designed to measure students’ understanding of important concepts, principles, and problem-solving skills.
- At least some tests should be similar in situations in which students might apply their knowledge in the real world outside the classroom. These tests should be structured so that students exhibit their thought processes and problem-solving skills. These are sometimes called performance assessments.
- It is appropriate to use ICT as part of the assessment. Tasks should have students use ICT tools to solve the problems and should provide information on ICT knowledge and skills, as well as their knowledge of school subjects.
- Information that comes from the assessment should not only describe what students know, but should provide program staff and teachers with information on how they can use to improve the program and student learning. This would include the types of errors or misconceptions that students typically exhibited.
- Regular testing throughout the duration of the program, rather than just at the end, will allow evaluators to monitor the progress of the program, allow program staff and teachers to improve the program, and allow students to improve their learning.

Adapted from Bransford et al.14; Pellegrino et al.15.

2.4.3.1 Learning of ICT skills

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describes the kinds of tasks that students should be able to accomplish with computers and software tools. For example, the NETS standards state that students will be able to “use technology to process data and report results”; or “employ technology in the development of strategies for solving problems in the real world”. These statements are specific enough to develop indicators that can examine the extent to which students have accomplished these standards.

### 2.4.3.2 Learning of “21st century” skills

With the continuing increase in average schooling attainment across the globe, and the ever-growing interconnectedness of national economies, it is no surprise that skill requirements are also increasing. Indeed, several initiatives have focused on the engagement of students in the use of ICT to measure the advanced, “21st Century” skills that are needed to participate in globally integrated, economic development. These skills include technology literacy, information management, communication, working in teams, entrepreneurship, global awareness, civic engagement, and problem solving19. In one such effort20 an assessment system, termed the Integrated Performance Assessments in Technology (IPAT), was developed to generate authentic, “real world” problems (with sets of tasks and questions) requiring students to engage in ICT strategies such as planning, analyzing, and communicating. This system was used to evaluate student learning in the World Links program, an ICT-supported program active in a number of developing countries, specifically Ghana, Paraguay, and Uganda. The IPAT system allows modules to be customized to particular types of technology tools and specific goals, grade-level, and content of a particular ICT-supported program. For example, the World Links assessment tasks asked students to use the Internet to search for information on a specific topic, students were asked to use productivity tools, such as digital image-clipping software. Tables were used to gather and organize information about the topic, and word processing and graphics tools were used to communicate findings in a newsletter. Rubrics specified the criteria of adequacy for the quality of technology use (productivity and Internet tools), problem-solving strategies (analysis, comparison, prediction), and communication (thesis, supporting evidence and reasons, organization).

### 2.4 Systemic outcomes

Policy makers are naturally concerned with the impact that ICT programs might have on systemic education indicators such as enrollment rates, pass rates and dropout rates—each of which is rather easily measured directly. These have been used widely in all types of M&E efforts. Fortunately, most ministries of education already have on hand the relevant data on the above systemic indicators.

### 2.4.5 Teacher outcomes

Teacher learning can also be an important outcome of an ICT-supported educational program or project. Many programs have teacher training components, and the goal of this training is to increase teachers’ knowledge of ICT or the pedagogical knowledge related to the integration of ICT into the curriculum and their classroom practice. These learning outcomes can be assessed directly, but more often they are measured indirectly through self-report surveys. In the World Links evaluation21, for example, a number of self-reported questions were provided to teachers, such as their knowledge of computer hardware; software applications; the Internet; Web page development; student groups in teaching; collaborative student projects; and design and use student assessment materials; and how to integrate computers into the curriculum.

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20 Quellmalz & Zalles, 2002
21 Kozma et al., 2004

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Educator Indicators for Monitoring and Evaluation Studies in ICS for Education - 27
However, one way to approach this is through the use of *tracer studies*. In these studies, a number of students in the target program and perhaps some that did not participate in the program are followed for several years afterwards. Measures of graduation rates, final average grade, tertiary matriculation, type of initial employment, and so on, can be used to estimate what the longer term impacts will be.

Another approach is to consider teacher attitudes, as was done in a study in Costa Rica (see Box 2.7). In any case, the reliability of such indicators can be increased by collecting information from more than one source, such as from both teachers and administrators.

Building ICT skills is often a goal of teacher training programs, and such skills are a necessary prerequisite for the implementation of ICT in the classroom.

### 2.4.6 Long-term outcomes

Often the investment in ICT-supported education programs is justified by their longer-term social and economic impacts, such as higher life satisfaction, higher income, improved health, and increased economic competitiveness and access to the global economy. Many of these anticipated outcomes are related to the internationally supported Millennium Development Goals, such as level of poverty, gender equity, literacy and health. More often these factors are considered the context for ICT programs; usually, the indicators that are used to measure such factors are provided in a general section on economic and social context. While it is fairly easy (although often expensive) to measure some of these indicators, it is much more difficult to attribute any changes in them to the specific introduction of ICT-supported education programs or projects because of the complex mix of educational, social, and economic variables that influence these indicators and the length of time needed to affect change.

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Often the investment in ICT-supported education programs is justified by their longer-term social and economic impacts, such as higher life satisfaction, higher income, improved health, and increased economic competitiveness and access to the global economy. Many of these anticipated outcomes are related to the internationally supported Millennium Development Goals, such as level of poverty, gender equity, literacy and health. More often these factors are considered the context for ICT programs; usually, the indicators that are used to measure such factors are provided in a general section on economic and social context. While it is fairly easy (although often expensive) to measure some of these indicators, it is much more difficult to attribute any changes in them to the specific introduction of ICT-supported education programs or projects because of the complex mix of educational, social, and economic variables that influence these indicators and the length of time needed to affect change.

However, one way to approach this is through the use of *tracer studies*. In these studies, a number of students in the target program and perhaps some that did not participate in the program are followed for several years afterwards. Measures of graduation rates, final average grade, tertiary matriculation, type of initial employment, and so on, can be used to estimate what the longer term impacts will be.

Another approach is to consider teacher attitudes, as was done in a study in Costa Rica (see Box 2.7). In any case, the reliability of such indicators can be increased by collecting information from more than one source, such as from both teachers and administrators.

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2.5 NATIONAL EDUCATION-AL AND SOCIO-ECONOMIC INDICATORS

2.5.1 National educational context

There are significant economic, technological, and educational contextual factors that enable—or more often in developing countries—constrain the potential impact of ICT-supported education programs. Identifying and describing these factors in an evaluation will provide a greater understanding of the national context for program development.

There are two types of educational indicators that need to be considered: those which pertain to the general educational system; and those which are particular to ICT for education (see Box 2.8). Based on such indicators, as reported by agencies such as the World Bank, UNESCO, and UNDP, policy makers have an opportunity to relate both inputs and outcomes of ICT-based projects to independently developed indicators.

2.5.2 National infrastructure context

The use of ICT in schools is very much dependent on the national ICT infrastructure. The extent to which power, telecommunications, and Internet service are generally available, even in remote and rural areas, will influence the extent to which an ICT-supported program can be successful. The “digital access index” used by the International Telecommunications Union26 is a compilation of indicators that describes a country’s information infrastructure (see Box 2.9).

Often there is a significant “digital divide” between developing countries and developed countries in these measures. Also, there are often digital divides within countries, such as between urban centers and rural areas, or gender, ethnic or minority groups. These should be acknowledged and addressed by program evaluators.

2.5.3 National economic and social context

The economic and social context indicators that are most relevant to developing countries are those related to the UN Millennium Development Goals. Indicators are listed for each of the MDGs (see Annex 1). Other basic economic and social indicators and data are reported in the World Bank Development Report and the UNDP Human Development Report.

BOX 2.8. Examples of national education indicators

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Test public expenditure on education</td>
</tr>
<tr>
<td>Educational expenditure per student</td>
</tr>
<tr>
<td>Relative proportion of public and private investment in educational institutions</td>
</tr>
<tr>
<td>School enrollment rates at various levels</td>
</tr>
<tr>
<td>Instructional time</td>
</tr>
<tr>
<td>Class size and ratio of students to teaching staff</td>
</tr>
<tr>
<td>Total public expenditure on education</td>
</tr>
</tbody>
</table>

Specific ICT for education

- Presence of a national ICT policy
- Presence of a master plan with a timeline
- National expenditure on ICT in education
- Ratio of students to computers
- Availability of computer networks in schools
- ICT as a separate subject in the curriculum
- Integration of ICT into the curriculum
- Number of schools incorporating ICT

Adapted from UNDP23, and UNESCO24.

BOX 2.9. National ICT indicators

<table>
<thead>
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<tr>
<td>Percentage of households with: electricity, radio, television, computer, Internet access</td>
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2.6 COSTS AND OUTCOMES

The kinds of programs and projects described in this handbook may be expensive in upfront and ongoing costs and could well be competing for funding with many other projects—including educational ones that seek similar outcomes without using ICTs. Policymakers should thus compare the outcomes of a program with its costs so that they can make the best choices for public investments. There are two ways to do this: cost-benefit analysis and cost-effectiveness analysis. 26

For a cost-benefit analysis, a common metric or indicator (money) is used to value the most significant costs and benefits for a particular project. This indicator allows for an analysis of a program or a comparison of several proposals, taking into account the time-value of money to determine the best return on the investment. The intent is to compute the monetary value of benefits and compare them to the monetary values of program costs or expenses. If a program does not achieve a minimum acceptable return of benefits to costs, then no funds should be invested. On the other hand, a cost-effectiveness analysis identifies and compares the costs of a project with some measurable outcome, without having to convert this outcome to a monetary value.

For either the cost-benefit or cost-effectiveness analysis, it is relatively easy to tackle the cost side of the equation. Fixed costs will be incurred irrespective of the size of a program: central buildings, facilities and equipment such as servers and radio/TV transmitters, central training and technical support, and infrastructure costs such as LANs, WANS, satellite connections and Internet Service Provision. Variable costs are per-user costs and depend on the number of users or participants in the program. These might include initial and recurring local facilities costs like computer labs, hardware costs, teaching materials, local connectivity and Internet usage, and local technical support. It is important to carry out a comprehensive analysis of all potential fixed and variable costs for a program, since often there will be not-so-obvious costs that might have serious cash flow implications as a program unfolds.

On the other side of the equation, it is often difficult to assign a monetary value to the outcomes of a project in the public sector because outcomes (such as improved test scores, increased school attendance, more competent teachers, and higher graduation rates) do not have a direct market value, as outcomes do in the private sector. Consequently, cost-benefit analysis may not be possible or appropriate. When it is used, alternative programs may be selected based on their highest net benefit, rather than the highest return on investment, since a very small project may have small benefits but even smaller costs, relative to a larger, more beneficial project.

Nonetheless, it is sometimes preferable in the public sector to use cost-effectiveness analysis, rather than cost-benefit analysis. The many measures and indicators of success described in this chapter show clearly that in the complex world of ICT for education, the “intangible” benefits (that is, in non-monetary terms) may be the most crucial ones. Thus, cost-effectiveness must take into account the many non-fiscal dimensions of a project that cannot always be put in strictly program monetary terms. As with a cost-benefit analysis, planners figure the program cost elements in monetary terms, but effectiveness (of outcomes) may be measured in other ways, such as improved test scores or number of students graduated or reduced downstream costs due to increased school retention.

2.7 CONCLUSIONS AND IMPLICATIONS

Policymakers and evaluators can draw on a wide variety of indicators of inputs, outcomes, context, and costs. Based on this review, we draw the following set of conclusions:

- Program evaluations should concentrate on measures of student and teacher learning. The learning measures that are likely to be most sensitive to ICT-supported programs are those that are custom-

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26 Monitoring and Evaluation of ICT in Education Projects

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designed for the program. These customized assessments should include measures of learning that are likely to result from the systematic use of ICT.

- Evaluators need to document and measure baseline inputs to the program, such as the amount and kind of ICT used, teacher training levels, and pedagogical practices that are associated with the program.
- Evaluators need to acknowledge and describe the national educational, technological, social, and economic factors that enable and constrain what can be done with the program.
- Evaluators may also need to calculate the fixed, recurrent and variable costs of the program and compare these to the program’s benefits (monetary and non-monetary), as well as the costs and benefits of alternative educational approaches.
- Direct measures of M&E indicators are the most reliable sources of information. They also tend to be the most costly. Indirect measures, such self-report surveys, can be less expensive, but also less reliable. The reliability of these measures can be increased by obtaining information from multiple sources.
- Finally, the program can benefit from obtaining and distributing information on these measures throughout the program’s implementation, rather than just at the end. This information can be used to spot problems in the early stages and make adjustments that will increase the likelihood of success.

In this chapter, we have tried to describe the different types of indicators that may be used in M&E studies of ICT for education projects. It should be evident that there is no single recipe, but there are nonetheless quite a few guideposts. Based on these elements, the next step in the M&E process is to focus on how to implement an evaluation study, which is laid out in the following chapter.

KEY REFERENCES:


Endnotes