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Technologies for Education (TEd)

A Framework for Action

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Technologies for Education (TEd)
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I. Technologies for Education: A Framework for Action

There is a broad consensus regarding the need to improve student outcomes in the educational systems of Latin America and the Caribbean. After an attempt to institute various reforms and initiatives, the demand for quality and equity continues to be heard throughout the region. Meeting this demand will require significant changes, regarding not only the teaching of subjects that are relevant to needs of a knowledge society, but also teaching them in a way that takes full account of the educational context that 21st century society has generated.

There is also a growing consensus regarding the importance of incorporating information and communication technologies (ICTs) in education (Kozma, 2008). These technologies do not in themselves make a marked impact on educational results. However, they can constitute an essential component in efforts to improve educational quality, to the extent that they are a part of systematic efforts.

The generalized use of this terminology has involved the challenge of incorporating an element (i.e., technologies that support information and communication) that is not intrinsically related to education. Such an element is "introduced" into school environments, and therefore requires adoption, adaptation, and appropriation to those environments. In contrast, the present document has been drafted within the framework of educational systems that are designed to produce quality results, to which end they use those technologies[1] that are relevant and appropriate. In other words, we are referring here to technologies for education (TEd) that have been conceived, designed, developed, and distributed in order to support processes aimed at improving student learning in accordance with educational needs and objectives.

The present document presents a framework supporting the design, implementation, monitoring, and assessment of projects designed to incorporate technologies for the purpose of improving educational outcomes.

The underlying assumption of this conceptual framework is that any genuinely educational project seeks to improve learning on the part of students. This involves a

[1] Specifically, in the present document, we refer to digital technologies that arise on the basis of the development and massification of information technology and network connectivity.

realization that there may be a number of different expected results, but that each of these must in some way be related to student learning. The following are fundamentally important considerations in this regard:

- Improvement in the commitment and involvement of students in the learning process, as reflected in their continued participation in this process.
- Changes in practices and experiences with respect to teaching and learning on the part of students, teachers, schools, and communities.

These changes and improvements are essential to any effective impact on the improvement of:

- Cognitive learning(curricular);
- The development of non-cognitive skills, or "21st century skills," including the acquisition of skills involving the use of Information and Communication Technologies.

The proposed framework emphasizes the importance of taking into consideration the use of technology in education within the context of educational policies, emphasizing four essential components (Infrastructure, Contents, People, and Processes) that need to be addressed. In addition, the proposed framework identifies the results and processes in which the project's planned intervention will be reflected, as well as those which, while not directly involved in the intervention, may nonetheless affect, or be affected, by the implementation of the project.

The present intervention also proposes the incorporation, in a more conscientious and rigorous manner than has thus far been the case, of a monitoring and evaluation process for each project. The review of the relevant data prior to the specific intervention (i.e., baseline) during the process of implementation (follow-up and monitoring) and, upon the end of the formal project intervention (final impact evaluation) both comprise an active and fundamental aspect of the proposed general framework.[2]

[2] Two other publications are of complementary importance: a project assessment guide for the use of educational technologies and a set of indicators associated with this framework. http://www.iadb.org/edu.ted

The use of indicators for the purpose of measuring the degree of development and maturation of systems will be an indispensable tool for making policy decisions that are based upon solid data and specific knowledge.[3]

Finally, because there is such a wide variety of initiatives, we have attempted to propose a sufficiently broad and flexible general framework that is capable of considering diverse projects in equally diverse environments, in different stages of development and maturity.

The application of this framework and indicators at the level of educational systems, at both the national and sub-national levels, seeks to provide a systematic and integrated vision that supports the decision-making process of those responsible for educational policies in countries within the region.

This conceptual framework for the design, implementation, and evaluation of initiatives for the use of technologies in education is aimed at policymakers, different levels of political and educational authorities, and those responsible for programs and projects. It is a framework that offers a way of simply understanding the various elements and environments that should be taken into consideration, and also offers the possibility of producing not only synergies between them, but also their systematic integration with educational policies.

As shown in figure 1, the framework encompasses the following elements:

- **Student learning** as the final objective of each intervention. Students are considered the direct and ultimate beneficiaries of all initiatives involving the use of technologies in education, whether for the development of cognitive learning processes or of the skills and abilities necessary that enable their participation in 21st century society.
- **Results**, which describe the direct products of the initiative that will allow the modification of the conditions and characteristics of the educational process in such a way as to facilitate an improvement in the learning expected of students.

[3] The World Summit on the Information Society (WSIS) concludes that "What must be developed is a realistic plan for assessing results and establishing references (both qualitative and quantitative) at the international level, through statistical indicators that can be compared and research results, for the purpose of following up on the application of the goals and objectives of the present plan of action, and taking into account the circumstances of each country." (WSIS, 2005).

- **Components and processes**, which present both the lines of action as well as the elements which will be modified by the initiative, and which should reflect the consequences of the proposed intervention.
- The process of **monitoring and evaluation** of the project, including the sources of data and information that are to be considered.
- The **policy framework** within which the initiative is to be implemented, and that will define its context and meaning, as well as describe its relationship with other initiatives and goals proposed for the educational system, as well as the actors who will be involved in its development.

On the basis of this Framework, we also propose a set of indicators that will facilitate the monitoring and evaluation of the initiatives to be implemented within different contexts.

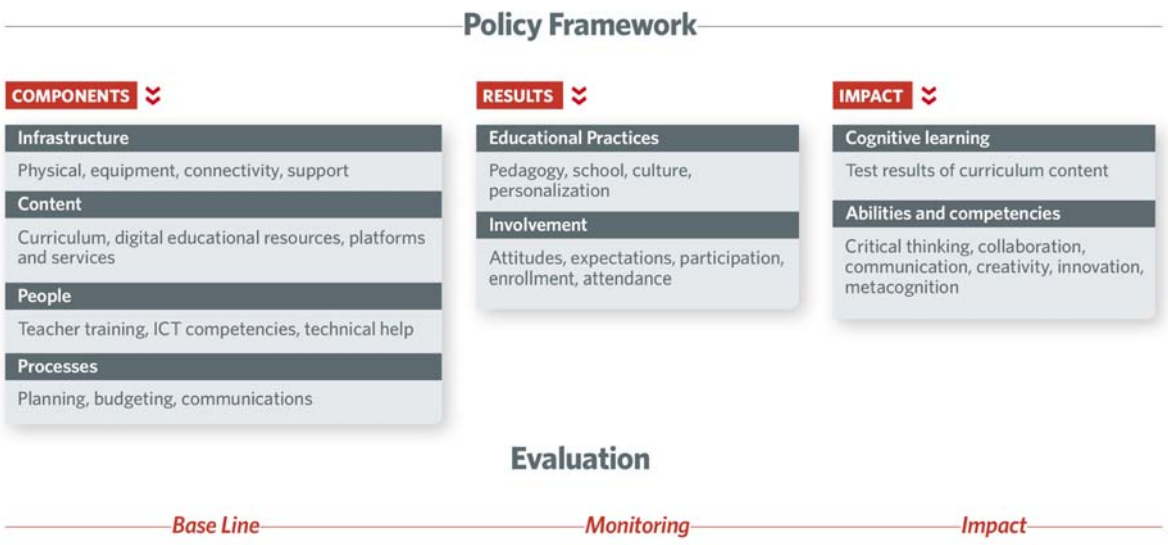


Figure I-1. Framework for Action

II. Impact, Results, and Components

In this document, we will examine the expected effects on student learning—something necessary in order to determine the educational nature of initiatives. In addition, we will define the direct results to be proposed in order to produce these effects, and also identify the components that a project involving the use of technologies in education should consider in order to attain the desired results.

This manner of structuring initiatives allows an alignment of actions with proposed objectives. In this way, planners and implementers will be able to draw upon an integrated means of designing, implementing, monitoring, and assessing the initiatives from a perspective that preserves coherence between the desired goals and the actions carried out.

2.1 Impact: Student Learning

Facilitating student learning is the ultimate goal and purpose of actions undertaken by educational systems. This must necessarily remain the case of initiatives that include the incorporation of technology into educational processes.

In each specific educational initiative, students are the direct and ultimate beneficiaries. Therefore, the expected results tend to be related to either the kinds of learning that explicitly seek to have an impact, or the kinds of learning that will be affected by their implementation. The impact of the project (whether positive, negative, or null) as well as its effectiveness will depend on the evidence of change that can be demonstrated in the kinds of learning seen by students, and their conditions. The relationship between the expected and real impact will define the success of a specific initiative.

Yet it is important to keep in mind the fact that student learning must be considered in the broadest sense of the term, and thus in a way that includes not only the standardized test results for some subjects, but that also seeks to measure outcomes in the largest number of environments possible—or, at least, in those environments which, from the strategic point of view reflected in these initiatives, are relevant.

It is rather common to declare that it is expected that these initiatives have an important social impact (i.e., reduction of gaps, social integration), as well as economic

(productivity, competitiveness, employment) and educational (non-cognitive skills, learning, school environment, internal efficiency) impacts, and to later measure only results in mathematics and language through the use of standardized tests. Yet another possibility, in the face of difficulties involved in measuring and showing educational results, is to address *only* social impacts.

Evidence regarding the effect of using technologies on educational quality is mixed in both developed and developing countries. Even in rigorous studies involving random assignment to treatment and control groups, there is a pervasive ambiguity with respect to the effects of technologies in the classroom. Some arguments in the literature that seek to explain this mixed evidence consider the initial level of students' knowledge, the design of software used, the attitude of teachers toward ICTs, whether ICTs are implemented within or outside the classroom, time of assessment, and the kinds of materials used. Comparing results is also difficult because the interventions are very different, and are implemented within different contexts.

Until now, the evidence has shown that the effect of digital technologies on learning depends on how it is adapted to the initial skill level of students. Banerjee et al. (2007) conducted a study of a computer-assisted teaching program in India. In this program, an educational kit that emphasized basic math skills was used with children two hours a week. The software used was adapted to student knowledge level, and the instructor motivated each student to play games designed to challenge their comprehension levels. The innovative component of the program that was used was that the software was adjusted to the knowledge level of each student. It was found that grades improved, with the most dramatic impact observed for students with lower initial knowledge levels.

Fang He and Linden (2008) analyzed a teaching program in which children were provided a machine called PicTalk, in which students can indicate figures with a pointer and listen to the machine's pronunciation of words associated with those figures. In contrast to Banerjee et al. (2007), they found that the strongest students benefited the most from the self-directed teaching, and that the weaker students benefited more from teachers. The authors stressed the importance of the role of software on the potential effect of the program on students. They contended that software must take into account the heterogeneity of skill levels within the classroom.

In the United States, Barrow et al. (2009) evaluated a teaching program based on computer programs involving random assignment in three school districts. The program involves various lessons that contain a preliminary test, a review of the necessary knowledge, the lesson, a cumulative review, and a test. The students can progress at their own pace. The authors found that computers had the greatest benefit on more heterogeneous skill groups. The authors contended that teachers are able to exert themselves to determine the right pace when a class is more heterogeneous.

In these cases, computers offer an efficient means of providing specific information to the user, thereby improving results. Many other studies support this same conclusion (Lepper & Gurtner, 1989; Heath & Ravits, 2001).

The central proposition of the present framework with respect to such studies involves taking into account that educational projects form an integral part of social and economic systems. Therefore, it is important to link interventions with results of projects in those settings. Nevertheless, this framework proposes a fundamental consideration of the impact of the results of learning—both cognitive gains (as determined by the acquisition of knowledge related to the curriculum content planned for students participating in the initiative) and the development of skills and abilities.

2.1.1 Cognitive gains

First and foremost, TEd projects are expected to have an impact either on cognitive learning processes (which are typically associated with subject or courses in which curricular content is subdivided) or on learning goals or expected skills.

The typical course of action has involved measuring this impact in a number of knowledge domains (language, mathematics, sciences) given that knowledge acquisition in these domains is what is measured in national or international standardized tests (whether administered to an entire defined group or a sample of a target group of interest). Thus, in some countries, there is a wealth of available data (i.e., national or international standardized tests such as TIMMs, PISA, etc. Even given that, until now, these instruments have involved only a limited scope of measurement (i.e., they are restricted to only some

skills and content); the few available studies have generally reported moderate positive correlations between TEd projects and the results of such tests.[4]

This process becomes difficult in countries that do not offer national standardized tests, or that do not participate in international tests. In these cases, consideration should be given to the development of *ad hoc* standardized tests that are administered before, during, and after the implementation of a project (i.e., baseline assessment) or, alternatively, to tests involving comparisons between groups participating in the project and non-participant groups (i.e., control or comparison groups).[5]

It is clear that the reasonable expectation of countries and individuals is that the incorporation of TEd (generally a complex and costly process) will lead to marked improvement in student learning. It needs to be established if such an expectation is warranted.

2.1.2 Skills and abilities

It has often been pointed out that the most important effect of the introduction of technologies in educational processes has been that they have led to students having new and improved abilities and skills. These skills have been described as "high-level skills" or "21st century skills" because of their importance within the context of personal functioning within the knowledge society.

Information and communication technologies (ICTs) are tools that are typically involved in a wide range of work and development opportunities. Therefore, effectively managing them can lead to personal and professional access and growth opportunities and, at the macro level, can make a difference in the development of a country.

The most ambitious initiative aimed at defining these skills and proposing instruments to measure them is an alliance of prestigious universities, led by the University of Melbourne, called ATC21S (Assessing and Teaching 21st Century Skills).[6] This alliance has proposed a framework that defines the expected skills, as well as the tools that allow them to be measured. By mid-2012, pilot projects under this initiative will have been

[4] Cf. E-learning Nordic (2006), SITES (2006), ImpaCT2 (2002), OECD PISA (2003-2006).
[5] CF. The later section on assessment.
[6] "Measurement and teaching of 21st century skills" (http://www.atc21s.org).

implemented in at least seven countries, including Costa Rica, with the support and participation of the Inter-American Development Bank (IDB).[7]

This international group has tentatively proposed a framework that incorporates the following 10 skills, grouped into four categories:[8]

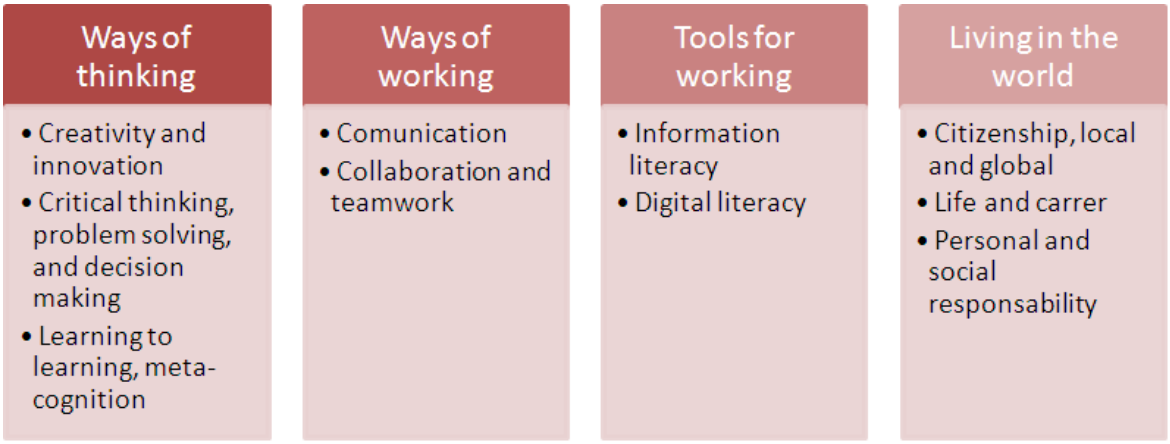


Figure II-1. XXI[st] Century Skills

2.2 Results

As a condition for improving learning outcomes, initiatives should propose two direct results: a change in educational practices and the strengthening of educational actors. These constitute *intermediate* results, and therefore are a necessary condition for producing the expected impact, but do not represent the final effect with which we should be satisfied. Any initiative involving the use of technologies in education in the form of projects, programs, or policies that would hope to succeed in modifying educational practices and increasing the level of involvement of the relevant actors that does not focus on improving the results of the learning process hardly deserves to be called an educational project.

7 Cf. "Twenty-first century skills: How to measure them and teach them," Eugenio Severin, IDB, May 2001 [Spanish].

8 ATC21S (2010). White Paper 1: Defining 21st Century Skills (Draft). Melbourne, Australia: Binkley, M., Herman, J., Raizen, S., Ripley, M., & Rumble, M. Available upon request at http://atc21s.org.

Case 1: Smart Schools (San Luis, Argentina)

The "Smart Schools" program was implemented in 2010 in the Argentine province of San Luis, and has been directed by the *Universidad de la Punta*.

This program targets educational institutions at the primary and secondary level in the province, and its goal is to improve student learning in the domains of language, mathematics, and sciences, and to install a management model in schools that is characterized by institutional responsibility for results, and that makes intensive use of educational technologies.

Admission into the Smart Schools program, which is optional for each educational institution, requires a commitment on the part of each teaching team to undertake a commitment to attain a higher level in successive academic years, on the basis of standards proposed by the Universidad de la Punta.

In order to enroll a school in the program, the director and 50% of the teaching team must indicate their agreement with these goals, and undertake a number of commitments.

Participating schools are informed of the parameters utilized for the assessment of their annual activity, and this allows them to organize their activities in a way that attains higher levels of recognition within the network.

In order to progress from one level to the next, schools in the program must demonstrate improvement in two of the three following areas: improvement in learning processes at the primary level, reading fluency, and SEC test results. All schools that obtain 65% correct responses on the SEC tests and performance tests in reading comprehension, mathematics, or life sciences are required to maintain this standard (and not necessarily to exceed it) for two consecutive academic cycles.

Smart School Levels:

Smart School 0. The baseline level at the time of signing on to undertake the above-described commitments.

Smart School I. A school that achieves an improvement in results of 5% Language, Mathematics, or Sciences at the primary and secondary level, plus an improvement in reading fluency at the time of testing in December.

Smart School II. A school that achieves an improvement of 7% in the results of two courses among the Language, Mathematics, and Science courses at the primary and secondary level, plus an improvement in reading fluency at the time of testing in December.

Smart School III. A school that achieves an improvement of 10% in the result of three courses—Language, Mathematics, and Sciences—at the primary and secondary level, plus an improvement in reading fluency at the time of testing in December.

Smart School IV. A school that achieves an improvement of 10% in the results of four courses, which must include *all* of the following: Language, Mathematics, and Sciences. The fourth course will be chosen by the Universidad de la Punta, and communicated in a timely manner to schools at the primary and secondary level. In addition, an improvement in reading fluency must be demonstrated at the time of testing in December.

Smart School V. Schools that, in addition to meeting the criteria for Smart School IV, demonstrate an improvement in the institutional environment. This component of school performance will be defined and presented to schools by means of specific indicators, and will be assessed by surveying parents of students regarding improvement in the functioning of the educational institution.

All levels must provide 180 days of classroom instruction.

Passing from one level to another will involve an increase of the incentives offered to institutions, teachers, and students (e.g., participation in teacher training programs outside of the province (but within the same country), consultation and support of the Digital Education Resource Group (DER Group) in different disciplinary areas in order to improve student learning, and publication of the experiences of program participants in different media.

2.2.1 Educational practices

The use of TEd implies a reasonable expectation that they will enable a substantial modification in both the teaching practices of instructors and the learning practices of students.

In order to maximize their affordances, the opportunities for accessing and constructing knowledge offered by TEd imply the development of new educational management practices, as well as the deployment of new pedagogical strategies and methodologies. There is a wealth of evidence in the literature that shows that wherever technologies have simply been incorporated as new tools for carrying out the same old activities, there has been little or no impact on education. Barrera-Osorio and Linden (2009) evaluated a program in Colombia in which students were randomly assigned, schools were provided with computers, and teachers received training over the course of 20 months. The innovative component of their assessment had to do with the fact that it focused on the component of the training provided to teachers. The authors argue that the training of teachers should make a difference in how computers affect the learning that goes on in classrooms. Yet what they found was that, in spite of the training they received, teachers did not subsequently incorporate computers into their teaching practices in the classroom. Thus, it is no surprise that no significant effect on learning outcomes was reported. The attitudes of teachers toward computers, as well as a change in their educational practices, play critical roles in the potential impact of any program.

This is an important environment for innovation, and one in which the development of TEd initiatives can serve as an important catalyst. The connection between teaching and learning practices, on the one hand, with growing daily student experience with digital, multimedia, and interactive environments, on the other, makes this component a highly relevant element for ensuring that there is a connection between projects and their expected results.

The data supporting educational management of classroom learning, platforms that facilitate personalized learning of each student according to his or her particular interests, learning style, and learning pace, the use of simulation games, or games that allow immersion intervals for the purpose of learning and problem solving, and the development of educational experiences that go beyond scheduled class times and the physical building of the school itself, for the purpose of reinforcing learning processes at any time and in any

place are some of the educational practices that the incorporation of technologies in education enable and strengthen.

Technologies are therefore just one more resource in the educational process, a resource with enormous potential, but one that needs to be incorporated in a coordinated manner, along with other processes, contents, and devices (whether digital or conventional) in order to produce the expected results. It seems clear that in instances in which an initiative does not succeed in modifying teaching and learning practices, it is not possible to expect changes in the results achieved by students, either in the different kinds of learning within their curricula or in the acquisition of new abilities.

2.2.2 Involvement of educational actors

The implementation of technological platforms that facilitate communication within schools, and within the educational system and its surroundings, as well as the strengthening of educational management processes that are more individualized and participatory—processes that provide relevant information in a timely manner for each party involved—represent highly viable aspects of a new approach for educational actors, one in which each participant exercises his or her role effectively and consistently.

Some of the fundamental components of educational processes have to do with the commitment of each of the actors involved: students, teachers, administrators, families, and the community. Their participation and continued involvement in these processes are necessary for success. Moreover, the attitudes and expectations in these processes have a positive impact that manifest in different ways—not only in the results of the learning that occurs and in the development of particular skills, but in the learning climate, in the expectations of other actors, and in the results of students with respect to their progress from one level to the next.

These processes also engender a dynamic of change in the motivations and expectations of families and the community. This dynamic is further magnified by a parallel process that occurs among the actors within the school itself, thus generating either virtuous or vicious circles (depending on how events play out) vis-à-vis the generation of conditions conducive to the development of learning processes. Yet this can only occur in the context of regular, integrated, and contextualized use of the technologies. Incorporating

them in a sporadic or token manner can only lead to short-term motivational effects that are quickly reversed.

Data regarding rates of attendance, grade repetition, dropout, and graduation are generally available, and allow for an analysis of impact that is relatively simple. The measurement of motivation and expectations requires the use of other instrument that, properly used, can provide important information regarding the effects of TEd projects.

2.3 Components

The effects of TEd projects also depend on proposed resources and an implementation strategy that view technologies as a complement to or supplement of other ingredients of the educational process. Implementing TEd projects as a substitute instead leads to mixed results. It is when TEds are implemented as a complement that a positive effect is found.

In a program implemented in India, Linden (2008) found that a computer-assisted learning program that was not adjusted to the level of student knowledge, and that served as a replacement of the teacher's instruction, led to poorer grades. On the other hand, implementation of the same program outside of the school was generally associated with an improvement of grades. The authors argue that the program is a good complement, but poor substitute, of classroom teaching. On the other hand, Barrow et al. (2008) argue that, in some contexts, technologies can replace tasks typically performed by teachers. Thus, they found that beneficial effects were associated with classes with increased numbers of students, variation in skill levels among students, and high absence rates within a class. Classes with a large number of students mean that there is less time for the teacher to provide individual attention to students. In such a scenario, computers fill the void, imparting instruction that the teacher is unable to provide. Barrow et al. (2008) also argue that a high variability in skill levels among students leads teachers to make special efforts to adapt the class to the majority of the students. Classes with high absence rates benefit because students can resume their engagement with material at the point where they previously left off. Thus, computers fill the void left by the absence of instruction in such circumstances. Consequently, technologies have a positive effect when they are introduced as a complement—and yet also as a substitute within contexts in which the instruction provided by a teacher is limited.

However, caution is advised when technology is used as a complement. In the absence of appropriate software, and parental and teacher supervision, relying on a computer may reduce the time students invest in homework. For example, Malamud and Pop-Eleches (2010) found that computers used in the homes of low-income children in Romania increased computer abilities and cognitive skills, but decreased scores in mathematics, English, and Romanian. This effect is diminished in homes in which the parents supervise the use of the computer.

The appropriate strategy for each context depends on the specific conditions of implementation. However, there are four basic components that, according to our proposal, need to be considered in the design, implementation, and assessment of any TEd project: infrastructure, content, people, and processes.

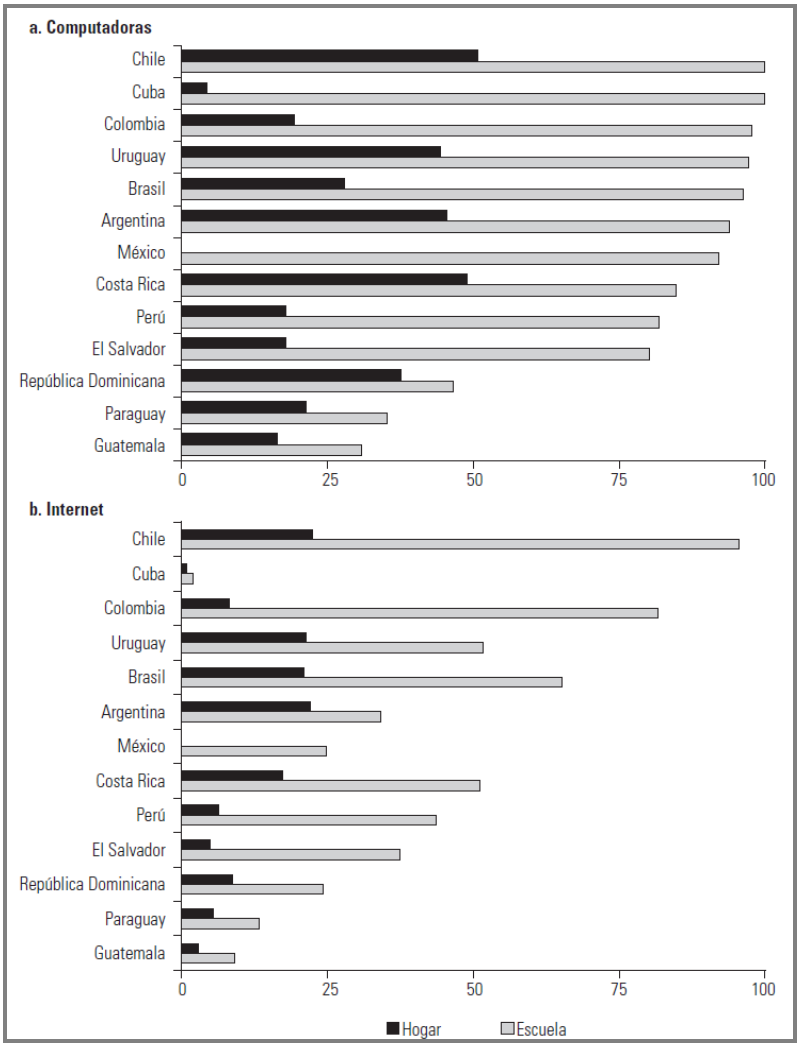
2.3.1 Infrastructure

We have already indicated that infrastructure and equipment are not in themselves sufficient for guaranteeing either educational innovation or improved learning results. Yet it is also true that innovation and results in schools without appropriate—or at least minimal—infrastructure equipment are very difficult to achieve.

Access to infrastructure for technologies for education (TEd) is highly variable throughout Latin America and the Caribbean. In Argentina and Chile, the percentage of students who have a computer in their homes is around 50%, while in Paraguay and Guatemala; it is close to 20%. In many countries, lack of home access to a computer is compensated by access in the school. In Argentina, Brazil, Chile, Colombia, Cuba, Mexico, and Uruguay, access to computers in schools is practically universal.

Internet connectivity has a enormous potential to enable students to access vast quantities of information, and also to facilitate communication, collaboration, and consultation of experts. In section b. of the above table, data are presented regarding home and school internet access. In the school, access varies considerably, from 96% in Chile to a mere 9% in Guatemala, a gap much wider than that of access to computers. It should be noted that in Cuba, while there is near total access to computers in schools, there is hardly any access at all to the internet.

Graphic II-1. Availability of technologies at home and in the school, 2006 (percentages)



Source: "Information and communication technologies in education (IDB, 2011)

It is clear that the existence of a single computer in a school can be interpreted as evidence that the institution has “access” to technology. But the reality is more complex. The number of minutes that each student can hypothetically spend in front of the computer on a weekly basis can be considered a reliable indicator of resources available to students. Yet, despite enjoying general access, students’ actual available time for such access is relatively limited. Costa Rica, Mexico, and Chile—where the actual time students have to use the computer averages 40 minutes a week—are the countries with the highest time availability for computer use.

The infrastructure requirements are strongly determined by the context in which each initiative is implemented. However, at a minimum, the following four factors should be considered:

Required physical support: Suitable conditions of the infrastructure elements necessary to enable use of and access to TEd must be in place: electricy, communication networks, classrooms, libraries, furniture, etc.

Equipment: This refers to the entirety of devices provided, including computers, projectors, printers, peripherals, and accessories, as well as the conditions associated with their acquisition and use (i.e., warranties, service levels, etc.). Costs associated with the end of life of equipment must also be considered. In some cases, equipment will need to be insured against loss or theft.

Connectivity: The importance of the Internet, and of access to the network under conditions that allow its use in educational settings, has undergone a transformation. The Internet will continue to constitute a growing challenge for TEd projects. It therefore merits special consideration. Bandwidth, connection stability, technologies that optimize traffic, filters that protect confidentiality (and that control the content to which students have access) are elements of concern. So is the structure of solid, secure, and accessible local networks. This requirement will increasingly exceed the bounds of the school, and will also encompass public spaces and private homes.

Technical support: This refers to the administration, maintenance, and repair of the available equipment, as well as to activities carried out for the purpose of resolving the technical problems and questions of users participating in the project.

As a consequence, the process of designing and implementing this component must, at a minimum, consider the development of the following products:

- **Technical specifications**: Refers specifically to the technical characteristics of equipment and networks, including conditions and characteristics of connectivity to the internet.
- **Logistical plan**: This includes the storage, localization, configuration, and distribution of equipment, as well as the specific way in which equipment will be selected, acquired, distributed, and integrated into the spaces to be used.

- **Usage plan**: Includes reference to investments that have been made, and which are necessary to the success of the program: classrooms, buildings, etc. It also includes schedules and systems to be used for providing users access to equipment, as well and an indication as to how equipment is to be made available.
- **Help desk**: Systems available to support direct and indirect users in the case of technical or pedagogical difficulty. Service fees, response times, mechanisms utilized, frequently recurring issues, the responses considered most helpful, and other indicators that provided a picture of the support available to users should all be included.

2.3.2 Educational resources

The essential purpose of educational systems is to enable students to master skills and acquire fundamentally important knowledge for their development as persons, citizens, and workers. The incorporation of technologies simultaneously offers the opportunity to develop new abilities (among others, those which allow for the productive and creative use of the technologies themselves), new supports for content through the use of digital resources (i.e., multimedia, online platforms, social networks, games, dynamic content), and new pedagogical strategies that are supported by the use of technologies (i.e., collaborative work on the network, remote communication, smart systems of knowledge management). This component should, at a minimum, consider the following elements:

TEd curriculum: Curricular development for the implementation and/or adaptation of content regarding TEd, and via cross-sectional usage of the technologies, for the purpose of supporting the deployment of all materials stipulated in the curriculum.

Digital educational resources: Digital material that corresponds to the curriculum and that is to be used for teaching and learning via technological means. This includes educational software, digital resources, encyclopedias, manuals, school texts, books, guides, videos, images, hypertexts, etc. Also included in this category is the development of portals that facilitate access to the resources provided on the part of educational actors.

Learning management systems: Applications and services: development or incorporation of software or support initiatives in order to conduct teaching and learning activities, including productivity applications, simulators, modelers, etc. Also to be included are

mechanisms and means for distributing digital content to individual users of the educational systems, taking into consideration various contexts and usage models.

Consequently, the design and implementation of this component must indicate that it includes, at a minimum, the following elements:

- **Curricular review**: Work conducted for the purpose of connecting the curriculum or learning goals with the objectives associated with the use of educational technologies. This includes the incorporation of TEd into the curriculum at different educational levels, their inclusion as a cross-sectional or vertical skill (or content), and the learning goals that have specifically been proposed for their management by each of the actors.
- **Pedagogical model**: Determination of times, forms, and behavior expected from the different actors that form part of the group involved in the project (either directly or indirectly) with respect to access, as well as the general and educational use of the available equipment and resources. This includes the forms in which learning (i.e., didactic) activities are structured and organized, including the way in which the curriculum (whether in terms of its separate subjects or considered as a whole) is developed; the hours and frequency of use (separated by subject matter); the principal pedagogical approach or approaches at the institutional level, and the knowledge management strategies.
- **Resource Development Plan**: Definition of the mechanisms that will facilitate efficient and timely access to educational resources on the part of the direct or indirect beneficiaries and an indication of their relevance and quality in terms of the proposed objectives. This is to be done through an educational portal and/or local servers in the schools. It should also include technical and pedagogical standards for the development of digital and educational resources and a classification strategy.

Case 2: Digital Educational Resources (Colombia)

The Educational Portal *Colombia Aprende* (http://www.colombiaaprende.edu.co) was created in 2004 to serve as a virtual home for the Colombian educational community and is the principal means of accessing networks. The portal has digital content that supports the development of pedagogical practices, strategic media, and ICT projects.

The value propositions of the *Colombia Aprende* Educational Portal include offering the educational community tools, educational resources, and services for supporting quality improvement, fairness, and efficiency in Colombian education. These tools address the needs and interests of that community. The portal also aims to do the following: promote the creation of learning networks and communities by actors within the educational community in order to facilitate their incorporation into the knowledge society; provide users access to knowledge reflecting diverse perspectives, formats, and tools, and that is connected to national and international networks; and to serve as a forum for research, analysis, collaboration, innovation, and the fostering of critical attitudes.

The portal receives more than one million hits every month, and provides dashboards to users with basic, intermediate, and higher education, and to the community in general. The portal also provides these users tools, educational resources, and services though microsites in accordance with their needs and interests. *Colombia Aprende* is a center of pedagocial resources, services, and tools that facilitates the exchange of information regarding significant experiences, the participation in networks and communities, access to educational processes, collaborative research, and educational innovation.

At present, the portal includes more than 33,000 educational items, and houses the National Bank of Learning Materials, which contains 4,348 items. The portal is also the entry point for the national educational activities, and students from all over the country are invited to participate in projects such as the National Story Contest, History Today, and Botanical Expeditions.

All of the educational processes promoted by the ministry include a virtual interactive space on the portal that serves as a forum for discussions, academic reflections, and collective constructions which have grown into virtual learning networks and communities. Thus far, 62 virtual courses designed for teachers and administrators have been generated for the community, with 17,007 users participating in these courses, which are supported by 45 tutors, who are responsible for providing counsel and coordination to facilitate the process.

Since 2004, the educational portal has formed a part of the Latin American Network of Educational Portals (RELPE). From 2006 to 2010, the Colombian Ministry of Education has presided over this network, which now links 22 educational portals.

The future of the portal is connected to a cooperative project involving South Korea which includes, among other objectives, the definition of quality standards for the production of digital educational content to be distributed throughout the country.

2.3.3 Human resources

At one time, it was thought that technologies would, in and of themselves, be able to substantially modify educational practices and results, yet the available evidence has led to the abandonment of this hypothesis. The presence of well-trained and available teachers, committed school administrators, involved families, and enthusiastic students have collectively made an enormous difference in the impact that projects have had. Preparing, training, and accompanying each of the actors involved is indispensably necessary for

successfully implementing initiatives for the use of technology in education. A commitment on the part of all of the actors with schools is especially necessary within the context of the poorest and most isolated communities, where isolated students do not have social, cultural, or economic resources for developing for themselves the abilities that the knowledge society requires. At a minimum, the following elements need to be taken into consideration:

Training of teachers and administrators: Initial and ongoing training in the adoption, adaptation, and updating of educational contents and practices for the purpose of integrating TEd into the classroom and reinforcing positive attitudes on the part of teachers toward integrating technologies into their instruction. This includes the development of general skills involving the use of TEd (i.e., training initiatives for the acquisition and/or certification of general skills involving the use of TEd, basic training, and both productivity and communication tools) and specific skills that guarantee the educational use of TEd (i.e., training and educational initiatives associated with the specific use of TEd for specific educational purposes, and within specific educational contexts).

Pedagogical support: Efforts to provide pedagogical support and follow-up for participants, providing orientation for them or developing ongoing tutorials for the implementation of proposed activities. This includes the training of professional teaching communities comprising teachers, and essentially permanent collaborative and professional development networks.

Community involvement: Actions that promote and allow the active participation of the community in the development of projects, and as direct or indirect beneficiaries of the program.

For this purpose, the design and implementation of this component must indicate the inclusion, at minimum, of the following elements:

- **Teacher registry**: All data relevant to teacher performance in terms of learning objectives: training, hours of instruction, student-professor ratio, salaries, performance evaluation, incentives, etc.
- **Educational use models**: Document that summarizes the characteristics of training accessed by the involved actors for the purpose of exploiting the potential of TEd in

educational contexts, as well as experiences of the educational use of TEd, both inside and outside the classroom.

- **Educational support plan**: Mechanisms designed to motivate, accompany, and support the work of the actors involved in the project, such as technical assistance to schools, tutorials or assistanceships for teachers, plans for providing support (either personal or online), training resources, peer support, guidelines for families, etc.
- **Contract with the community**: Document proposed and agreed upon by the community that describes the way in which the project considers or affects the involvement of the community for the purposes of attaining the proposed objectives, especially as regards the families of students. Also to be included are actions that have been undertaken in order to publicize the initiative, and to include it in the context of development, the orientation provided to direct and indirect participants, and the communication with involved parties that facilitates legitimating the project.

Case 3: Training in the use of educational technologies (Chile)

In the case of Chile, a computer education program called *Enlaces* ("Links") was introduced in 1992. The pilot phase of this project lasted from 1992 until 1996, at which time a national policy was introduced that, through 2004, gradually provided ICT infrastructure, connectivity, and educational resources to more than 90% of Chile's primary and secondary schools. In addition, *Enlaces* constituted a national technical assistance network during this period that provided training and technical support to schoolteachers who utilized the program. Beginning in 2005, *Enlaces* began an institutionalization process that led to the creation of the Center of Education and Technology of the Chilean Ministry of Education.

The program's digital skills training program consists of the development of a set of initiatives aimed at reinforcing the capacity to exploit the potential of ICTs within the school context. The principal strategies of this program are as follows:

a. **Ongoing teacher training program**. This strategy seeks to provide teachers with the skills necessary for exploiting ICTs in their professional work. For this purpose, *Enlaces* developed ICT competency standards for teachers on the basis of which it offered a series of basic-level courses (i.e., functional ICT skills) general courses (i.e., in the general use of ICT in teaching and learning) and specialized courses (i.e., in the use of ICT by specific categories of professionals who work in educational establishments, such as administrators, support staff, teachers, etc.). These courses are offered in classroom, distance-learning, and mixed formats, by both the Center for Advanced Pedagogical Studies (CPEIP) and by RATE.

b. **ICT skills for initial teacher training.** *Enlaces* developed ICT competency standards that education students need to meet during their professional training. These standards are enforced in institutions where teachers receive their initial training. In addition, consideration has been given to the application of these principles in the *Inicia* ("Getting Started") program of the Ministry of Education. Finally, *Enlaces* took part in the international study "IT in Initial Teacher Training," which was conducted as part of the "New Millennium Apprenticeship" program of the OCDE.

c. **ICT skills for students**. Enlaces formulated a series of objectives and created content related to ICT that students with an intermediate level of education should attain upon completing secondary grade IV. In addition, during this period, *Enlaces* has been in the process of defining a set of standards for twenty-first century skills. These definitions were complemented by participation in the "New Millennium Apprenticeship" project, in which a series of ICT skills for teaching were defined, and in which an instrument for assessing and testing these skills was constructed and evaluated.

2.3.4 Management

The implementation of these kinds of initiatives is extremely complex, and requires highly developed management skills in order to administer complex processes involving a number of simultaneously operating variables in complex contexts. The design of the program must include management mechanisms and structures that make resources and skills available for leadership at all levels—from the school to the national level. At a minimum, the following three elements must be taken into consideration:

Leadership: Clear and specific functions should be assigned that each actor will meet in accordance with his or level of responsibility, including the distribution of resources that make this possible, and the proper communication with all actors that allows the formulation of an informal contract in which the commitment of all parties to the proposed objectives is specified in writing.

Administration: Structures and strategies for the management and administration of systems and projects at all levels under consideration (national, regional, school, department), as well as the relationship with other institutional actors involved in the project (financing entities, strategic allies, etc.).

Information systems: Developments designed to support the implementation of management and information systems at the national, regional, and school level, and of systems that enable the follow-up of educational projects and their actors, including curriculum management and pedagogical management.

The implementation of this component includes both the process of training leaders of the initiative, as well as the provision of technological resources the technological resources that facilitate this process. It may include the development of the following elements:

- **Administration and management model**: This will include a presentation of the way in which the provision of education is organized in the academic institution, the hours that teachers will work, and the systems dedicated to organize and supervise functioning with respect to the incorporation of TEd. The model should also include systems and mechanisms available to the school and/or educational system, or which the project affects or modifies, and which collectively enable administration and follow-up with respect to the actions involved in meeting the proposed learning objectives.
- **Management systems**: Ease of use and ease of accessibility of the software, services, or platforms that facilitate both management and communication among the actors within the school and among schools and higher organizational levels within the school system. The purpose of these components is to reinforce decision-making process at each level, and to ensure the availability of information for that process.

III. Policies and Technologies in Education

In this section, we will explore the relationship between, on the one hand, the design and implementation of educational policies and, on the other hand, the development of educational technologies (TEd). This subject comprises two different yet complementary aspects. The first and most important involves the consideration of initiatives that propose the incorporation of technologies in educational systems as an integral part of educational policies, and not as a parallel and disconnected component. The second consists of exploiting technologies in order to improve the design and management of those educational policies.

3.1 Educational policies that incorporate the use of technologies

The history of education in Latin America during the past 30 years is full of isolated episodes involving the incorporation of technologies. The spontaneous enthusiasm of a president or minister of education, the pressure of an "irresistible offer" extended by a manufacturer, and the social pressure of a citizenry calling for immediate action to improve quality have all acted as forces that have encouraged the implementation of projects that have been disconnected from the objectives and actions that have formed part of the educational policies of Latin American nations.

Yet in instances in which initiatives have been closely tied to educational objectives and strategies, they have enjoyed a more welcome reception on the part of educational communities, better integration into educational practices, and greater persistence over the course of time. Examples include *Enlaces* in Chile, *Colombia Aprende* in Colombia, the efforts of the Omar Dengo Foundation in Costa Rica and, most recently, the "Policy for Integrating CIT's in education" in Paraguay, as well as the efforts to foster educational initiatives undertaken as part of the Ceibal Plan in Uruguay.

In order to help achieve the expected results, the design, implementation, monitoring, and assessment of initiatives for the use of technologies in education should form a strategic part of educational policy, state their intention to contribute to the attainment of the objectives they propose, and be coordinated with other policy components in an integral fashion.

In this regard, the following four points of coordination and integration should, at a minimum, be considered:

Leadership: The conviction and support of educational and national authorities is critically important. The experience of many countries shows how, especially during difficult times when resistance is shown and beneficial results cannot be demonstrated, that the presence of educational leaders who are both convinced and capable of convincing is crucial. Initiatives capable of contributing to achieving the expected results are increasingly probable to the extent that they are understood, valued, and supported by these leaders. This includes the incentives that reinforce the participation and commitment of other educational actors by means of plans and programs that spotlight (either positively or negatively) the participation of leaders, and the results that they have been responsible for obtaining.

In this regard, it is crucial to consider those who lead each initiative, and the roles of each person and agency that will bear responsibility for each initiative. Experience shows that countries have tried different models: information technology units within the Ministry of Education (in Chile, Paraguay, Honduras, and Colombia), a dedicated ministry (in Argentina and Brazil), a public office dedicated to innovation (Uruguay and Mexico) or a private public-interest foundation (in Chile and Costa Rica). In all of these cases, over and apart from the institutional arrangements in place for implementation, the greatest success has been associated with the unambiguous and forceful support of political authorities.

Planning: Initiatives should be explicitly tied to medium-term and long-term priorities that clearly establish the contribution that they will make to the policy as a whole. The existence of national plans (or sub-national, regional, or municipal plans, as applicable) that comprehensively describe the introduction of technologies into educational systems, and that interconnect these systems both with one another and with the remainder of educational goals and policies, and with development strategies, are indispensible not only to the future sustainability of the effort, but also to the coordination of actions, the commitment of participants, and the effectiveness of implementation over the course of time.

Sustainability: The incorporation of technologies into education will involve the dedication of an important quantity of economic resources that cannot be supplied by means of a one-

time investment, but that instead involves long-term commitments that assure operational continuity and the development of complementary initiatives that are necessary for achieving the expected results. In our region, it has often been the case that only initial costs of buying equipment have been taken to account, without considering the costs involved in maintaining, supporting, and expanding initiatives. This has resulted in the abandonment of projects prior to completion because no adequate provisions had been made for their sustainability.

Adequate budget allocations involve the identification of sources and procedures by means of which operations involved in the initiative (as well as related operations) have been financed. In addition, expenses must be considered, with recurrent expenses necessary to the future sustainability of the program specified. For example, an assessment of total appropriation costs should be included.[9]

Legal framework: The recent development of technologies requires the creation of new legal frameworks (or the modification of those already in existence) with respect to a number of important issues. Therefore, actions must be encouraged that are aimed at adjusting and adapting available rules for the purpose of promoting and improving the impact of the initiative, and minimizing any risks involved. This includes measures that are aimed at improving the protection and security of legal minors, the regulation of associated industries (e.g., telecommunications), and safeguarding copyrights, among others.

[9] Known as TCO (Total Cost of Ownership). West, R., Daigle, S., (2004). Total Cost of Ownership: A strategic tool for ERP planning and implementation. Educause Center for Applied Research Bulletin. Or you can reference the One-to-One Technical Note.

Case 4: Integral policies for the use of educational technologies (Bahamas and Paraguay)

Bahamas has an educational ICT policy that was developed in 2009-2010 as part of the "Education and Training for Competitiveness (ETC) Project, which has received financing from the IDB.

This policy proposes a vision of "incorporating a range of technologies into public schools in order to make possible the optimization of learning conditions, strengthen all of the educational actors, and assure global competitiveness." In order to achieve this vision, three strategic development areas have been proposed:

1. Assuring effective educational management, focusing on making possible the use and analysis of evidence for designing policy, school management, and teaching practice.
2. Improving ICT teaching and learning, focusing on reading, writing, and arithmetic at the pre-school and primary levels, and then mathematics, science, and language at the secondary levels, while improving access and use of ICT in order to support the learning process in all areas and levels.
3. Providing ICT-related opportunities, mainly in order to improve the ICT skills of all students; align CIT resources utilized in secondary and tertiary education; and design and implement a technical-vocational area linked with secondary education ICTs.

On this basis, the implementation of the policy will consider seven different lines of action:

1. Information systems for school management.
2. Pedagogical training and support.
3. Integration of ICT in the curriculum and digital educational resources.
4. ICT infrastructure.
5. Technical support.
6. Monitoring and assessment.
7. Research and development.

Between 2008 and 2010, Paraguay developed a "ICT Educational Policy" which established a series of different actions to be implemented. The policy sought to realize the vision of "contributing to both the improvement of educational processes through the use of ICTs, and to the engendering in all students of the digital skills that are necessary for participating in, and contributing actively to society." Within the context of this vision, it proposes the following objectives:

1. Providing a digital infrastructure to primary and secondary schools, attaining a national ratio of two students per computer.
2. Assuring that secondary-education students acquire basic ICT skills.
3. Assuring that MEC professors, trainers, and functionaries attain a defined standard of ICT skills.
4. Support the improvement of the teaching and learning processes through the use of CIT.
5. Support the improvement of school-management processes through the use of CIT as a planning, administration, and monitoring tool in educational institutions.
6. Support the initial training of teachers through the use of CIT in various educational processes.
7. Support a predictive capacity in the use of CIT in education through developing national capacities and infrastructure for research and development in CIT.

Finally, in August, 2010, a Presidential Commission for the Incorporation of CIT into the Paraguayan educational system was established. This commission comprises representatives of the office of the presidency, the Ministry of Finance, the Technical Secretariat for Planning, and the MEC itself, among other entities. This commission has a dual role. On the one hand, it facilitates the coordination of MEC policies with the policies of other governmental entities that are necessary for developing aspects of policy that are beyond the scope of the MEC (e.g., coverage of telecommunications services). Its other role involves the integration of relevant points of view into decision-making processes involving CIT investment in order to assure that this policy represents the interests of the state as a whole, and not just those of the MEC.

3.2 Technologies in the design of educational policies

Technologies can also function as an ingredient that facilitates quality improvement in the very process of designing, constructing, and implementing educational policies. The opportunities created by the massive presence of technologies in society and in the hands of citizens constitute a singular moment in history that may help strengthen citizen participation and facilitate communication between authorities on the one hand, and the various actors of the educational system on the other.

Educational and governmental authorities, as well as private actors in education, are able to have access to information ingredients that could be crucial to improving educational systems. Examples include access to available curricular or pedagogical proposals available in specific places (even if these places are in other countries or regions); to innovative educational material; to comparative pricing data regarding each ingredient; comparative policies, aggregate expense data in education, more precise enrollment data, as well as data regarding the movement of students and/or teachers, grade repetition, and training curves. Yet another example is access to information regarding market demands, in terms of geographical distribution, types of skills required, and specific industries. A final example is access to information regarding good systems of data collection and analysis that allow the development of educational policies and the strengthening of evidence when it comes to making decisions.

The same applies to the potential for improving communication between authorities, on the one hand, and each of the educational actors, and citizens in general, on the other. Information regarding specific actions, along with the ability to quickly obtain opinions and reactions, and to facilitate participation, are possibilities that have until now hardly been explored but that, especially on the basis of developing social networks, are potentially very useful.

It is also important to consider the positive impact that the use of technologies might have on the cost of many of the processes that are part of our educational systems. Examples include processes involving the production and distribution of educational materials; administering learning tests and surveys, and disseminating and distributing of content and information.

The array of ingredients involved in drafting and implementing policies may be strengthened and promoted if educational systems and their leaders seriously consider the opportunities offered by technologies. Other spaces and systems of societies (banking, finance, health, engineering, and urban architecture, to name a few) have already actively incorporated technologies for improving the processes and results of their efforts. This process has been slower in education, and its development reasonably requires explicit promotion and clear leadership in order to obtain effective advantages in the management of educational systems conducive to achieving quality results.

All this requires specification of new institutional capacities, not only in schools but also in ministries or secretariats of education (or in whichever other entity bears final responsibility, as previously described) so that their professional and support staff, and their policies and procedures, are able to properly exploit these kinds of investments. Just as doctors nowadays use technologies to obtain an accurate diagnosis, and a health minister also uses technologies to make public health decisions (i.e., regarding the acquisition of medications or the management of hospitals), educational systems need to assure that their actors have the ability and the needed supports to carry out similar processes.

All of the processes indicated until now are not only related to the improved efficiency of the educational system, but also to their effectiveness. In other words, it is not just a matter of achieving the same results in less time and at reduced cost but, most importantly, of obtaining *better* results.

In the following section, we will review three different domains in which the development of institutional and personal capacities, as well as the improvement of processes involving the design and implementation of educational policies, requires special attention if one hopes to improve the quality of educational results.

3.3 Technologies for improving quality

The knowledge society requires citizens who are active, creative, innovative, flexible, critical, oriented toward resolving problems, collaborative, prepared to engage in lifelong learning, responsible, and able to communicate. All of these abilities have always been present in societies, but it is only in the twenty-first century that they have become required of *all* citizens, and not only an elite.

The use of educational technologies offers original opportunities for developing these "21st century skills." In many instances, teachers need to foster these abilities on the part of their students when they themselves have not benefited from any similar effort. In reality, information and computer technologies, especially those that have arisen in recent years, such as pad tablets, smart telephones, low-cost laptops, and easy access to the internet, along with Web 2.0 and social networks, have become transformed into spaces and instruments that are particularly conducive to such a development.

The massive presence of devices, along with access to programs and content that are highly collaborative in nature and oriented toward the resolution of specific problems, collectively support educational efforts. Without such supports, it would be very difficult to work on fostering these abilities.

The framework that we propose in this document places special emphasis on the fact that one of the results that we must require of educational projects that use technology is that they be able to foster students' acquisition of twentieth century abilities and skills.

This is critically important for society in terms of upgrading the quality of its human capital, and thus improving productivity. It is similarly important for renewing the citizenry, and therefore for strengthening democracy. Thus, from this perspective, the demand for higher-level abilities is a demand made by society as a whole of twenty-first century education. It is therefore fundamentally important, on the basis of the national public interest, to align public policies in accordance with this demand, not only policies of the educational sector, but also those that will benefit from this development (i.e., policies re justice, health, citizen participation, and social cohesion, among others).

The second important aspect has to do with the potential of technologies to develop individualized instruction.

Agricultural society made available individualized education to an elite that constituted a minority of the population, and that therefore was highly homogenous in character. Industrial society expanded access to education. Educational systems became more democratic and, therefore, not only broad-based but also highly heterogeneous. However, individualized instruction inevitably fell victim to this process. Industrial society could do nothing more than standardize the education that it provided, offering an average solution for average students. The industrial educational solution was to group students according to age, offer the same content at the same pace to all, using the same educational methods, and without considering individual differences among students.

The information society, which arose at the end of the twentieth century, has for the first time in human history offered the possibility of maintaining the broad-based, democratic, and heterogeneous nature of educational systems, while also recovering the element of personalized instruction.

Today, technologies offer tools that are sufficient for "profiling" each student according to his or her characteristics, tastes, interests, abilities, previous achievements, and learning styles. In this way, technologies provide support to the work of teachers. Through using technologies, it will be possible to design and implement differentiated pedagogical strategies that are based on the profile and data available for each student, and that propose a learning itinerary for each that most effectively leads to the attainment of the objectives of the curriculum.

Somewhat counterintuitively, the available data in this regard[10] show that none of this involves *more* work for teachers, but rather *a different kind* of work. Thus, the teacher will no longer be expected to be the source of knowledge that he or she transmits to a group of passively receptive students, but rather an articulator of educational experiences and a manager of learning processes who, making use of technological supports, is able accompany students during their educational process.

[10] Severin & Araneda. Report on Individualized Learning Environments in Latin American Countries. Forthcoming.

Finally, the third special beneficiary of the incorporation of technologies into education is specifically that part of the population not currently served by formal educational systems as currently constituted.

There are contexts that are especially important in this regard. One example is communities that are located far from urban centers and that lack schools and/or sufficient numbers of teachers. Another is the many young persons and adults who have left school (or who have been expelled from school) and who do not have at their disposal more flexible opportunities to resume education—and thus open the doors to new opportunities. Yet another example in this regard are schools with insufficient numbers of teachers (or with teachers lacking proper qualifications), and where access is required to educational materials that facilitate learning and that complement the work of the school itself.

Within all of these contexts, the use of technologies offers opportunities to improve the education that is provided, either by offering education in places where it does not exist today or by complementing the education currently available with quality content that is certified either by educational authorities or by users themselves (whose use in and of itself constitutes an endorsement and recommendation).

Education available in any space and at any time is possible with the support of technologies. The ubiquity provided by increasingly small, portable, and cheap technological devices offers opportunities to expand educational experience far beyond the five or six hours of classroom instruction.

With respect to these three characteristics (i.e., development of high-level abilities, individualization, and ubiquity) educational technologies offer new opportunities for improving the quality of our educational results. Thus, it is not a matter of using technologies for the purpose of reproducing the educational practices of industrial society, but of using them specifically in order to modify the educational practices of all actors and school systems, to extend their availability to all children and adolescents, and to make these practices more relevant to the characteristics of students and the needs of society.

This in no way denigrates the function of the school as a fundamentally important venue of education. On the contrary, the school will continue to be focal point in which these aspects can be identified and where they are developed—but it will not be the school as we know it today.

IV. Assessment

The research that has been published thus far does not offer conclusive evidence that sheds light on the decision-making process with respect to educational quality, specifically in terms of what to do and how to do it.[11]

The inadequate assessment of initiatives that have incorporated TEd is the result of implementation that has in many cases been intuitive and lacking in rigor. However, it is also related to the lack of specific tools that reliably measure the effects of such initiatives, that properly isolate such effects from the other numerous variables present in educational processes, and that are dynamically affected by the introduction of TEd. Another problem in terms of assessment is that the introduction of TEd involves recent developments offering radically different solutions, and that evolves at a very rapid pace.

In fact, the recent literature[12] has drawn attention to the phenomenon of the lack of innovation in educational practices when TEd are incorporated, noting that, until now, the majority of initiatives have been limited to the "digitalization" of existing processes and practices. Thus, the same activities undertaken in the past have been repeated, the only difference being that such activities are not supported by computers and other technological devices. The predictable result of this is that the impact of this kind of use of TEd has been rather limited.

The use of TEd within the context of disruptive innovation,[13] as well as comprehensive interventions that represent a radical departure from previous practices, probably have a higher probability of leading to better results. However, there is even less data available regarding such interventions, and few evaluations and/or studies have been published.

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11 The exercise used for establishing a "knowledge map" which was developed by InfoDev of the World Bank (Trucano, 2005) showed how, over and apart from the large investments that have been made in many countries for introducing CITs into educational systems, the data that support assertions regarding its important role in improving education are not only limited, but susceptible of varying interpretations.

12 Some studies have found a positive effect on achievement tests (NCES2001a, NCES2001b, Banerjee et al. [2007], Barrow et al. [2009], He and Linden [2008], Cox et al., [2003], Harrison et. al. [2002], Kulik [2003], Linden et. al. [2003], Machin et al. [2007], Wenglinsky [1998]). Others show no affect at all (Angrist and Lavy [2002], Barrera-Osorio and Linden [2009], Goolsbee and Guyryan [2006], Machin et al. [2007] and Leuven et al. [2007], Rouse and Krueger [2004]), while still others have reported negative effects (Linden [2008], Harold Wenglinsky [1998]). For a US literature review, see Kilik (2003).

13 Cabrol, M., and Severin, E. (2010). Disruptive Innovation.

The present framework is not being developed as an assessment model. Nor does it explicitly propose the use of specific tools. Instead, it is essentially a guideline presented for taking into consideration the elements involved in a system and/or project of this kind. Those who assess these elements will apply and/or develop assessment models or tools that are appropriate for each context.

The central assumption of this framework is that the purpose of the educational process is to attain results with respect to students' learning, as well as students' development of skills and abilities. Therefore, the expected results of the interventions are associated with positive changes in teaching practices and study practices, as well as with a higher degree of involvement of students in the learning process. The long-term expected impact is a significant improvement in different kinds of learning, as well as in the development of the skills necessary to function in a global world.

What follows is a step-by-step description of the basic actions to be carried out as part of an assessment of the results and impact of these kinds of programs. This description takes into account all of the important aspects of such programs within the context of the previously described conceptual framework. In the section that follows, we will refer to the follow-up or monitoring of initiatives, as well as to the ingredient and process indicators associated with such activity.[14]

It is important to remember that assessment is part and parcel of each stage of the project and that, ideally, the assessment process should be designed as part of the project, and not after it has been implemented. However, it is also important to remember that there are mechanisms for assessing impact in those cases in which neither a beneficiary nor a control group were identified within the program design.

In order to conduct an impact evaluation, it is necessary to identify and separate the benefits achieved as a consequence of program intervention from those which would have occurred as a result of: 1.) the absence of the implementation of said program; 2.) the normal development of environmental conditions; or 3.) the activities of other public or private programs. Given the fact that the counterfactual situation by definition does not exist (i.e., we do not know how the program beneficiaries would have been in the absence

[14] For a more detailed description of the assessment process, the IDB has published "Assessment Guidelines for Projects Involving Educational Technologies". 2012

of program implementation) it is necessary to construct a hypothetical situation that allows us to simulate the counterfactual situation. This construction involves the use of a control group that comprises non-beneficiaries that are part of the group that the program seeks to affect, and that share with the beneficiary group the same social, economic, educational, and other relevant characteristics. The following two mechanisms are typically used to create such a situation:

***Random assignment**:* This involves the construction of beneficiary (i.e., experimental) groups and control groups through the use of random assignment of group members eligible for inclusion in a given program. Random assignment assures, from the beginning of a study, the presence of a control group that is statistically identical to the beneficiary group.

***Quasi-experimental assessments**:* It is often not feasible to randomly assign the beneficiaries of a program. For this reason, there are a series of statistical methods that are utilized to construct control groups, with "matching" the most common method. These procedures seek to identify, within the group of students who are *not* beneficiaries, a group that is similar to the experimental group in all relevant aspects for the purpose of comparing results.

Another important factor to consider in conducting an impact evaluation is deciding how one will compare the beneficiary and control groups. The response to this question is closely related to the information available for each group:

***Longitudinal information**:* Longitudinal information is available when there exists, at a minimum, and for both groups, a baseline measurement (i.e., prior to implementation of the project) and a measurement taken at the conclusion of the program. Having longitudinal information enables the construction of what is called "a differential indicator of differences" in which a change in results for students before and after a program (i.e., the first difference) is initially measured, before a later comparison between the beneficiary and control groups (second difference).

***Cross-sectional information**:* Cross-sectional information is available when there has been only a single measurement taken at the end of the program for the beneficiary and control groups. In these cases, it is only possible to compare the results of both groups, and not their evolution over time.

This situation is common when we are dealing with quasi-experimental assessments, in which the decision to conduct an assessment was made only after implementation of the project was begun, and therefore no baseline data is available.

In those cases in which it is not feasible to construct a control group, the only viable alternative for assessing results is to compare the results of beneficiaries before and after the program. In such cases, it is difficult to establish a cause-effect relationship between the results obtained and the program in question because there may have been other factors that have affected the results, and no control group has been utilized to control for such factors. For example, one of the expected results of programs involving the use of technologies in education is an improvement in the motivation of students, as reflected in an increase in enrollment rates. If, parallel to such a program, another program is implemented that aims to improve school attendance (e.g., a school-retention bonus), it will not be viable to attempt to distinguish which part of the increased enrollment is attributable to one or the other program.

For the purpose of constructing indicators of results, a series of tools must be used. In order to measure changes in educational practices, the most recommended methods are surveys and class observation. Indicators associated with student involvement in classes can be constructed by utilizing administrative records of enrollment, attendance, grade repetition, and withdrawal, along with surveys that have been especially designed to measure motivation and expectation. However, if the researcher seeks to construct indicators of results of cognitive learning, standardized tests (either national or international) are the instrument of choice for their construction. Similarly, the development of skills and abilities should be measured through standardized tests. This represents a great challenge, since it involves not only clearly defining what “twenty-first century skills” exactly are, but also proposing tools to measure them.

Last but not least, it is necessary to consider the professional requirements associated with the design and implementation of an impact evaluation. Specifically, professionals are needed that are highly knowledgeable with respect to sampling, statistics, and econometrics (i.e., statisticians or economists). Just as in an assessment of processes, given that the ultimate purpose of any assessment is to provide feedback to the system, it is necessary to have available professionals that can transmit, in a clear and usable manner, the results of this assessment to the different actors within the educational community so

that the assessment results come to constitute, for all intents and purposes, a relevant piece of information that supports decision-making regarding future policy.

Case 5: Experimental assessment (Peru)

The "Laptop for Every Child Program" (LEC) was launched in 2008 in order to respond to "the demand for educational quality and educational fairness through the integration of computer and information technologies (ICTs) in the educational process on the basis of national identity, and especially in those areas characterized by high rates of poverty, illiteracy, social exclusion, population dispersion, and low rates of concentration of students attending school."

The main objective of the program during its first stage is the *improvement in the quality of public education, especially the education of children in remote areas characterized by extreme poverty, with priority assigned to single-teacher, multi-grade schools.*

Among the specific objectives mentioned on the official website of the project are the following:

• Generating educational management capacities in educational institutions that enable access to ICTs.

• Fostering in students the capacities, abilities, and skills that are identified in the curricular design for primary level students through the pedagogical use of laptop computers.

• Training teachers in the pedagogical exploitation (i.e., appropriation, curricular integration, methodological strategies, and production of educational material) of laptop computers for the purpose of improving the quality of teaching and learning.

During the initial stage of the project, activities focused on multigrade schools in rural areas, where an XO laptop was given to 293,631 students, 5144 teachers were trained, and where instruction booklets, pamphlets, and cards were employed in order to maximize the pedagogical potential of computer resources.

The program delivered a laptop computer to each student and teacher that was to be used both inside and outside the school. These computers contained educational programs, as well as other digital resources.

The projected scope of the first stage of this program includes 21,829 educational units (34% of Peruvian schools), 51,344 teachers (25.5%), and 1,003,150 students (30% of enrolled students). In February 2011, the program reported that it had been implemented in 10,228 educational units (i.e., 50% of institutions targeted for the initial stage) and had reached 813,341 students (80% of the target).

The experimental assessment of the program conducted by the IDB during the year 2010 reports the following educational achievements:

- Improved attitudes and expectations on the part of students, teachers, and parents.
- Students adopted a broad-based and critical point of view regarding the school and the work conducted in it.
- Students were more self-critical and less satisfied with their own performance.
- Teachers indicated that the use of computers enabled students to work better in groups.
- Teachers indicated that computers made their work easier and increased the quality of their teaching.

The following challenges posed by the program were also noted:

- Better training of teachers.
- Encouraging students to take their computers home.
- Increasing technical and pedagogical support in educational institutions.
- Enabling the computer to be an indispensable educational tool used by teachers in their classrooms.
- Optimal utilization of computers in classrooms.
- Increased internet connectivity.

V. Monitoring and evaluation: Indicators

The process of monitoring and evaluation involves the necessary routine activities that are carried out in order to identify changes that have occurred as a result of the initiative's activities. The purpose of the periodic application (i.e., annually, biannually, or as frequently as possible) of these activities is to determine the state of maturity of the initiatives introducing ET, and to shed light on the decisions made by policymakers.

For the purpose of organizing the indicators and associating them with the proposal of the framework, we propose a division into ingredient and process indicators (Initiation) and Result and Impact Indicators (Completion), according to the type of data one wants to analyze, and the domain in which said data is applied.

5.1 The monitoring process

The methodology proposed for the application of indicators within the context of this conceptual framework and its associated indicators comprises five different phases:

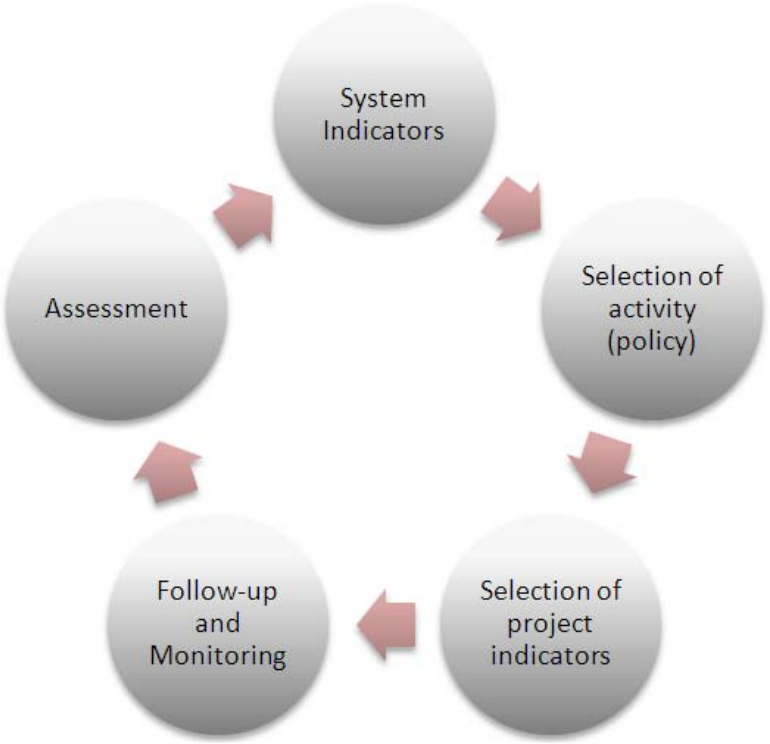

Figure V-1. The monitoring process

System indicators

At the systems level, the proposal of the IDB recommends a consideration of all (or as many as possible) of the indicators proposed. This will enable a construction of the most complete picture possible of the state of development of the incorporation of ET.

Having complete and updated information regarding this set of indicators will enable the construction of one or more indices that reflect advances in the incorporation of ET. This, in turn, will enable, through the use of categories, the determination of the development stage of the system as a whole, as well as of particular domains of the system.

Selection of activities (Policy)

Based upon the data supplied by the indicators, policymakers will be able to make more informed and complete decisions that prioritize the achievement of specific kinds of impact.

Selection of relevant indicators

At the project level, not all of the ingredient indicators defined will be able to be modified by a project or plan for the purposes of inclusion in ET. Thus, upon initiating a project of this nature, the first priority will be to define which indicators of the proposed set can possibly be impacted by this initiative. Along with this, indicators will be constructed with respect to the process that will allow the follow-up and monitoring of the development of the project.

Irrespective of what has previously been indicated in this section, the proposed methodology recommends that all content indicators be measured or considered at every opportunity. This is for two reasons: 1.) because a project may, in practice, generate types of impact not foreseen in its original design, and it would be interesting to know what these are, and to quantify them, and; 2.) for reasons pertaining to the system or public policies, knowing all of the indicators will provide the implementer with a broad-based vision of the general impact of different educational projects in any country, and of their status at any given moment.

Follow-up and monitoring

The methodological proposal provides that, at the systems level, data will be analyzed periodically, at a frequency determined by the availability of data at each level. This availability will be related to the specific implementation of each plan or project. At a minimum, data will be compiled at three different times:

- Prior to initiating the project: construction of baseline
- Mid-term analysis: intermediate analysis, to take place while the project is being implemented. This will provide information regarding kinds of impact in the medium term and will enable action to be taken, if such is necessary. Mid-term measurement also includes any ongoing activities that might occur throughout the life of a program, for the purpose of observing critical factors in its development via key implementation indicators.
- Analysis at end of project: Analysis of information at the time the intervention has been completed. This will allow the quantification of change in indicators during the period of project implementation. At this time, the status of all ingredient indicators will be known, and this will provide information regarding the impact that can be associated with the project, as well as changes observed in the global situation of the system within which the intervention has been carried out.

A fourth analysis is recommended, when feasible:

- Post-follow-up analysis: Analysis of information one or more periods following the end of the project in question. This will allow an assessment of the mid-term status both during the process of implementation and following termination of the project. This will allow an assessment of the mid-term status during the process of implementation, and following the conclusion of the project. At this time, for example, it might be found that there is a decrease in some indicators as compared to the previous analysis, perhaps as a result of a lack of financing for recurring expenses.

In addition, process indicators should be defined that the project is required to report. The report of these indicators will be highly useful for the implementer, since it will allow him or her to exercise a high degree of control over implementation of the project, make suggestions and, if necessary, propose remedial measures.

At the outset of the project, it is suggested that a timeline for reporting these indicators be determined. It may be that not all indicators are relevant for all processes. If this is the case, an agreement among all parties will be required with respect to both the definition of indicators to be utilized for the management plan of the project in question, and the times when these indicators are to be reported.

Impact evaluation

Impact evaluation of a project may consider a broad array of tools, models, and indicators that reflect its results, such as those that we describe in section IV. Under the proposal we present, it is recommended that, in terms of impact, consideration be given to the form in which project results have been conducive to change in the indicators within the system in which the project has been implemented. These indicators were established in the definition of general indicators, as well as in the selection of specific indicators pertinent to project activities.

In this way, the definition of indicators will establish goals for the project. These goals will be expressed in the same terms used for the indicators which will be used to reflect the impact of the project. Therefore, the impact evaluation of the project will present, for each relevant indicator, its pre-intervention status, the desired status to be attained as a result of the intervention (i.e., the goal), and the percentage reflecting the extent to which the goal has been attained.

5.2 Stages of development

It is clear that the kind of initiatives to be implemented or evaluated, as well as the expected kinds of impact of each intervention, will be determined to a great extent by the

degree of maturation of the use of TEd in the educational context in which a given project is implemented.[15]

The maturation time attained by the incorporation of TEd in educational systems is correlated to a large extent with the kinds of changes and the depth of change within particular contexts. Thus, intensity of use and impact increase to the extent to which incorporation efforts are sustained over time.

In this regard, and following the Applied Morel Matrix, four possible project stages are proposed. Consideration of these stages is a key element in the design, implementation, follow-up, and assessment of projects, and in the comparable follow-up within educational systems.

In this way, the analysis of the set of indicators associated with different domains must enable the determination of the degree of maturation of the project (Emergence, Application, Integration, and Transformation). Thus, they report the kinds of impact expected for the indicators of results. For example, these stages can be generically described for each domain considered within the Conceptual Framework in the terms indicated in table:

[15] "Countries that are in the initial stages of incorporating CITs into education have assessment needs that are different from those countries that have a long CIT tradition. For example, it is important at the beginning that teachers and students have access to software and hardware, and that they have acquired basic information technology skills. In the case of countries in more advanced stages, other considerations, such as the management of educational innovation, changes in curriculum and organization within schools, sustainable support, and ongoing staff training take on a higher degree of importance." ("Manual for Generating Statistics on the Information Economy," UNCTAD, 2008)

	Emergence	Application	Integration	Transformation
Infrastructure	PCs dedicated to administrative processes; off-limits to students and teachers.	Computational laboratories; broadband internet access. Trained teacher or administrator (in order to provide technical support).	Networks of computers in laboratories and classrooms; can be used with other devices (e.g., cameras, scanners, etc.). Ongoing access for students and teachers. Local specialized support staff.	Diverse communication and learning platforms available. Web-based communication and collaboration services; self-guided learning systems. Local staff highly specialized in support and developing solutions.
Content	Curriculum does not explicitly address the use of ICTs. Office IT applications and educational games. Local CDs or software with educational content (encyclopedias). Teacher-centered instruction.	Curriculum includes the basic development of ICT skills. Educational portals with access to digital resources supporting the curriculum. E-mail and web search services available. Teacher-centered instruction.	Curriculum includes the cross-sectional use of ICTs. Enriched educational content and applications adapted to specific practices. Basic applications for the creation of content and reconstruction of teaching and learning objectives. Student-centered and collaborative instruction.	Curriculum comprehensively incorporates use of ICTs as strategy for constructing knowledge. Advanced options for content development and collaboration among diverse actors. Platforms for experimentation and the publication of resources. Student-centered, experiential, and collaborative instruction characterized by critical thinking.
Human Resources	Training according to individual interests. No pedagogical support for integrating ICTs.	General training in ICTs through ongoing training programs for teachers. No local pedagogical support for the integration of ICTs.	Initial and ongoing training re curriculum and educational use of ICTs in the classroom. Training of local staff for supporting pedagogical integration of ICTs.	Peer communication networks, ongoing self-guided training system. Peer networks and online collaboration.
Management	Reactive vision, based on individual interests. Traditional management of information with isolated systems. Community participation absent or infrequent.	Pragmatic vision based on the adoption of new technologies. IT management of some systems that are not interconnected. Partial and isolated involvement of the organized community.	Holistic vision that seeks to integrate processes via the incorporation of technologies. Complex and interconnected IT systems for recording and critical communication within the system. Regular incorporation of community in formal processes and communications.	Proactive vision of innovation that seeks to generate development that facilitates new and improved information systems, recording, and communication. Active community searching for solutions and involved in the collaborative construction of shared knowledge.
Policies	Casuistic and experimental development of isolated ICT initiatives. No long-term policies or budget allocations. No adjustments to legal framework or consideration of specific incentives.	Limited development of ICT plans, based on centralized and focused decisions. Partial and generic policy development that includes consideration of some components to a greater or lesser extent. Short-term budgets (associated with individual projects). Generic and indirect adjustments of the legal framework (telecommunications and educational plans).	Development of broad-based and comprehensive ICT policies that encompass all domains with similar levels of depth, allowing some flexible spaces for specific contextual adaptations. Guaranteed medium-term budgets. Legal adjustments that facilitate the incorporation of ICTs and their educational use. Incentive systems that are integrated with.	Development of educational plans and policies that comprehensively consider ICTs as part of their strategies and components, leaving considerable space for specific inclusion in context. Long-term inclusive budgets. Legal framework completely adjusted to new requirements. Incentives for meeting general learning goals of system.

In practice, the above table functions as a framework for reading indicators present in a system or project, and which in turn enable one to know its stage of maturation or development.

The reading of this framework, once applied to each system or project, may provide criteria for the purposes of decision making regarding domains in which there has been a

greater or lesser degree of progress, and therefore may serve to indicate the kinds of priorities that might be conducive to the implementation of new activities.

The determination of this stage of development is also directly related to reasonable expectations regarding the impact of TEd on educational systems and, especially, on the different kinds of learning, abilities, and skills of students. Thus, it is possible to propose in the following table some examples of the kinds of results that one might find in educational systems, or in the groups that are targeted in this project, according to the maturation stage determined by the results of the analysis of indicators:

	Emergence	Application	Integration	Transformation
Practices	Predominance of expository and vertical classes. Teacher-centered classes focused on teachers' knowledge. CITs utilized as a specific content for training students. Students have difficulty in accessing technologies.	Teacher-centered classes that sporadically incorporate the use of CITs in some school activity as a result of consistent curriculum planning. Students have regular access to technologies, but they rarely connect these technologies with school experience.	Student-centered classes, with the teacher assuming the role of a presenter and tutor who actively proposes and accompanies the work of students who use CITs collaboratively in their schoolwork. Use is relatively intense within the context of the school, but substantially reduced outside of both the school and the proposed activities.	An ongoing learning environment in which teachers and students consistently collaborate in the creation and communication of knowledge. Emphasis on inquiry and the development of projects, with increasing autonomy of each actor and an abundant use of communication and collaboration platforms.
Student Involvement	Passive attitude of students regarding learning. Low or moderate expectations regarding the impact of studies on their future lives.	Passive student attitude regarding learning. Moderate expectations regarding the impact of school on their future lives. Motivation generated outside of the school.	Active student attitude regarding learning. High expectations regarding learning and personal achievement, but not explicitly connected with their school experience.	Proactive and independent attitude involving ongoing lifelong learning. High expectations regarding their future and the role of education in their future.
Learning Results	None	Low impact	Medium impact	High impact
Skills and Abilities	None	Low impact	Medium impact	High impact

Until now, it has often been expected that highly restricted investments in TEd, which are conducive to only very isolated changes in certain ingredients, can quickly be translated into results involving the learning or development of new and better abilities and skills among students. The reading of this framework allows us to recognize that achieving a significant impact is the result of a development process that requires a broad-based vision and comprehensive implementation, along with comprehensive implementation and a sufficient degree of maturity to show a real impact.

VI. Conclusion

The action framework described in this document has been developed in a way that has taken into account the empirical evidence thus far available, as well as both the experience that we have had at the Inter-American Development Bank and the experience of other experts in the implementation of TEd projects. The framework itself, in its first version, published in 2009, has been applied in various different projects, and has been subject to extensive debate.

Taking into account the fact that each project involving the introduction of technologies in education develops different lines of action, the framework, along with its associated set of indicators, have a general character that allows for the review of the different variables available, in the form of a kind of map. This allows the selection of those variables involved in each specific project, either directly or indirectly, as well as those variables that the project can affect, or be affected by.

The framework has mainly been proposed as an instrument supporting the design, follow-up, and assessment of initiatives for using technologies in education. In this regard, it is hoped that the framework will help support the activities of educational authorities, experts, policymakers, and administrators.

Independently of the variables and components that each project develops, and of its geographical scope or size, this framework proposes that the expected final objectives be associated with the improvement of learning. Implementation of the framework must include follow-up and assessment mechanisms associated with these objectives.

A proper assessment will allow for the comparison of results obtained by an educational ET project with other projects, whether ICTs or not, for the purpose of determining the efficiency of the investment that has been made.

Whatever the case may be, this document should be considered a second version of a conceptual framework and indicators that must change and be updated on an ongoing basis as part of its application in the development of new projects. Such a function is fundamentally a part of this framework's essential association with processes and products that fundamentally in a state of constant and rapid flux.

VII. References

ALNOAIMI, T.; HINOSTROZA, E.; ISSACS, S.; KOZMA, R. & WONG, P. (2011). Using ICT policy to transform education. In R. B. Kozma (Ed.), ICT Policies and Educational Transformation (pp. 189-213). UNESCO.

BALANSKAT, ANJA; BLAMIRE, ROGER; KEFALA, STELLA (2006). The ICT Impact Report A review of studies of ICT impact on schools in Europe, 2006.

BARRERA-OSORIO, FELIPE Y LINDEN, LEIGH L. (2009) The Use and Misuse of Computers in Education Evidence from a Randomized Experiment in Colombia.

BECTA 'The Becta Review: Evidence on the progress of ICT in education', UK: Becta. Accessed at: http://dera.ioe.ac.uk/1427/

BENAVIDES, FRANCISCO, HANNA DUMONT AND DAVID ISTANCE (2008), *The Search for Innovative Learning Environments*, on Innovating to Learn, Learning to Innovate, OECD.

COBO, CRISTOBAL ROMANÍ; y PARDO KUKLINSKI, HUGO (2007) Planeta Web 2.0. Inteligencia colectiva o medios fast food. Grup de Recerca d'Interaccions Digitals, Universitat de Vic. Flacso México. Barcelona / México DF.

CHRISTENSEN, CLAYTON M., HORN, MICHAEL B. & JOHNSON, CURTIS W. (2008) Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns. McGraw-Hill, 2008.

HEPP, P., HINOSTROZA, J. E., LAVAL, E., AND REHBEIN, L. (2004) Technology in Schools: Education, ICT and the Knowledge Society, Washington: World Bank.
http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/01/10/000160016_20050110162933/Rendered/PDF/311940PAPER0Ed110ICT0oct0401public1.pdf

FULLAN, MICHAEL (2010) All Systems Go: The Change Imperative for whole System Reform. Corwin.

FULLAN, MICHAEL; HILL, PETER; CREVOLA, CARMEL (2006) Breakthrough, Corwin Press.

GERTLER, PAUL; MARTINEZ, SEBASTIÁN; PREMAND, PATRICK; RAWLINGS, LAURA & VERMEERSCH, CHRISTEL (2011) Impact evaluation in Practice. World Bank

KOZMA, ROBERT B. (2008) ICT, Education Reform, and Economic Growth: A Conceptual Framework.
http://download.intel.com/education/EvidenceOfImpact/Kozma_ICT_Framework.pdf
KOZMA, ROBERT B. (2008). Comparative Analysis of Policies for ICT in Education. In J. Voogt. G. Knezek (Eds.), International Handbook of Information Technology in Primary and Secondary Education.

KOZMA, ROBERT B. (2005), *Monitoring and Assessment of ICT for Education Impact: A Review*, en Monitoring and Assessment of ICT in Education Projects (Michael Trucano, Editor), InfoDev, 2005.

NEW MEDIA COSORTIUM (2010) Informe Horizon, Edición Iberoamericana 2010.

OECD (2010) PISA 2009 at a Glance, OECD. France.

OECD (2011) PISA 2009 Results: Students On Line: Digital Tecnologies and performance, OECD, France.

OECD, CERI (2010) Inspired by Technology, Driven by Pedagogy, OECD, France.

PARTNERSHIP FOR 21ST CENTURY SKILLS (2009) *P21 Framework Definitions Document*.

PEDRÓ, FRANCESC (2006) The New Millennium Learners: Challenging our Views on ICT and Learning, OECD-CERI.

PEDRÓ, FRANCESC (2011), Tecnología y escuela: lo que funciona y por qué, Fundación Santillana.

RODRÍGUEZ, PATRICIO; NUSSBAUM, MIGUEL & L. DOMBROVSKAIA (2011) Evolutionary development: a model for the design, implementation, and assessment of ICT for education programmes. Blackwell Publishing Ltd Journal of Computer Assisted Learning

SAWYER, KEITH (2008) Optimizing Learning Implications of Learning Sciences Research on Innovating to Learn, Learning to Innovate, OECD.

SEVERIN, EUGENIO (2010), Tecnologías de La Información y La Comunicación (TICs) en Educación Marco Conceptual e Indicadores. Banco Interamericano de Desarrollo.

SEVERIN, EUGENIO (2011), Competencias del Siglo XXI, Cómo medirlas y enseñarlas. Banco Interamericano de Desarrollo.

SEVERIN, EUGENIO y CAPOTA, CHRISTINE (2011), Modelos Uno a Uno en América Latina y el Caribe, Panorama y Perspectivas. Banco Interamericano de Desarrollo.

TRUCANO, MICHAEL (2005), Knowledge Maps: ICTs in Education. *InfoDev / World Bank, Washington, DC.*

UNWIN, TIM (2005) *Capacity Building and Management in ICT for Education*, en Monitoring and Assessment of ICT in Education Projects (Michael Trucano, Editor), InfoDev.

UNESCO (2011) ICT Competency Framework for Teachers Version 2.0, UNESCO.

UNESCO (2003) Performance indicators for ICT in education. Bangkok: UNESCO.

http://www.unescobkk.org/education/ict/ict-in-education-projects/monitoring-and-measuring-change/performance-indicators-on-ict-use-in-education-project/

UNESCO (n.d.). *Indicators for assessing ICT Impact in Education* Bangkok: UNESCO. http://www.unescobkk.org/index.php?id=662.

UNESCO Institute for Statistics (UIS) (2005) "ICTs and Education Indicators: Suggested core indicators based on meta-analysis of selected International School Surveys", WSIS Phase II, Tunis. Available at: http://www.itu.int/ITUD/ict/partnership/material/ICT_Education_Paper_Nov_2006.pdf.

UNESCO Institute for Statistics (UIS) (2010) "Proposal for internationally comparable core indicators on ICTs in education", UNESCO

Appendix: List of TEd Indicators

The following is a list of indicators that the IDB proposes for the effects proposed in this chapter. These are part of our work with UNESCO UIS, the World Bank, KERIS, and OECD regarding the establishment of common indicators for these kinds of initiatives[16]:

Order Code	Ingredient Indicator	Indicator ID
1	Percentage of schools that have electricity (CINE CINE levels 1-3)	EDR1
2	Percentage of schools that have telephone lines (CINE levels 1-3)	ED3
3	Percentage of schools that have local networks (LAN): cable/wireless)	I01
4	Percentage of schools that have a radio to use for educational purposes (CINE levels 1 to 3)	ED1
5	Percentage of schools that have a television to use for educational purposes (CINE levels 1-3)	ED2
6	Number of televisions available in schools, per 100 students (by type and by CINE level 1-3)	ED28
7	Quantity of audiovisual equipment available in schools, per 100 students (by type and by CINE levels 1-3)	ED29
8	Student-to-computer ratio (CINE levels 1-3)	ED4
9	Percentage of schools that have computer-assisted learning (CINE levels 1-3)	ED24
10	Percentage of schools that have internet-assisted learning (CINE levels 1 a 3)	ED25
11	Percentage of computers owned by students that are available for educational purposes (CINE level 4 and levels 5-6)	ED34
12	Percentage of all computers available for educational purposes (CINE levels 1-3, 4, and 5-6)	ED35
13	Percentage of all computers available for administrative purposes (CINE levels 1-3, 4, and 5-6)	ED36
14	Percentage of computers with 4 or less years of educational use	I02
15	Total number of technological platforms available, and their scope (i.e., number of users): for learning / for communication	I03
16	Percentage of schools that have Internet access (CINE levels 1-3)	ED5
17	Ratio of student-to-computer with internet access (CINE levels 1-3)	ED31
18	Proportion of schools with high-bandwidth and medium-bandwidth connection, by geographical area.	I04
19	Average stability (service level) of connection in schools, by geographical area	I05
20	Proportion of schools with firewalls and privacy systems, by geographical area	I06
21	Monthly fees for high bandwidth connection in schools (average value in dollars per MB of bandwidth)	I07

[16] The description, tools, and calculation formulas for each indicator are available on the website of the IDB. http://www.iadb.org/edu.ted

22	Percentage of schools that offer wireless access to Internet: restricted / open to the community	I08
23	Percentage of schools according to level of support): teacher / technical staff / development staff)	I09
24	- External support contract	I09-B
25	Rate of reported problems in relation to the total number of computers available for educational use	I10
26	Average response time and solution time for reported problems	I11
27	Percentage of registered users satisfied with the technical support they have received.	I12
28	Percentage of grades that offer courses teaching basic information technology knowledge as prescribed in the curriculum (by type of teaching, by type, and by CINE levels 1-3).	ED11
29	Percentage of students enrolled in grades that offer courses teaching basic information technology knowledge as prescribed in the curriculum (CINE levels 1-3)	ED11 bis
30	Average estimated hours per week to be dedicated to the use of CITs in the classroom, as prescribed in the curriculum (by main courses and CINE levels 1-3): (by course)	ED13
31	Average number of hours per week dedicated to the use of CIT in the classroom, as prescribed in the curriculum (CINE levels 1-3) (software, internet, and others)	ED14
32	Average ratio of classes incorporating use of CITs as an instrument of experimentation and content construction to the annual total number of classes	I13
33	Proportion of schools with curriculum innovations for the use of CITs for educational purposes	I14
34	Availability of national educational portals	I15
35	Percentage of registered users participating in national educational portals: (by actor)	I16
36	Percentage of curricular coverage of digital or web educational resources for the teaching community (course/level)	I17
37	Number of digital resources available by course/level	I18
38	Ratio of resources available to users to the total resources available on the national educational portal	I19
39	Percentage of teachers that develop and share educational content in relation to the total number of teachers registered on the national portal.	I20
40	Percentage of schools that have an institutional website (CINE levels 1-3)	ED50
41	Percentage of schools that have and educational website (CINE levels 1-3)	I21
42	Percentage of schools that have blog service (CINE levels 1-3, 4, 5-6)	ED51
43	Percentage of educational establishments that offer distance learning programs (CINE levels 5-6)	ED54
44	Percentage of students and teachers with: e-mail/blog and other communication mechanisms	I22
45	Percentage of schools offering services to teachers and/or students to create and share educational content on their page or portal	I23

46	Average proportion of the curriculum of the initial teacher training dedicated to the curricular adaptation of CITs.	I24
47	Percentage of primary and secondary teachers who have received training to teach any course using CIT (by training modality)	ED39
48	Percentage of primary and secondary teachers certified in the basic use of information technology.	I25
49	Percentage of primary and secondary teachers certified in the educational use of information technology.	I26
50	Percentage of primary and secondary teachers certified to teach basic information technology knowledge (CINE levels 1-3)	ED8
51	Percentage of primary and secondary teachers certified to teach basic information technology concepts (by training modality)	ED38
52	Average annual hours dedicated to direct training of students in the use of word processors, spreadsheets, presentations, etc; by level, geographical area, and type of school	I27
53	Percentage of primary and secondary students who are certified in the basic use of information technology	I28
54	Percentage of adult population trained in the basic use of CITs	I29
55	Ratio of students to teacher using CITs to teach (CINE levels 1-3)	ED44
56	Ratio of students to teacher in the area of basic information technology knowledge (CINE levels 1-3)	ED43
57	Number of public initiatives aimed at promoting CITs for educational purposes (contests, meetings, challenges, festivals)	I30
58	Percentage of primary and secondary students who have participated in initiatives for using CITs for educational purposes (contests, meetings, challenges, festivals)	I31
59	Percentage of schools that have participated in the use of CITs for educational purposes (contests, meetings, challenges, festivals)	I32
60	Percentage of schools that have direct professional pedagogical support for teachers for the purpose of incorporating CITs into the curriculum	I33
61	Ratio of CIT coordinators in schools to the number of schools that offer assisted learning employing CIT (CINE levels 1-3)	ED12
62	Percentage of teachers participating in collaboration networks for the implementation of CITs in education	I34
63	Percentage of schools with formal projects involving the incorporation of CITs into educational processes	I35
64	Percentage of schools with formal projects for incorporating CITs into administrative processes	I36
65	Percentage of administrators certified in the basic use of CITs.	I37
66	Percentage of schools that have a **staff** administration system	I38
67	Percentage of schools that have a **financial** administration system	I39
68	Percentage of schools that have internal or external (off-line) student management systems (i.e., grades, attendance, graduation, registration)	I40
69	Percentage of schools that have interconnected (online) student management systems with regional and/or national levels	I41
70	Percentage of schools with management systems that are accesible online, and with community services (i.e., for parents and legal guardians)	I42

71	Percentage of schools that have equipment and schedules facilitating community access and use (i.e., for parents and legal guardians)	I43
72	Percentage of schools with programs that provide training in the use of CITs for the community (i.e., parents and legal guardians)	I44
73	Percentage of parents and legal guardians trained by schools in the basic use of CITs.	I45
74	Existence of a national plan for incorporating and developing CITs for educational purposes	I46
75	Percentage of CINE levels covered by current national policies, or policies of the sector responsible for the use of CITs in education (CINE levels 1-6)	ED9
76	Percentage of grades covered by current national policies, or by policies of the sector responsible for the use of CITs in education (CINE levels 1-3)	ED9 bis
77	Percentage of students in grades utilizing CITs in teaching and learning activities (CINE levels 1-3)	ED10
78	Percentage of total public expenditures on CIT in education earmarked for the regular CIT education budget (CINE levels 1-3, 4, 5-6)	ED15
79	Percentage of total public expenditures on CIT earmarked for capital expenditures on CIT in education (CINE levels 1-3, 4, 5-6)	ED16
80	Percentage of total (regular) government expenditures earmarked for regular CIT education budget (CINE levels 1-3, 4, 5-6)	ED21
81	Percentage of total governmental expenditures (of capital) earmarked for capital expenditures on CIT in education (CINE levels 1-3, 4, 5-6)	ED22
82	Average (regular) budget for CIT in education, per student (CINE levels 1-3, 4, 5-6)	ED55
83	Proportion of public and private expenditures for CITs in the educational system	I47
84	Percentage of official communications of the Ministry of Education that Refer to plans, programs, and initiatives for the incorporation of CITs in education in relation to all official communications.	I48
85	Frequency with which official communications of the Ministry of Education refers to plans, programs, and initiatives for the incorporation of CITs in education.	I49
86	Percentage of total expenditures on CITs in education earmarked for incentive programs for schools that use CITs as part of the educational process.	I50
87	Percentage of total expenditures on CITs in education earmarked for incentive programs for teachers that use CITs as part of the educational process.	I51
88	Percentage of total expenditures on CITs in education earmarked for incentive programs for students who use CITs as part of the educational process.	I52
89	Percentage of total expenditures on CITs in education earmarked for incentive programs for communities (i.e., parents and legal guardians) who use CITs as part of the educational process.	I53
90	Presence/absence of legal provisions that regulate aspects of education and technology	I54
91	Percentage of homes with PC access in the home, per income quintile (CEPAL/OSILAC)	propuesto 1
92	Percentage of homes with internet connection, per income quintile (CEPAL/OSILAC)	propuesto 2

93	Percentage of sixth-year primary-level students that use computers, by place of use and socioeconomic index of students' homes (CEPAL/SERCE)	propuesto 3
94	Percentage of users within the 13-19 age group that use the internet at least once a day, by place of use (CEPAL/OSILAC)	propuesto 4
95	Percentage of establishments with computers	propuesto 5
96	Percentage of establishments with computer room	propuesto 6

The following is a list of indicators of results and impact:

	Indicator	ID
97	Percentage of certified teachers that utilize CIT resources in their teaching (by gender and type of establishment) (CINE levels 1-3)	ED40
98	Average percentage of classes that are conducted using CITs in relation to the total number of classes, by course and level	S55
99	Average total time per week dedicated by teacher to the use of CITs	S56
100	Average time of use, by level, made of CITs in work carried out in the school, by type of activity (i.e., discrete skill-building activities)	S57
101	By level and course, proportion of average class time, divided by type of educational methodology (i.e., discrete uses of CIT)	S58
102	Proportion of teachers who indicate that CITs constitute a support in their work as teachers	S59
103	Proportion of teachers who utilize some means of digital communication with their students: by geographical area, type of school, and teaching cycle	S60
104	Percentage of time that students, on the average, dedicate to educational tasks and work, in relation to the total weekly time that they spend using CITs	S61
105	Average time of educational use of CITs (by gender and level)	S62
106	Average weekly percentage of homework and schoolwork that is completed with the support of CITs	S63
107	Average student weekly usage time of CITs in work outside of the school, by type of activity	S64
108	Proportion of students indicating that CITs support their school studies	S65
109	Proportion of student project users indicating that their classes are more interesting when their teacher uses CITs to support his or her activities, by geographical area, type of school, and academic year	S66

110	Cohort enrollment rate by gender, level, and geographical area	S67
111	Percentage of students enrolled in post-secondary (but not tertiary) education in fields related to CIT, by gender (CINE level 4, and levels 5-6)	ED7
112	Percentage of students enrolled in distance learning programs at the tertiary educational level, by gender (CINE level 4, and CINE levels 5 and 6)	ED45
113	Proportion of alumni promoted to the next course, by geographical area, type of school, and academic year	S68
114	Graduation rate of students utilizing CITs as auxiliary learning tools (by gender and type and of establishment, in the 4th, 8th, and 10th grades)	ED46
115	Graduate rate of students not utilizing CITs as auxiliary learning tools (by gender and type of establishment, in the 4th, 8th, and 10th grades)	ED47
116	Impact index of CIT in education (by gender and type of establishment) (CINE levels 1-3)	ED48 = ED46/ED47
117	Proportion of students dropping out of school each year, by geographical area, type of school, and academic year	S69
118	Percentage of tertiary level students that have graduated in CIT-related fields in the final academic year, by gender (CINE level 4 and levels 5-6)	ED42
119	Monthly average student attendance at schools, by geographic area, type of school, and academic year	S70
120	Percentage of students who believe that school will have a “high” or “very” high level of impact in their future lives	S71
121	Percentage of students who indicate “agreement” or “strong agreement” with the importance of participation/independence	S72
122	Results of standardized tests of curricular knowledge that can be compared over time, by subject matter and level. Percentage of students meeting “passing” criteria of these tests.	S73
123	Results of *ad hoc* standardized tests that measure this skill. Percentage of students achieving “high” and “very high” levels.	S74
124	Results of *ad hoc* standardized tests that measure this skill. Percentage of students achieving “high” and “very high” levels.	S75
125	Results of *ad hoc* standardized tests that measure this skill. Percentage of students achieving “high” and “very high” levels.	S76
126	Results of *ad hoc* standardized test tha measure this skill. Percentage of students who attain “high” and “very high” levels.	S77

127	Results of *ad hoc* standardized test that measure this skill. Percentage of students who attain “high” and “very high” levels	S78
128	Percentage of students certified in the competent handling of CITs by means of a standardized test	S79