UNESCO

**Education
Sector**

United Nations
Educational, Scientific and
Cultural Organization

A MODEL FOR OBTAINING
ICT INDICATORS IN EDUCATION

Josep M. Mominó
and Juli Carrere

UNESCO WORKING PAPERS ON EDUCATION POLICY

Designed by UNESCO

This paper belongs to a series which is designed to nurture the international debate about a wide range of education policy issues.

ABSTRACT

This working paper, proposes a conceptual framework for obtaining ICT indicators in education which is defined by a set of distinctive features: a holistic and systemic approach, a flexible and comprehensive strategy of analysis and, lastly, a willingness to monitor and set benchmarks to promote innovation. The potential of this model lies in its ability to provide comparable data on the dynamics of ICT integration into schools, which permits the various people responsible for this process to take decisions that are based on the result of empirical analysis rather than belief or intuition. For education systems faced with the challenges posed by the network society, making such decisions is indisputable and critical, but especially in the case of countries that are less developed and where the cost of applying tentative solutions is hardly acceptable. Obtaining indicators for monitoring this process should help identify sustainable solutions that do not give up on using ICT, efficiently, for innovation and improving education.

03

working papers
on education policy

TABLE OF CONTENTS

INTRODUCTION

Information and communication technologies (ICT) have provided the necessary technological substrate for the development of the new form of social organization and economic and cultural production embraced by the world we live in today. This is true for developed countries, but also for emerging economies and even poorer countries. This "network society" (Castells, 1999) into which we enter each day, leaving behind the parameters established by the industrial society, is based on a new kind of economy for which information is the raw material and the ability to transform it into knowledge is the main strategy for productivity and progress. In the knowledge economy, the ability to learn and innovate constantly has become the main engine that propels any competitive business and lifelong learning has become a vital necessity for all citizens. In a society like ours, education takes on special importance as a basis for access to knowledge and has become, more than ever, a strategic priority for economic and social development.

In this scenario, confidence in the role that ICT can play at the service of education has been enormous. Internet activity is transfiguring all areas of our society and there is nothing strange in education placing great hope in the potential of ICT. The "Report to UNESCO of the International Commission on Education for the 21st Century" (Delors, 1996) already pointed out, when this process was still at an early stage of development, that ICT, and specifically the Internet, "offers education tools for children and adolescents, an unprecedented opportunity to respond with the necessary quality to a demand that is increasingly great and diversified". These expectations can be found, mainly (Kozma, 2008, Pedro, 2011), in the capacity attributed to technology as a catalyst for innovation, to promote such diverse aspects as: the training people need to acquire to participate actively in the knowledge economy and to adapt to the changing needs of a globalized labor market; the organization and management of information and knowledge in schools, reduction of costs, and increasing productivity and teaching efficiency; the blurring of the boundaries of the school as a learning space, access to education and equal opportunities to continue learning throughout life; improving social cohesion, which is a product of the options made available by technology to share knowledge, access to institutions and citizens' participation and, principally, ICT has been seen as an instrument to improve students' academic performance, as part of a new pedagogical paradigm where they should acquire the skills required by the knowledge society.

Attracted by these expectations and conscious of the critical role that the Internet is playing in shaping the new economy, many countries have opted for the incorporation of ICT into their education systems. The growth of government investment in the technological infrastructure of schools, together with the rapid increases in their levels of connectivity, that can be seen internationally (OECD, 2006) shows that, almost everywhere in the world, this has been the dominant direction taken. The problem is, however, that today we have little empirical evidence to affirm categorically that this investment has begun to translate into something that, ultimately, is the main objective of schools: improving students' academic performance. Different studies have analyzed the correlation between the use of ICT and academic performance, but their conclusions have not always in agreement. Even though, in some cases, positive effects are detected (Becta, 2002; Machin et al., 2006), other studies (Fuchs and Woessman, 2004; Leuven et al., 2004; Goolsbee and Guryan, 2002) have shown that, when controlling for socioeconomic factors, this effect fades.

In fact, some studies (OECD, 2006, 2010, 2011) also indicate that increased use of ICT by young people is not as positively associated with academic achievement as the moderate use of these technologies. In this confusing situation the dissonance between the expected benefits and the reality of how schools are appropriating technology has begun to generate reasonable doubts about the effectiveness of the predominant strategy being followed. Thus, there have been significant questions raised about the true nature of the process that is being adopted. The lack of evidence is particularly uncomfortable for those primarily responsible for the implementation of this process, who want to see more tangible returns on investment or, at least, have hard data on which to base the design of new strategies for the efficient integration of ICT in education systems.

Surely, what we do know about the way technology has been adopted in schools (Cohen, 1987; Cuban, 1986) would have enabled us to anticipate that the process of ICT integration would not be any different and, unlike other technological advances, would be incorporated into the daily activities of the schools in a simple or unidirectional manner? Research into the dynamic of technology introduction has shown, long ago, that the main obstacles to overcome are diverse and, in most cases, unrelated to technology (Cuban et al., 2001). Often, however, effort has been directed primarily to provide the technological infrastructure,

which while necessary, is not sufficient in itself. The focus must be, simultaneously, on other factors that affect what always ends up being fundamental to the effective integration of technology: *the way it is used for educational purposes*. In this sense, although the investment needed is an obstacle that cannot be belittled, technological endowment is, almost always, the difficulty that is overcome most easily.

In any case, although expectations appear to have given way to a certain disappointment, and the momentum of this process, in some contexts, has been eroded by other priorities, the objectives established in the international context in relation to the digitization of education have been maintained, despite the fact that some challenges have been redefined and new problems identified (UNESCO, 2002, 2005, 2008b). In fact, the binomial ICT-education remains a policy area for promoting specific priorities in education that concurrently integrate state strategies through which each country (based on their uniqueness) aim to facilitate the integration of younger generations into their particular knowledge society. The educational rationale that defines this policy area is part of the potential that governments attribute to ICT for responding to the major economic and social developments resulting from the network society. The education of active citizens, participatory and professionally competent, in a society like ours, requires education systems capable of providing the "21st century skills" (Partnership for the 21st Century, 2005, International Society for Technology in Education [ISTE], 2007, Kozma, 2009; OECDE, 2009; Trilling and Fadel, 2009, European Commission, 2010) and, specifically, the digital skills that young people need for their personal development and to adapt to a labor market that is configured according to the parameters set by the knowledge economy.

At the same time, alongside economic concerns, governments and other institutions also face the challenge of promoting ICT policies that are able to compensate for inequalities that occur in this process. These inequalities are related to two ways of avoiding the digital divide. The first comes from the possibility of connectivity and access to ICT. Despite the trend towards universal availability of connection, the gap between those who have access and those that do not still remains, especially in disadvantaged contexts. The second digital divide is not visible so directly and necessitates unique compensation strategies of its own. It can be revealed by a qualitative approach to the ways in which young people use the technology, which shows that, distinct from access, there is another form of inequality. Not all young people appropriate ICT in the same way or have the same opportunities in terms of the benefits they are able to obtain from using the Internet in educational ways, raising cultural or social capital.

The policies that have been developed to support this process have only been relatively successful and imbalanced (Pedró, 2011) because, although designed to facilitate innovation, they do not ensure its proper implementation at all stages, nor do they present solutions to the diversity of issues involved in adapting to specific contexts. Consequently, they cannot guarantee results (Tyack and Cuban, 1995). ICT policies often have been directed primarily to providing the necessary technological infrastructure, neglecting the bond established between the digitization of school activity and other fundamental aspects that form part of this dynamic, such as the nature of pedagogical practice that is occurring in the classroom, teacher beliefs about the use of technology, the training they have received for the use of ICT in their specific area of expertise, professional incentives that are at the service of innovation, the design of the established curriculum, the evaluation processes or the forms of organization and use of space and time in schools. When it has been assumed in these cases, using a unilateral strategy, that schools would begin to use ICT effectively once they have the technologies, these policies have proved ineffective. The incorporation of the new technologies resulted, in the most cases, to staff continuing to do what they had always done, but now with new tools that are too sophisticated and expensive when used only to reinforce traditional teaching methods rather than for innovation. The contrast between what is expected and the reality has revealed that we cannot expect an immediate return on investment, that this is a process that has to deployed gradually and needs to take into account its own dynamic nature that is inseparable from the functioning of the education system and the organizational culture of the schools.

In this situation, an analysis of the phases followed by ICT policies in education policy (Benavides and Pedro, 2007) reveals that the stage where we are today reflects a certain disenchantment, which has its roots in the broken technological promises and incomplete results which have led to a lower priority in education policies for the role of initiatives for the digitization of school activity (Pedró, 2011). The challenge now is to find alternative ways to design interventions that, on the one hand, promote coordinated action of the various components of the education system and, at the same time, are able to incorporate all the dimensions that end up conditioning the effective use of technologies in classrooms. The impact of ICT is most effective when its introduction is accompanied by changes in fundamental aspects of the organization and dynamics of running schools. This dynamic seems no different than that established by the knowledge economy in other sectors of our society. ICT has become a key factor for productivity in companies and other organizations only when the technologies are at the service of a set of new organizational solutions, work dynamics and professional practices that are

mutually reinforcing and with viable and sustainable technological solutions. In the field of education, however, this situation is rare. Education systems, in this context, have remained practically unchanged in their operational dynamics. ICT has been integrated, in many cases, by pursuing policies that are driven unidirectionally and based on a top-down and outside-inside logic. A complex process such as this, on the other hand, is seldom driven by systematic analysis. In practice, ICT is too often applied arbitrarily or, at the very least, only slightly based on a clear strategy or coordinated with other programs related to innovation in the curriculum, evaluation, pedagogical practice or teacher training (Farrell et al., 2007a, 2007b, 2007c, Trucano, 2007).

The analysis of this situation shows that we are facing a powerful challenge that affects the entire education system and requires substantial coordination of all its components. The complexity of the way forward requires a clear vision of the role the educational systems have to play in the knowledge society, for social and economic progress and, consequently, a proper interpretation is needed of the potential of ICT for achieving these objectives. We now know that the distance to cover is not short and we should probably learn to adopt a position of "possibilistic realism" (Pedro, 2011) to choose goals that are achievable, progressive and adapted to different contexts. In this regard, it should be understood that in developing countries, and especially those that suffer higher rates of economic and social exclusion, it would be particularly valuable to have analytical tools to facilitate decision-making and allow the promotion of sustainable strategies, aimed at achievable targets and the objectives established by the educational policies themselves.

Many countries have sought ways to find empirical information that would allow them to track their pace of implementation of policies for the integration of ICT into their education systems. The problem remains, however, that we still do not have a system of indicators to facilitate international comparison, one that can monitor the evolution of this dynamic complex, incorporate all the dimensions involved and facilitate the analysis of the kind of results we can expect from this process, according to their stages of development. Among the available indicators, we can highlight those designed to capture the expansion of Internet access and that measure the increasing availability of technological infrastructure. Attention has been mainly focused on these aspects in an aim to show an immediate return on investments. In any case, the interest in obtaining evidence about connectivity and use of technology has not had the same intensity when it comes to the analysis of how schools end up appropriating the technology, in their organization and in the everyday activity of their classrooms. Nor is there comparable evidence of

other factors that very likely directly affect the success of ICT policy in education, such as teachers' beliefs; their training in the educational use of technology and the associated incentives; leadership of this process or use that teachers and students make of the technology beyond the boundaries of schools and, in the case of the latter, the role of the family context. Ultimately, an approach to what technology can offer should be able to establish objectives that point us in the direction of what the school should be in the knowledge society, and not just what the school is now and what it demands of students today. Thus, other indicators are required for a new definition of competencies that students should be able to develop in each of the phases in which the digitization of school activity occurs.

Currently, many countries have spent more than a decade implementing major investments to promote the incorporation of ICT in education and, nevertheless, we still do not have sufficient conclusive empirical data about how the incorporation of these technologies is contributing to the improvement of education quality. Surely, the relatively new process of incorporating these technologies in schools can justify this deficit of data. In any case, this situation does not contribute to decision-making in policy development, nor does it facilitate the efficient design of strategies, which should rely less on intuition or trial-and-error. It requires efforts to develop methodologies that are widely accepted with comparable indicators and achievable goals. The tools necessary should provide a complex analysis of the relationship between the use of technology and the various factors that determine how schools take ownership of it. The effort needed to identify these variables (Scheuermann and Pedró, 2009) should enable progress towards the design of a systemic model of indicators to assess and monitor the evolution of the process, where we can see all the dimensions involved and identify the different types of results. The distinctive features of this model, in order to fulfill this function, must respond to a shared understanding about how schools should appropriate technologies to meet the demands of the network society and the knowledge economy.

The Internet has become a key driver of social and economic transformation in our world. Education, however, despite the crucial role it has been assigned for the development of the knowledge society, does not seem to have established itself as one of the leading sectors in this process. The contribution that ICT has made to the global economy, the virtualization of culture and, ultimately, to the daily life of people, remains difficult to see in the activity of schools. The obsession to identify the impact of investment into ICT policies has come from a traditional understanding of the dynamics of schools' operations and educative systems. Thus the scope of analysis is often restricted to specific type of results, referring to individual academic performance, framed by conventional curriculum design and forms of evaluation. The incidence of ICT use in schools, from this point of view that is limited to this interpretation of academic performance, is virtually nil.

The effect of technologies, in other sectors, has begun to be noticed in the field of productivity, to the extent that organizations have been able to make use of the potential of ICT to introduce structural changes in different components of their business models and thus respond competitively, using online solutions, to the changes in the knowledge economy. This organizational evolution, which finds ways to ensure efficiency using technological solutions, does not seem to have found its parallel in schools, at least generally. A retrospective look at the effect that other technologies have had on the traditional dynamic of education systems shows us how difficult it can be to alter this dynamic.(Tyack, and Cuban,1995; Cuban, 1986).

However, the uniqueness of ICT is that, with informationalism (Castells, 2004), these tools have become inseparable components of the social structure of our time. The essential character of these technologies in shaping the new organizational model of our society means we can have confidence in their potential to provide new ways to improve organizational efficiency and pedagogical and cultural innovation in those schools able to take advantage of existing solutions, at the same time as the conditions that led to industrialization begin to fade away. In this sense, an interpretation of this transition in education requires a conceptual framework that addresses the conditions and the process through which schools, taking advantage of ICT, should be able to meet the demands of our society. The challenge is based on a complex design, able to identify the dimensions that should be involved in this transformation and providing

indices about how technologies are incorporated. It is through this multilateral approach and analysis of the interaction between the different levels in which ICT can act that we can reach an adequate representation of their impact.

Thus, the conceptual framework in which we can situate a model for obtaining ICT indicators in education is defined by a set of distinctive features: an holistic and systemic approach, flexibility and comprehensiveness as a strategy of analysis and, lastly, a willingness to monitor and set benchmarks to promote innovation.

A holistic and systemic approach

The ability of ICT to integrate itself at different levels in the education system and to be incorporated into every fields of activity in schools requires an approach that allows us to show how technology is being adopted simultaneously in these different domains and, at the same time, reveals the interaction between them. An approach such as this should specify what needs to be measured at each level and, based on the contrast between the different groups of indicators identified, construct a complex understanding about the way the field of education is capable of appropriating technologies and show the range of effects that are associated with this process. The application of this holistic view to the interpretation of changes in the field of education (Fullan, 1991, 1993) and, specifically, in relation to the role of technology, seems increasingly shared (Cabrol and Severin, 2009; Erstad, 2009; Thomson, 2007). In any case, it is a conception that implicitly admits that the impact of ICT and how they contribute to innovation can only be rigorously interpreted from a comprehensive, multi- layered and comprehensive perspective.

Moreover, the systemic nature of this approach not only relates to the study of how technology is incorporated institutionally, in the interaction between the various components of an organization, and neither is it restricted, in the final analysis, to analysing the dynamics between the elements involved in the pedagogical practice that takes place in the classroom. Beyond these considerations, this approach reaches the way the education system itself is able to adapt to meet the new social requirements of today's society and uses technologies for life online. This way of understanding systemic change (CERI, 2009a, 2009b) not only takes into account innovation

and interaction between each of the components of the education system, but also provides indices as to how the system itself is transformed (UNESCO, 2002; Kozma, 2011) and how the relationship between its nodes is redefined and appropriates ICT to adapt to the requirements of the new social structure of our time.

Applying this holistic conception should facilitate the development of a model of indicators that serve as a tool for decision-making in the development of strategies that simultaneously affect different components of the system. This means supporting distributed actions that work together to ensure that ICT can be introduced efficiently in the service of innovation. For this purpose, it is essential to adopt a perspective that can incorporate the different actors involved. The question is that, although there may be a shared vision of what kind of innovation is desired, how to concretely implement this change depends, in the final analysis, on issues such as leadership displayed during the process, the beliefs of the teachers, students' perspectives and how their families are involved in this process. Indeed, this approach requires that the "angle of vision" required may exceed the limits of the educational centers. The prominent position held by ICT in the daily lives of these players, especially the young, means that it is essential to grasp how they use such technologies not when they are in school but in the family context. Opening up this wider perspective is not hard to justify when you consider that, often, it is precisely outside the school where ICT is being adopted with more intensity, where young people acquire their digital skills and take advantage of the full range of functionality that these technologies offer, more so than they do at school.

A flexible and progressive focus

The incorporation of ICT never occurs identically in different educational systems. Despite the similarities we can find in the policies that are driving this process, its takes different forms to suit the characteristics of different contexts. The strategies adopted by each country for the digitalization of their educational system are neither identical nor static. The formulas are modified depending on many different variables that may be related to the uniqueness and dynamics of each educational system – the sociocultural aspects of each country, the evolution of its economy and, frequently, changes in government. Furthermore, the instability is also fruit by the rapid evolution of ICT. The emergence of new products and the continuing development of new applications provides, almost on a continuous basis, new possibilities of application for the education centres. To capture this evolution requires a model of indicators that can offer the flexibility to adapt

to a reality that is diverse, changeable and that, in practice, is developed in different strata and stages.

Indeed, from this point of view (Engeström, 1987), this evolution can be seen as a complex process that often does not occur in a linear fashion, is not completed in one step, and is not visible on just one level. We have many data sources that provide information on specific aspects of the incorporation of ICT in schools. Often, however, these indicators are shown in isolation. The challenge, from an analytical point of view, is first to develop a conceptual framework for understanding the different strata at which technologies are incorporated into educational activity. This means a progressive analysis that provides insights into the

configuration of ICT policy at the state and local levels, on the strategies used by education centres for incorporating technology into their organization and, finally, on the daily activity of their classrooms. In fact, the challenge lies in having a model of indicators that are not merely displayed in parallel, but which can capture the interaction that occurs between these different levels. It is through an understanding of the synergy that is produced between these strata, and an analysis of covariance of the indicators that are available in each of them, that we can get a sufficiently complex picture of how ICT can be of service to innovation in education.

Moreover, in each of the planes involved in the integration of technology in schools, the activity is carried out along a trajectory that is not always linear. We should be able to interpret this trajectory with an approach that distinguishes the various phases in which it unfolds. A model of indicators regarding this dynamic should be able to show how each phase in this process is constructed and sets the stage for the following phase. Ultimately, this model should be adaptable to the historical moment of each country and, at the same time, enable us to observe, through comparable data, how each progresses towards a shared vision of the role of technology in schools that are adapting to the requirements of the knowledge society.

An instrument for assessment

A model of indicators capable of capturing the complex impact of ICT in education, ultimately, should be able to meet its primary objectives: to offer comparable data for assessment, tracking the progress of individual countries in terms of how they are incorporating ICT in their education systems and set goals that can be taken as a international benchmarks as to the place education should occupy within the knowledge society. The impact of ICT on educational outcomes has been discussed since the

moment computers were installed in schools and even more so now, when access to the Internet is almost universal. Several meta-analyses (Kulik,

2003; Cox i Abbot, 2004) have managed to identify some of the positive effects associated with certain uses of ICT, when put to the service of specific teaching methods and sustained over time. Overall, however, although significant investments in recent decades to incorporate technologies into schools have resulted in an increased presence of ICT, the results from this effort are still unclear (Trucano, 2005) .

The difficulties in obtaining a clear picture of the contribution of technology to the productivity of the educational system probably do not arise solely from the complex and dynamic nature that is unique to this area. The drawbacks can also be attributed to the difficulty of developing appropriate methodologies and evaluation tools that can be effectively and systematically integrated into the process. The demands of the knowledge society prevent individual countries from abandoning their efforts to incorporate ICT into their education systems. However, accumulated experience alone cannot provide us with clearly measurable results to claim as evidence for the results of this effort. This highlights the need for an analysis of the process of integration of ICT into schools that offers standardized indicators, which are internationally accepted and valid for measuring the complex evolution of this process in a comparable way.

In fact, the same lack of hard data to which we are referring is one of the brakes that prevents education systems from accelerating the incorporation of technologies that can best fit their specific situation and contribute to innovation. In this sense, apart from indicators, an analysis of this process should enable us to set goals that can best serve as the policies and strategies most suitable for the different levels and spheres in which they can be implemented. Thus, identifying landmarks of different magnitude (Johannessen, 2009) that are sufficiently accurate, valid and useful in guiding activity is another critical element in this analysis. Ensuring the success of this proposal requires a collaborative effort between the researchers and stakeholders involved at the various stages of this process, both in policy-making and in the schools.

Ultimately, in the conceptual framework to which we are referring, evaluation is not only considered as a static representation of a specific moment in this process of appropriation of technology in education. Rather, this conception establishes the conditions that, beyond mere diagnosis, can promote progress towards the objectives set. Assessment,

for this purpose, establishes a cyclic process that enables us to observe how the process unfolds, in each of its planes and stages. It is, in fact, a monitoring mechanism (Pelgrum, 2009) that ensures critical information for decision-making, both in the strategies that drive education centres and also in the field of education policy. Therefore, evaluation provides an essential tool for intervention and the implementation of measures that, at every moment, may end up being more appropriate to ensure forms of ICT integration that are more favourable to innovation in education centres.

DISTINCTIVE FEATURES OF A MODEL OF ICT INDICATORS IN EDUCATION

The perspective from which we derive this framework enables us to characterize a model of indicators to observe the complex contribution of ICT to innovation in education systems. Distinguishing the distinctive features of this model meets the following objectives:

➡ To facilitate the systematic analysis of the process of incorporating ICT into the educational context through a structure of internationally comparable indicators.

➡ To distinguish the various levels at which this process unfolds, focusing attention on the plane on which schools' activity takes place, identifying areas of activity that integrate technologies, and the technological factors that shaped and ultimately provide a basic structure for the design of valid indicators to gauge the integration of ICT in each area.

➡ Offer an alternative point of view of the critical actors for each of the dimensions identified, and thus provide a complex representation of the process of ICT appropriation from the different and complementary perspectives of the protagonists.

➡ Identify the topology of expected results regarding the use of technologies in each of the areas of school activity, marking stages and landmarks along the way and, additionally, providing a structure on which to develop the mechanism of assessment and monitoring. All of this with a threefold purpose: to guide the process, propel it and promote innovation.

➡ The application of this model should reflect the principle of sustainability. For this purpose, where possible, it should draw on existing data sources. In the event that new information is involved, it should guarantee efficient strategies for obtaining this information.

Based on the theoretical framework outlined earlier and with the above objectives in mind, we can begin to define the set of distinctive traits that distinguishes the specific structure and dynamics of a model of performance indicators for the study of the process of ICT incorporation into schools.

A multi-layered approach

This model takes into account that the incorporation of ICT into educational systems does not occur at a single level. This open approach is in contrast, as we have said, with a more restrictive but persistent approach found in research on this area: the restriction of the analysis to the effect of these technologies on the academic performance of each student. The difficulties in observing the impact of technologies from this perspective, limited to the impact on individual results, has led to other approaches that try to capture the impact of ICT in a more complex manner. From this point of view, we have distinguished (Erstad, 2009; Kikis, 2009) three levels for the analysis of the incorporation of technology into education systems, each of which brings together particular types of indicators:

➡ The macro level refers to the policies and strategies at state or local level, aimed at facilitating access to and use of ICT in schools. At this level, we find indicators on levels of connectivity and the technology infrastructure available, but that are also able to capture the degree of implementation of any other action that is being promoted to facilitate this process, e.g. the incorporation of ICT in the educational curriculum design of each country, the actions aimed at promoting the production of new digital learning resources, the plans for technological support that can be implemented at the local level to encourage this process or, as a final example, the incorporation of digital competencies in initial and ongoing training for teachers.

➡ The meso level is situated at the institutional level, i.e. where the schools' activity takes place, which brings together indicators that shed light on the strategies and dynamics that follow the incorporation of technology into the school. Here we pay attention to aspects relating to leadership and the specific initiatives aimed at driving the digitization of school activity and, especially, the way the Internet is incorporated into its organizational culture, both for internal collaboration and for participation in and establishment of links with the educational community in its broadest sense.

➡ The micro level refers to the activity that takes place in the framework of pedagogical practice and contains indicators to identify the frequency and types of uses of technology in the teaching and learning processes. Here we pay attention to specific areas of knowledge, the diversity of digital resources that are incorporated there, teachers' digital skills, those of the students and, ultimately, in each group's beliefs regarding the role of technology at this level. On the other hand, based on the inability to ignore the prominence acquired by the Internet in the daily lives of young people and teachers, this plane also incorporates

indicators on frequency and ways of using technology beyond the school, specifically in the family context.

Access to the information needed for the construction of ICT indicators at each of these levels requires specific processes and even involves different methodologies that can generate data using efficient formulas, adapted to each level, to ensure the sustainability of the process. Thus, at the macro level, various international organizations (World Bank, OECD, Eurostat) provide comparable data on the availability of technological infrastructure and the development of the information society. For the analysis of this level in educational systems, the set of indicators designed to measure the use of ICT in education produced by UNESCO's Institute for Statistics (UIS) are particularly relevant. This source of indicators groups them into a set of conceptual domains (UNESCO, 2009) reporting on key aspects that converge in ICT education policy: the commitments made by these policies in the international context, the characteristics of the technological infrastructure available, the place of ICT in teacher training, the integration of these technologies into the curriculum, the form and intensity of use of ICT in schools, the importance placed on these technologies when measuring competencies and, finally, the transformation in terms of results and the impact on the systems themselves. The grouped indicators in these domains incorporate international norms that ensure standardized and consistent statistical data for use by policy makers, researchers and large organizations that operate globally. The numerous international reports that utilize these data also help monitor, on a large scale, the process of ICT integration into education systems at the macro level to which we are referring. Data collection, in this case, is performed following the procedures used by the UIS in its main survey, and thus focuses on the schools' digitization process (UNESCO - UIS, 2008b). The methodological and operational constraints that these indicators can have, as a result of the restrictions associated with obtaining information and, especially, of the difficulties of adapting to the rapid evolution of ICT, require continuous review procedures for updating and incorporating new indicators to achieve the changes experienced in this field (UNESCO - UIS, 2009). Given these limitations, this source uses the information available to public administrations, thus reducing the high cost involved in obtaining data through questionnaires administered at the state level. Thus, it guarantees the sustainability of constructing indicators at this level that would otherwise be difficult to maintain for many countries. Additionally, it ensures the continuity and regularity of the procedure and ensures comparable ICT indicators.

Accepting the potential of this mechanism for building ICT indicators at the macro level, the model proposed here should serve in an alternative and complementary way. Therefore, it focuses on meso and micro levels in order to provide other types of indicators that are essential to accurately interpret how schools and its main actors appropriate ICT in their daily activities and within their specific sphere of action. Obtaining other sources and indicators requires other sources and the perspective of different stakeholders that are specific to or provide a unique vision for each of the levels to which we are referring. Triangulation of this range of perspectives becomes fundamental for a complex interpretation of the facilitating elements and the obstructions that, in practice, ICT brings to innovation.

A perspective of the journey

From this flexible and progressive approach, this model of indicators has the aim of capturing the process of how ICT is being introduced and, therefore, tries to avoid the limitations of a still image that cannot be interpreted in evolutionary terms. The potential of this approach, which enables us to distinguish and position indicators taking into consideration what is analyzed as being a *trajectory*, should be framed in models that arise from analyzing the differentiation of a number of successive stages through which education systems gradually appropriate ICT.

We have a broad array of proposals, with different nuances, that follow the progression towards innovation in schools (Fullan, 1991; CERI, 2009a; CERI, 2009b) and, in the final analysis, the dynamics of ICT incorporation into educational systems (Moersch, 1995; Kikis et al., 2009). In these cases, from a first stage in which the difficulties of Internet access prevent its use or reduce it to merely testimonial application, we see the unfolding of a path that can culminate in a phase in which the schools are able to get the most added-value out of ICT and apply it in a manner than can contribute to educational innovation. Beyond the conditions of accessibility offered by the IT infrastructure and how often it is used, the aim of this analysis is to show the evolution of how technology is used. In any case, it aims to differentiate the stages running through the adoption of ICT, to characterize them and to provide an instrument to discover the indicators that education systems need to be part of this process and the objectives that should orientate the strategies they should employ to move efficiently from of the initial stages to the following ones.

Following this approach, UNESCO (2002) has distinguished four stages (emerging, applying, infusing, transforming) in order to facilitate the comparison of education systems, in terms of their position in these consecutive phases of absorption and progressive use of ICT as a tool for innovation. In the analysis of indicators for this process, educational systems requiring special treatment that takes into consideration which stage they are at. In this sense,

the challenges faced by each country as they formulate ICT policies are not identical. The strategies adopted and the expected results must evolve according to this progression.

More recently, the distinct stages of this process have been differentiated, paying attention to the potential contribution of ICT policies in education for social development and sustainable economic growth. From this perspective, and emphasizing the competencies that can bring added value to productivity in the knowledge society, four phases have been identified that provide insight into the progression of education systems towards encouraging innovation. This relates to a *"Knowledge Ladder"* (Kozma, 2011) comprising four successive steps: *basic education, knowledge acquisition, knowledge deepening, knowledge creation*. Each of these steps defines the characteristics of the stage that provides the basis for progression, in a process of transformation into a system for innovation. The model provides a representation of the expected development, up this ladder, of the key factors that shape educational systems. Thus, predicting progression in the use of ICT, from the most basic level to more advanced use of the Internet for the shared production of knowledge, is accompanied by the representation of these same phases of change in critical aspects of this process, such as for educational policy, teachers' professional development, characteristics of pedagogical practice, curriculum development, the assessment process or the uniqueness of school organization. In any of these examples, it deals with issues that end up having a major influence on how schools use technology in their daily activities. The sum of these factors, incorporated into the model, offers the possibility of an interpretation, one that is both complex and flexible, capable of capturing the specific phase of development of each education system in the process of ICT appropriation for innovation.

A delineation of the areas of impact

Another characteristic feature of the model of indicators to which we refer is its ability to distinguish a typology from the results that can be expected from the application of ICT in educational systems. This means offering a strategy for distinguishing the range of products that can be obtained from the incorporation of the Internet into the different areas of schools' activities. This systematization of results should facilitate international comparison and, ultimately, a valuation of the investments made in terms of efficiency. This component of the model should allow us to assess the effectiveness of the process of incorporating ICT, focusing attention on the product of the evolution of each of the components

involved in achieving the ultimate goal: improving the teaching and, finally, the quality of learning.

Expectations about the impact of ICT in education have attempted to identify its influence on students' academic performance and, specifically, the results they obtain in different subjects. For this purpose, the analyzes that claim to offer comparable measures rely on the data provided by international assessments and results provided by the "Programme for International Student Assessment" (PISA) in the areas of languages, mathematics and science. The question is, however, that efforts to identify the impact of technology-use on the results obtained in these subjects have not provided conclusive evidence. Harnessing the potential of ICT to improve educational processes occurs in a complex dynamic in which the provision of technological infrastructure is only one of the conditioning factors.

In this sense, the model should allow us to reflect on the diverse nature of the results: it should be able to show the intensity and, mainly, how schools incorporate the Internet to find organizational solutions; it should help us discover how, and in what conditions, the principal actors are able to appropriate technologies in pedagogical practice and, ultimately, in what ways use of the Internet by students enables them to put bring into play the skills that are considered most important in the knowledge society. Among the set of results produced in the field of education, this model distinguishes the typologies of those emerging from innovation that can occur in the areas, processes and methodologies dynamically affected by the adoption of ICT. The results thus provide evidence on alternative strategies generated in the Internet, efficient for school organization, to establish partnerships with the education community and to improve the teaching and learning that occurs inside and outside the classroom. This block of results, therefore, should provide an overview of the evolution of these aspects in which innovation takes place, and it should provide data to facilitate comparison of its dynamics in the diverse educational systems that, ultimately, facilitate decision-making.

Obtaining ICT indicators and benchmarks in education

The model we propose should ultimately provide a basis for obtaining, as a product, a comprehensive set of indicators that are consistent with the different traits of the process just outlined. In this sense, it should provide the structure on which to develop differentiated and specific measures to assess the integration of technology at the institutional level and, on the other hand, for analysis at the micro level of pedagogical practice, as has been outlined above. This structure should also facilitate the development of

formulas that provide enough flexibility to assess the dynamics of the process, with measures tailored to each of the stages in which it is deployed. At the same time, the indicators should allow for differentiation according to their suitability for analyzing the approach to ICT by each of the actors involved and, finally, taking into account the measurement of the sections and typologies identified by the model.

Thus, we are talking about a complex model that primarily refers to that which is incorporated, from the beginning, for linking schools with the Internet. This has been a recurring unit of measurement, evident from the fact that national policies often search for this when examining the strategies of schools, especially when promoting access to the Internet. The model, however, is not aimed at measuring only *input, but* also places special emphasis on the process. For this purpose, it provides measures concerning the use of ICT that have to show how the appropriation of technology takes places in the various stages of its dynamics. Finally, this model of indicators looks at the impact of use on results. Thus, it also incorporates the output of the process. For this purpose, the indicators not only refer to the relationship between use of ICT and academic performance in different areas of knowledge, although this has been a priority. With a more ambitious vision, these indicators should make it possible to measure the return of technological integration in terms of innovation at different levels and areas of activity of the schools that the model itself distinguishes. Thus, this model situates the impact of technology in a complex framework of interactions that are not well suited to logical treatment from top to bottom, in which ICT education policies are considered a necessary starting point for the innovation process. This model of indicators aims to provide a complex interpretation of how schools gradually appropriated technologies and are able to configure a context for the acquisition of those skills required by the knowledge society.

Ultimately, given that this model should help us track the development of this process, and at the same time be useful for guiding it, it should be designed with a set of benchmarks to establish the objectives to be achieved in each of the phases, levels and dimensions of ICT integration into education systems. The main challenge in developing this system of benchmarks, is to bring together the perspective of policies, the needs arising from educational practice in schools and, at the same time, the research questions posed in the analysis of this process (Johannessen, 2009). The validity of this system of benchmarks should be precisely in its ability to incorporate this tripartite perspective. Finally, the usefulness of the model of indicators for informing the different actors involved and helping in the decision- making process of the key decision-makers, means that it should be linked to the resolution of this methodological challenge.

Much of the potential of the model for analysis and international comparison depends on this being achieved.

A monitoring instrument

The configuration of this model of indicators is aimed at developing an instrument for efficient monitoring of the process of ICT integration in education systems and the different types of outcomes associated with this process. Thus, the model should facilitate the design of appropriate indicators for the cyclical evaluation of this dynamic, thus enabling us to observe its evolution in each of the levels, phases and areas. It is, in this sense, a tool for systematic monitoring that should provide information that is internationally comparable and, at the same time, on which we are able to base decisions on the progression of this process at a national level.

The act of monitoring converts the model into a tool for regulation, planning and intervention. As a regulatory tool, this should allow the process to be adjusted in each of the areas of school activity that incorporate ICT. In fact, it also gives the model of indicators the potential to be used as a mechanism for planning (James and Miller, 2005) that could provide an overview of the process and help identify critical factors in any program aimed at the introduction of technologies capable of promoting innovation in educational systems. Finally, as a basis for monitoring, the model acquires additional value as a tool for intervention and it could be used to guide policy decisions based on the information provided by the indicators on the evolution of the process. In response to this tripartite potential, monitoring should be considered a fundamental feature of this model of indicators.

The accuracy of the diagnosis and the effectiveness of the intervention that may arise from it will depend, ultimately, on the correct definition of indicators and, specifically, on its "comprehensiveness" (Pelgrum, 2009). In this regard, monitoring should be linked to the capacity the indicators may have to adequately represent the dynamics of education systems as they are at the particular moment of their evaluation by the model. This comprehensiveness, however, should be linked mainly to the ability of the model to incorporate those other types of indicators with the ability to anticipate how these same systems could be from a future perspective. This entails incorporating into the model the ability to measure the factors of change that, through ICT, can contribute to the evolution towards innovation called for by the 21st education system.

A MODEL FOR OBTAINING INDICATORS ON ICT INTEGRATION IN SCHOOLS

Within the parameters set by the conceptual framework described above and in accordance with the set of distinctive features outlined, we can build a model from which to identify, define and operationalize a system of indicators capable of measuring the process of ICT integration, specifically in the area of schools. The proposed structure is based on a review and adaptation of some of existing models that were developed for this very purpose (Carstens and Pelgrum, 2009; Scheuermann and Pedró, 2009; Kozma, 2011; UNESCO – IEU, 2009).

Thus, this model aims to provide a holistic and integrated process regarding the appropriation of ICT in schools and, especially, in the daily activity of its main actors. For this purpose, four lines of complementary analysis will be differentiated: (1) the penetration of technology in the forms of organization and management of schools; (2) the adoption of ICT in what we might consider the fundamental activity of schools, i.e. the pedagogy employed by the organization, inside or outside the classroom; (3) the use of the Internet for collaboration among the educational community, both within the centre itself, and beyond its limits; (4) access and use of ICT beyond the centre itself, and especially in the family context. The approach to each of these lines of analysis is carried out from a multidimensional perspective. Thus, each line is displayed as a set of branches that enables us to focus attention in specific ways to the use of technology.

In order to offer a complex vision of the digitization process, this structure is not built around a single optic, but incorporates the vision of all the actors involved in the process. For each of the lines of analysis, we identify key informants that can provide us with additional indicators in the areas discussed. Ultimately, to help us measure the impact of the adoption of ICT, the model uses specific indicators to anticipate the type of results that can be expected in the different lines of analysis. However, considering the dynamic nature of this process, the description of these results is not seen as a static product. The structure of the model involves the need to separate the evolution of these results into a progression of four stages, which should enable us to differentiate what can be expected at the initial stage of introducing technology from the impact that should occur when ICT has been more thoroughly appropriated in the later stages. Ultimately, the model derives meaning from, and is configured as a tool for, systematic monitoring (Pelgrum, 2009). It is this purpose that distinguishes the types of indicators and reference points that should be designed for each line and dimension of the analysis, for each component of the model and for each of the development phases anticipated.

Within this general framework, it is advisable to pause the development of the model and examine each of the four lines of analysis to which we referred earlier so as to focus for a moment on the types of results, indicators and reference points that will have to be designed in each case.

Indicators on the incorporation of ICT in the organization and management of schools

The incorporation of ICT in schools can be observed immediately, by looking at how these technologies are used in the management of the organization. In this area, technologies can offer alternatives to improve major information and communication processes. The Internet offers new opportunities
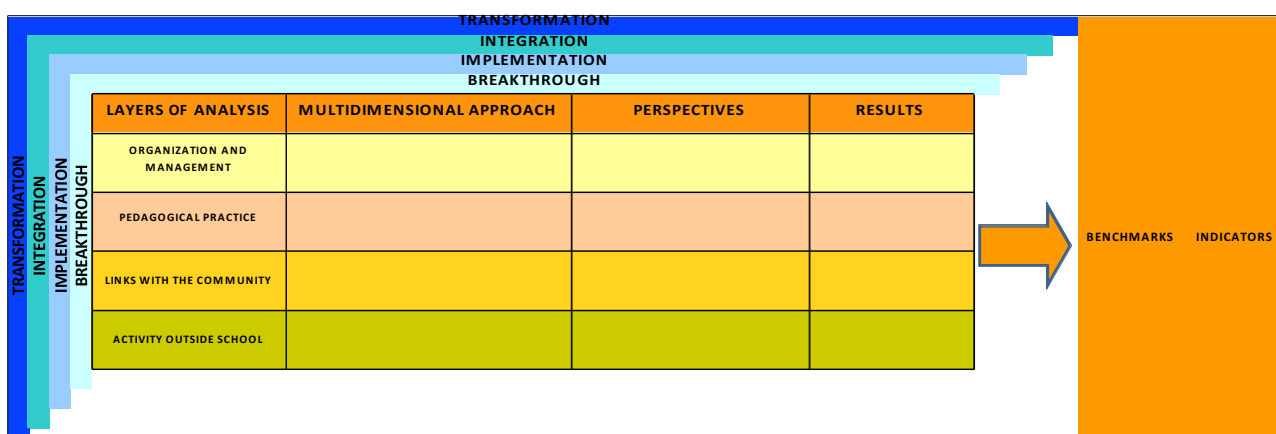

Figure 1.   A model for obtaining indicators on ICT integration in schools

to any association and educational organizations to manage their administrative processes and service offerings. From this point of view, ICTs are seen as an efficient solution in the economic sphere, in the management processes and schools' internal and external communication (Pedró, 2011). Moreover, beyond their contribution to the management of these processes, an analysis of the role of technology in this aspect of organizations cannot ignore what they can also contribute to the definition and promotion of institutional strategies (Frank, Zhao y Borman, 2004).

Therefore, the indicators needed to measure the incorporation of ICT in the organization of education centres should be able to provide information on these different dimensions. For one, it will be necessary to obtain evidence of the process of digitizing the institutional vision and culture of the centre, such as the incorporation of technology in leadership strategies. Additionally, we must gather evidence about the characteristics of the technological infrastructure available to the organization. Moreover, beyond strategy and accessibility, it is essential to have evidence on how the Internet is used, ultimately, at this level of organizational management. Finally, among the dimensions that should be covered for this first type of indicators, it is essential not to overlook the features of training and technical support available to those responsible for the efficient implementation of these technologies in these processes of the schools' organization.

In order to be able to show, in detail, the objectives to be measured using these indicators in this first line of analysis, we should describe the content of each of these dimensions, identify the different perspectives for obtaining information, as well as the type of results that these indicators are able to illustrate in each case. Thus, in the first of the dimensions to which we have referred, it will be necessary to construct indicators that can reflect the function given to ICT in the institution's vision and how this has actually penetrated into the culture of the centre. For this purpose, it is desirable to obtain indices about the characteristics, the level of definition and the implementation of a strategy of incorporating ICT

within the school's educational project. Also, it would be appropriate to gather evidence on the use of

technologies to create a culture of innovation in the centre and, specifically, to boost new ways of organization based on the possibilities offered by the Internet. Ultimately, the forms of regulating the use of technology employed by the centre can also provide interesting information to complete the analysis of this first dimension. We should point out that to obtain this type of information the point of view of the centre directors is particularly valuable, but we neither can underestimate the contrasting point of view of the ICT manager, when there is such a person, or the views of students' families. Finally, the evolutionary perspective we can expect, in terms of the results garnered from this dimension, should allow to distinguish a progression from the early application of technology in administrative processes, to the more advanced application used by the entire organization as a network, this being a key defining feature of the organizational culture of the centre.

The second dimension is closely linked to the first: ICT as a tool for leadership in pedagogy, i.e. a form of leadership that, beyond its administrative and technical function, aims to improve the educational results obtained by the school (Hopkins, Ainscow and West, 1994; Hopkins, Harris and Jackson, 1997, Fullan, 2002). In the analysis of this area, information on how schools appropriate technologies to support their institutional strategies is indispensable. In this sense, indicators on the use of ICT by the director of the centre are especially valuable. Moreover, bearing in mind the value of distributed leadership and the contribution that the Internet can make to this form of management, it would also be interesting to obtain indicators about the way the teaching faculty uses technology to participate in this shared strategy. The evolution of this dimension should provide indicators showing a progression from purely administrative uses of ICT, to the most advanced forms networked collaboration for pursuing leadership innovation strategies and the effective functioning of schools.

LAYERS OF ANALYSIS	MULTIDIMENSIONAL APPROACH		PERSPECTIVES						RESULTS	
	Dimensions	Subdimensions	Directors	ICT Managers	Teachers	Students	Parents Tutors	Organizational capacity for innovation and learning through ICT		
ORGANIZATION AND MANAGEMENT	School's vision and culture	Strategic Integration of ICT in the educational project	*	*	*				Adoption of ICT for organizational innovation strategies	
		Innovation through ICT								
		Reorganization								
		Regulations on use of ICT								
	Leadership	Using ICT for a pedagogical leadership	*	*	*				Instrumentation of ICT for a pedagogical leadership	
	Infrastructure	Computers / Connectivity / Software	*	*					Organizational adaptation to school structure as a network	
		Institutional Website / Intranet								
	Use	Using ICT in the administration and management of information	*	*					Capacity for technology management characteristic of a learning organization	
		Use of ICT for internal and external communication								
		Use of ICT in knowledge management								
	Training and competences	ICT Skills for organization and management	*	*					Availability of digital competences for a networked organization	
		Ttraining in the use of ICT for organization and management								
	Support	Technical support in ICT	*	*					Development and quality of support for the adoption of ICT	
		Pedagogical support in ICT								
		Incentives for incorporating ICT								

Figure 2.   Analytical perspective of organization and management

The third dimension referred concerns the technological infrastructure available. Although, by itself, this does not guarantee innovation in the organization, it is a prerequisite that needs to be understood. Thus, the ratio of computers used for administration, management and organization is relevant. We should also gather information on the characteristics and level of connectivity of the centre and on the software used for this type of activity. The data set for this area would be completed with an analysis of the characteristics of the centre's website and intranet, where they exist. Ultimately, beyond mere descriptive information about the characteristics of these two factors, there should also be indicators on the frequency and the way they are used by the educational community, especially for school organization. Possibly, the best person to ask about these issues would be the centre's director and the ICT manager, when one exists. The analysis of the evolution of this process should enable us to observe progress from basic connectivity to situations in which the technological infrastructure permits the organization of the centre as a network.

Beyond the description of the available infrastructure, it is essential to know how it is used for the organizations' activity. In this area, there is evidence available on how often ICT is used and how it is used in schools' management processes, and also on how technologies are used to manage information related to these very processes. Also, we need to look at how the Internet is used, by the administration of the centre for internal and external communication. Finally, we should have indicators to reveal to what extent the centres also are appropriating these technologies to manage and share the knowledge that the centre itself is capable of generating, from and within their own organization. In this case, again the centre director and the head of ICT would be the right people to provide such information. The analysis of this dimension should show progress from the use of ICT for basic administrative processes, to more sophisticated forms of appropriation of technology for knowledge management.

In this same area, we must also take account the degree of training of the people who have to use these tools in the organization and administration of the school. For this purpose, there should be a distinction between the skills that these people have to incorporate technology into their daily activities and the skills that they lacking. Correspondingly, we must also be able to discover the origin and nature of the training in ICT, at this level of the center's activity, and what are the gaps remaining to be filled. The center's director and the ICT manager, in this case, have to be considered key informants. The analysis of results from this dimension should show different levels of training, from basic computers skills, to those with more advanced skills that should enable

them to promote the reorganization of the centre as a network.

The analysis of ICT implementation in the organization and management of the school should be completed paying attention to the support mechanisms available to the organization for the promotion of this process. Here we should have evidence about the options available to facilitate the deployment, maintenance and upgrade of the technological infrastructure. We should obtain indicators on the support available for the resolution of technical problems that arise from the application of ICT in the daily activities of the centre. In fact, this support should not be restricted to purely technological aspects, but also to the specific application of ICT for educational purposes. Thus, we should have indicators to measure the mechanisms that the centre has to guide appropriate use of ICT, converting its potential into improved pedagogical practice. Ultimately, the support structure for the digitization of school activity should be observable by also paying attention to the types of incentives offered by the organization to drive this process and promote the involvement of those responsible for its development. It is likely that the ICT manager is the best person to ask about the characteristics of the support available. In cases where the centre does not have someone with this position, it should be the centre's director that provides the information regarding these indicators. Ultimately, analysis of this dimension should enable us to observe the quantitative and qualitative increases in mechanisms that the school makes available for these different forms of support in the process of integration of technology into their organization.

Indicators on ICT integration into pedagogical practice

Obtaining indicators on the incorporation of technology in the organization management processes of centre provides the foundation and framework for a proper interpretation of the ways ICT is adopted in pedagogical practices, i.e. what we might consider the fundamental activity of the school. In a complex and ecological understanding (Zhao and Frank, 2003) of the process by which schools appropriate technologies, a view which underpins the model of indicators we propose, the adoption of ICT in teaching cannot be explained independently of the organizational culture we have just referred to, regardless of the influence of the educational practices that are rooted in the daily activity of schools (Cuban, 1986, 1993 and 2001; Cuban et al., 2001).

Thus, the delineation of indicators for measuring the incorporation of ICT for teaching and learning activities should consider the context in which the processes are inscribed. At the same time, these indicators

LAYERS of ANALYSIS	MULTIDIMENSIONAL APPROACH		PERSPECTIVES						RESULTS
	Dimensions	Subdimensions	Directors	ICT Managers	Teachers	Students	Parents Tutors		
PEDAGOGICAL PRACTICE	Infrastructure and digital resources	Computers and connectivity	*	*	*	*		Adaptation of pedagogical practice to the demands of the knowledge society	Infrastructure and digital resources for a networked pedagogical practice
		Other devices							
		Distribution of the infrastructure throughout the centre							
		Availability and accessibility of digital pedagogical resources							
	Curriculum	Integration of ICT in the centre's curriculum	*	*					Incorporation of digital skills throughout the curriculum
	Use	Experience of using ICT			*	*			Use of ICT as a catalyst for educational innovation
		Frequency of ICT use							
		Specific use of ICT in different disciplines							
		Integration of ICT in the assessment system							
	Beliefs	Attitudes to ICT			*	*			Perception of the potential of a networked teaching
		Motivations for using ICT							
		Expectations regarding ICT							
	Training and competences	Initial training in ICT			*	*			Digital competences for life-long teaching and learning
		Ongoing professional training in ICT							
		Digital competences							

Figure 3.   Analytical perspective of pedagogical practice

should be sufficiently diverse in order to illustrate the interaction of the multiple factors involved in the way ICT is used in pedagogical practice. For this purpose, this second line of analysis incorporates various indicators that complement and give meaning to the core use of technology in educational activity. Therefore, this area should be supplemented by indicators that refer to the characteristics of the technological infrastructure used for educational purposes, the place of ICT in the curriculum, the beliefs of teachers and students about the role technology should have are in the process of teaching and learning, the training of these same actors in digital skills and, ultimately, to the availability of digital pedagogical resources.

As for the technological infrastructure, now comes the moment to shine the spotlight on the kind of pedagogical hardware and software used by the schools for educational purposes. In this aspect, the student-to-computer ratio and, more specifically, the ratio of student-to computer-that-has-an-Internet-connection is a fundamental indicator to measure. Moreover, we should also identify the level of connectivity available to the centre to know how possible it really is for them to connect to the Internet. It is also important to find out to what extent the centre's technological infrastructure includes other devices such as digital whiteboards, projectors, scanners or other technologies that are incorporated into pedagogical practice. In this case, it is also interesting to have ratios as a measure, but the proportion of available devices is more relevant compared with the number of teachers. The representation of this dimension must be supplemented by evidence of the spatial distribution of hardware, when it is not portable. This means reflecting on the extent to which technologies are readily available to the teacher and students and, therefore, gathering additional data that demonstrates the degree of integration of ICT in everyday teaching practice. To obtain this information, we consider again the centre director or ICT manager

as key informants. The analysis should enable us to observe the progression from technology solutions that are an addition to traditional classrooms activity to the more integrated and innovative forms of use that these tools provide for teachers and students to carry out their daily activity as a network.

Beyond the infrastructure available, this second line of analysis should be directed, first, to identifying the place of ICT and digital skills development in the curriculum of the centre. The available evidence on the strategy adopted regarding the form and intensity of ICT integration into the curriculum should help identify the progression from approaches limited only to a specific area of knowledge, to those that treat ICT as a tool to be integrated into all areas of the curriculum for the interdisciplinary and dynamic acquisition and evaluation of digital skills. With this perspective, the focus must be directed at what we might consider the nucleus of the

analysis: the use of technology in the teaching and learning process. For the analysis of this dimension, first we have to obtain evidence about the experience of using ICT accumulated by teachers and students and also on the frequency with which they use technology in the school setting. Ultimately, for the analysis of this dimension, we must put special emphasis on obtaining indicators to identify the intensity and, mainly, the specific forms of technology use in different areas of knowledge. Thus, we should obtain evidence of the use of ICT for teaching, but also as a learning tool. Specifically, we should look for evidence on the use of ICT for teamwork among students. For this, we should able to show in what way and to what extent the Internet is used for peer collaboration in educational situations in which ICT is at the service of cooperative work (Johnson and Johnson, 2004). Putting the focus on different disciplines, it should be possible to develop a differential analysis showing variability in the application of ICT at this level of specificity.

For a correct interpretation of the process of ICT integration into teaching practice, indicators on infrastructure and the digital resources available, on the adoption of technologies in the curriculum and on how teachers and students use them are not enough. We also need to identify the beliefs of students and teachers about the role of technology in education and, more importantly, the pedagogical concepts underpinning the educational practice of teachers. The latter constitute a variable that must be taken into account because of their influence on the way these actors appropriate ICT to undertake their daily activities at school (Becker, 1994; Becker and Ravitz, 1999; Kozma, 2003; Ertmer, 2005). It will therefore be necessary to obtain indicators on their perceptions so as to provide us with insight into the attitudes and motivations that end up conditioning the adoption of technology. Access to evidence on expectations, in the case of young people, will enable us to understand the potential they attach to the Internet for their education. In contrast, indicators on teachers' expectations will allow us to better interpret the terms in which they calculate the cost/benefit of ICT, which frequently end up being determining factors on whether they use technology to solve some of the problems which arise in in their daily teaching activity. The analysis of this dimension, based on evidence provided by students and faculty, should enable us to observe how technology has evovled from being understood as a tool for traditional teaching, which ultimately means continuing doing what one is doing, to those other understandings that see the potential offered by the Internet as a valuable ally for efficient teaching activity.

Finally, it must be remembered that the configuration of this belief system and the ways of using technology are also associated with the training that teachers have received, not only in how to use technological devices, but mainly in the application of ICT for educational purposes and particularly in specific knowledge areas. Thus, the analysis of ICT incorporation into teaching practice still needs to be supplemented by indicators that shed light on the type and level of ICT training that teachers have received in their initial training. On the other hand, we also need to examine the role of continuing education in teachers' acquisition of skills to use technology in their teaching and what forms this training takes. Ultimately, we should obtain evidence on the characteristics of the digital skills demonstrated by teachers and students. The data provided by each group on the characteristics and level of these skills would provide a valuable indicator regarding the practical capacity of incorporating the Internet into school activity. The analysis of this last dimension, in the case of teachers, should allow us to observe the evolution of training from the development of skills to use technological devices and basic software, to more advanced teacher-training in using the Internet

in specific disciplines. For students, we should be able to observe the progression towards the types transverse digital skills can help them develop the ability to learn throughout life, in different knowledge areas.

Indicators on ICT integration for engagement with the educational community

For a complex analysis of the incorporation of the Internet into schools, indicators on the use of technology in the organization of the school are not enough, although, as mentioned above, how ICT is used in teaching and learning processes must necessarily be situated in the context of the organizational transformation that enables ICT integration. In fact, in order to understand how schools appropriate technologies for promoting educational activities, in a broad sense, neither are the set of indicators that provide information on how this process occurs in pedagogical practice sufficient. An analysis of ICT incorporation into schools should also consider the enormous potential offered by the Internet for communication and collaboration with everyone who makes up the school community. Thus, a rigorous study of the penetration of the Internet into schools should consider the options it offers for the development of social interaction and community action. For this reason, this model incorporates a third line of analysis that should provide indicators on the use of technology for engagement with the educational community, understood in a broad sense. From the perspective of our study, in a society like ours (Castells, 2004), the school must be understood, more than ever, as a form of organization that operates through communication and collaboration networks that extend both internally within the school itself, and also externally to establish partnerships with other actors in the educational community that are beyond the limits of the school.

Engagement with the community in schools' activity has been noted as a critical factor in the effectiveness and improvement of education centers (Hopkins, Ainscow and West, 1994). The development of a school culture (Hargreaves, 1995) can foster involvement of the actors in the everyday activity in schools (Cohen, 1983), but also ensure the distribution of leadership (Spillane, Halverson, Diamond, 2004), the participation of families (Dornbusch and Ritter, 1988) and the collaboration of other stakeholders in the community, either locally or from more distant contexts. These are factors that, from this community perspective (Mominó and Meneses, 2008), are of particular interest for the quality of education. From this perspective, the introduction of the Internet into schools' activity can be observed by paying particular

LAYERS of ANALYSIS	MULTIDIMENSIONAL APPROACH		PERSPECTIVES						RESULTS
	Dimensions	Sub-dimensions	Directors	ICT Managers	Teachers	Students	Parents Tutors	Configuration of a networked school in the community activity	
ENGAGEMENT WITH THE EDUCATIONAL COMMUNITY	Internal Network	Collaboration, through ICT, among them administrators and others representatives of the education community.	*	*	*	*			Adoption of ICT for creating internal links for collaboration
		Cooperation between teachers through ICT							
		Use of ICT for interaction between teachers and students							
		Use of ICT for teamwork among students							
	External Network	Cooperation between schools through ICT	*				*		Adoption of ICT for creating external links for collaboration
		Collaboration with other educational institutions through ICT							
		ICT use for collaboration with other institutions or companies							
		ICT use for interaction with families							

Figure 4.   Analytical perspective of engagement with the educational community

attention to the potential of the Internet following two complementary dimensions: first, as a tool for participation and teamwork within the school itself and, secondly, as a tool for collaboration with the external community.

In the first of these dimensions, paying attention to the internal use of technologies, we should design indicators that distinguish how the Internet is used and with what intensity, for collaboration between those responsible for the administration and management processes of the center and for interaction between the administration itself and others in the educational community. On the other hand, we should also be able to show how the Internet is used for collaboration among teachers, in the development of their professional activities beyond teaching classes. For students, we should measure in what way and with what intensity they use the Internet for interaction and cooperation for school tasks, but not related to the activity in the different subjects being studied as this is already being examined by the indicators

analyzing pedagogical practice. The analysis of this dimension should enable us to observe the evolution of the internal deployment of the Internet, from basic uses for communication, to more sophisticated processes where schools use the network to develop real links for internal collaboration.

The use of the Internet to facilitate the participation of the educational community, on the other hand, should not be examined only by the indicator relating to internal dynamics. The Internet also offers a huge potential for communication and the establishment of ways of working together beyond the boundaries of the school. So, looking to the outside, we should look for evidence of the use of ICT for collaboration with other schools. For a qualitative analysis of this process, we should design indicators to highlight the extent to which schools are able to use the technologies to be get involved, as an active node (Gordó, 2010), in the development of learning networks (Harasim et al., 2000) in which a set of schools, regardless of location, adapt their organizations to collaboration and networked learning. On the other hand, an analysis of this form of reticular adaptation in the organization

of schools should also be observable through indicators that, beyond interaction between schools, demonstrate the extent and forms of cooperation with other institutions that also have educational purposes and, even, the emergence of new solutions for networking with other organizations or companies.

Ultimately, this external perspective should also take into account the options open for collaboration with families. For this purpose, we should obtain evidence on which to judge the extent to which schools also appropriate technologies to establish partnerships with families. In the analysis of this process, it is the director of the center and the families who can provide the data necessary for the interpretation of a dynamic that, both from an internal and external perspective, should show an evolution from initial positions in which the Internet is used to exchange information with people or other institutions in the educational community, to more advanced situations in which the school is able to use the technologies to find networked solutions regarding its organization that enable it to effectively engage with the community to generate participation, support, collaboration and shared learning.

Indicators on ICT integration, beyond the school

This model for obtaining indicators draws its potential from focusing its attention on three lines of analysis relating to the ways technologies are adopted for the organization, for educational activities and for engaging with the education community. This threefold approach covers, through a complementary manner, the components involved in the process of appropriation of the Internet in the main areas of schools' activity. However, the ambition of this model to provide a greater understanding of ICT integration in schools as a complex phenomenon requires a last line of indicators on how young people use technology beyond the school and, specifically, the conditions of access and use in the family context. An adequate interpretation of the incorporation process of the Internet in the fundamental activity of schools in a society like ours, based on information and communication networks, cannot be undertaken

LAYERS of ANALYSIS	MULTIDIMENSIONAL APPROACH		PERSPECTIVES					RESULTS
	Dimensions	Sub-dimensions	Directors	ICT Managers	Teachers	Students	Parents Tutors	
ACTIVITY OUTSIDE SCHOOL	Infrastructure	Computers	*	*	*	*	*	Availability and access to ICT
		Connectivity						
	Use	Type of ICT use	*	*	*	*	*	Use of ICT privately and in the family context
		Frequency of ICT use						
		Experience of using ICT						
		Space and time of using ICT						
	Family Environment	Digital competences				*	*	Capacity of families to support the use of ICT
		Family support of the use of ICT						
		Attitudes to ICT						
		Motivations for using ICT						
		Expectations regarding ICT						

(Column labelled vertically between Perspectives and Results: "Appropriation of ICT in everyday activity")

Figure 5.   Analytical perspective of activity outside the school

without taking into account how children and young people are using ICT in other areas of their daily lives. In fact, in the network society, the limits of the school, as a place of teaching and learning, are blurred. Schools, without losing their critical role, are required to join, as a node, a network of knowledge that far surpasses them. The boundaries of the school thus become permeable to the techno-cultural revolution (Facer et al., 2003) that has been begun in our society and, especially, in the daily lives of young people.

The last line of analysis focuses attention on the way young people use ICT when they are not in school. More specifically, it seeks to obtain evidence about how they have integrated such technologies into their homes and how their families use them. In fact, it seems that the Internet has been installed more readily in the home context than in other key areas in the daily life of young people, such as the school (Papadakis 2003). Fathers and mothers, in this process, often act as enabling factors. Driven by the belief in the educational potential of ICT, families find a reason to invest in home Internet access and facilitate their children's use of the Internet in favorable conditions (Mumtaz 2001, Buckingham 2002). In this scenario, it seems that young people appropriate technology differently compared to use when they are in school (Kaiser Foundation 2000; Loveless and Ellis 2001). This difference in use, in practice, results in the emergence of various digital skills that young people develop in accordance with the conditions offered by each context. Beyond the clear dissociation between the competencies that come into play, in one context or the other, no clear evidence has been found on its impact on educational outcomes, despite the widespread assumption that the use of technology should have an impact on academic progress. The attempt to identify this association, in the school, has been recurrent (Attewell and Battle, 1999; Penuel, 2006; Gulek and Demirtas, 2005, Tarpley, 2001, Sharpley et al., 2010) and, beyond the school, at a time when the Internet tends to dilute the traditional boundaries of educational activity, the impact of the use of ICT and digital skills that young people acquire in the family context has not been adequately distinguished. This analysis has encountered methodological difficulties and has often taken the conventional curriculum as its only reference for measuring performance. However,

it seems essential to incorporate other skills related to a capacity for communication, interaction and knowledge representation made possible by ICT, through a rigorous concept of a digital literacy frequently acquired by young people in large part when they are not in school.

The potential of this last line of analysis is precisely in its ability to provide evidence of how young people appropriate ICT beyond the school context and with particular attention to the conditions offered by the family environment. In designing this line of analysis, it must be remembered that the incorporation of ICT into the family context has occurred relatively recently. The studies undertaken, in most cases, have provided indicators that respond to market interests. They have obtained little evidence about how young people adopt technologies for their daily activities outside of school and, in particular, on how they use them, with the support of families, for educational purposes. This last line of analysis aims to provide, firstly, indicators that shed light on the characteristics of the technological infrastructure available in homes: available hardware and conditions of access that directors, teachers, students and their families can count on.

However, both in an alternative and complementary manner, other types of indicators can be incorporated to help identify the intensity, experience and, above all, the specific way these same actors use ICT in their daily lives outside of school and, in particular, for school purposes. Ultimately, these indicators on activity outside the school should pay special attention to the conditions in which young people, in the family context, use the technologies for educational

achievement. Distinguishing the characteristics of this context will enable us to properly interpret how technologies are adopted. For this reason, we should obtain indicators on attitudes, motivations and expectations of the various actors involved towards technology and also about the forms of support provided by the family context in this process. Finally, we should see an evolution of the conditions that facilitate the development of the digital competences needed for active participation in the knowledge society.

CONCLUSIONS AND NEXT STEPS

Despite the effort that most countries have undertaken to ensure mainstreaming ICT into their education systems, the impact of these technologies on school activity, in most cases, is difficulty to find. The incorporation of the Internet into classroom activity, when it occurs, often does not do much more than reinforce traditional forms of teaching and learning. In this situation, although educational policies continue with the challenge of aligning their education systems to enable them to face the challenges of the network society, the disconnect between the expectations placed on the effect of the introduction of ICT, in terms of innovation, and the improvement of educational outcomes has called into question the nature of the investment and the strategy adopted to further this process. The policies that have been introduced top-down with the main objective of generically deploying infrastructure and uniformly providing technologies have shown little ability to transform the educational field and, in contrast with other sectors in society, have only resulted in weak changes to the conventional dynamics of education.

In fact, the ability to take advantage of the potential of ICT as a lever for educational innovation depends precisely on the ability that schools may have to use these technologies to support new forms of organization, new ways to generate pedagogical practice and new solutions for establishing partnerships with the education community. This highlights the need for systemic policies that take into account not only the set of factors involved in this process, but also the network of relationships established between them. However, the formulas adopted for the integration of ICT in schools are rarely based on a systematic analysis of these factors and their relationships. The emergence of ICT in educational systems, although not a new phenomenon, even in relative terms can be considered recent. For this reason, the appropriate tools to measure its development, in all of their complexity, are still incipient and, consequently, decision-making frequently occurs without the sufficient support of comparable data on the dynamics of this process.

Thus, it seems necessary to have tools to understand the complexity of the process of ICT integration and measure its impact in an area as specific as education.

The model proposed here is specifically intended to provide the basis for the design of a system of indicators that, in combination with quantitative and qualitative data, broadens our perspective on the dynamics that follow the adoption of technologies, in the main areas of school activity. This structure, in short, aims to contribute to the establishment of a monitoring process that allows cyclic and internationally comparable assessments. This would facilitate diagnosis and appropriate intervention in the education system to obtain the expected results, in each of the dimensions and stages of development.

To achieve this purpose, the model proposed reaches a level of detail that should be completed with successive processes of elaboration. First, the structure should be tested, with special attention to its orientation toward the goals set, in the long-term, by international organizations and, in the medium term, by statewide policies, regarding the incorporation of ICT in educational systems. The lines of analysis proposed should also be tested and agreed

upon by the scientific community, taking as a reference point other models that study in depth the factors that come into play in each of the dimensions of the analysis. Once this validation process is completed, it is essential to define as precisely as possible the reference points that should guide the progression of each line of analysis and that should allow the objectives to be achieved in the distinct stages of development. Once this point has been reached, we can start designing, properly, appropriate indicators to measure progress towards the benchmarks set.

With this purpose, the aim is to operationalize and establish the appropriate formulas for calculating, taking into account the definition of the indicator, the type of data that must be sought, and the sources and methods for obtaining appropriate information for each individual case. With the highest specificity, it is desirable to design technical mechanisms that guarantee the reliability of the instruments and the validity of the results, mainly in terms of comparability. Finally, this tool that should be of service for monitoring that, as a process of the cyclical assessment, should guide and facilitate decision-making.

Attewell, P. i J. Battle (1999). "Home computers and school performance", *The information society* 15 (1): 1-10.

Becta (2001). I*mpaCT2 – The impact of information and communication technologies on pupil learning and attainment*. Coventry: Becta.

Becker, H. J. (1994): "How exemplary computer-using teachers differ from other teachers: Implications for realizing the potential of computers in schools", a *Journal of Research on Computing in Education,* 26 (3), pp.291-332.

Becker, H. J. i Ravitz, J. (1999): "The influence of computer and internet use on teachers' pedagogical practices and perceptions", a *Journal of Research on Technology in Education,* 31 (4), pp. 356-384.

Benavides, F. and Pedró,F. (2007) Políticas educativas sobre nuevas tecnologías en los países Iberoamericanos. En Revista Iberoameriana de Educación. Nº 45.pp.19-69

Cabrol, M. and Severin, E (2009). A conceptual framework and indicators in the use of information communication technology for education (ICT4E). In Scheuermann, F.and Pedró,F., *Assessing the effects of ICT in education – Indicators, criteria and benchmarks for international comparisons.* Luxembourg: Publication Office of the European Union, pp. 83-105.

Castells, M. (1999): *La era de la información. Economía, Sociedad y Cultura,* Barcelona, Alianza Editorial.

Carstens, R. and Pelgrum, W.J. (Eds.) (2009) *Second Information Technology in Education Study. SITES 2006 Technical Report.* Amsterdam: International Association for the Evaluation of Educational Achievement (IEA)

Centre for Educational Research and Innovation (CERI). 2009a. *Beyond Textbooks: Digital Learning Resources as Systemic Innovation in the Nordic Countries.* Paris, Organization for Economic Cooperation and Development (OECD).

Centre for Educational Research and Innovation (CERI). 2009b. *Working Out Change: Systemic Innovation in Vocational Education and Training.* Paris, OECD.

Cox, M. y C. Abbot (eds.) (2004). A Review of the Research Literature Relating to ICT and Attainment. Coventry: BECTA.

Cohen, A. P. (1987) "Educational technology, policy and practice", *Educational Evaluation and Policy Analysis,* 9, pp. 153-170.

Cuban, L. (1986): *Teachers and machines. The classroom use of technology since 1920,* Nova York, Teachers College Press.

Cuban, L. (1993): "Computers meet classroom: Classroom wins" a *Teacher's College Record,* 95(2), pp. 185-210.

Cuban, L. (2001): *Oversold & Underused. Computers in the classroom,* Cambridge (MA), Harvard University Press.

Cuban, L.; Kirkpatrik, H. I Peck, C. (2001): "High access and low use of technologies in high School classrooms: Explaining an apparent paradox", a *American Educational Research Journal,* 38 (4), pp. 813-834.

Scheuermann, F. and F. Pedró. (2009) *Assessing the Effects of ICT in Education: Indicators, Criteria and Benchmarks for International Comparisons.* Luxembourg: Publication Office of the European Union.

Delors, J. (1996): *Educació: hi ha un Tresor amagat a dins,* Barcelona, Centre UNESCO de Catalunya

Dwyer, D. C., Ringstaff, C. and Sandholtz, J. H. (1991). 'Changes in teachers' beliefs and practices in technology-rich classrooms', Educational Leadership, Vol. 48, No 8, 45–52.

Engeström, Y. (1987). *Learning by expanding: an activity-theoretical approach to evelopmental research*. Helsinki. Retrieved 30.07.2009 at http://lchc.ucsd.edu/MCA/Paper/Engestrom/expanding/toc.htm.

Erstad, O. (2009). *Addressing the complexity of impact – A multilevel approach towards ICT in education.* In Scheuermann, F.and Pedró,F., *Assessing the effects of ICT in education – Indicators, criteria and benchmarks for international comparisons.* Luxembourg: Publication Office of the European Union, pp. 21-38.

Ertmer, P. A. (2005): "Teacher pedagogical beliefs: The final frontier in our quest for technology integration?" in *Educational Technology, Research and Development,* 53 (4), pp. 25-40.

European Commission (2007). 'Towards more knowledge-based policy and practice in education and training'. SEC (2007) 1098. Luxembourg: Office for Official Publications of the European Communities.

Farrell, G. and Isaacs, S. (2007a). *Survey of ICT and education in Africa: a summary report, based on 53 country surveys*. Washington, DC: *info*Dev/ World Bank. Retrieved at 22.09.2009. http://www. infodev.org/en/Publication.353.html.

Farrell, G., Isaacs, S. and Trucano, M. (2007b). *The NEPAD e-Schools demonstration project: a work in progress (a public report).* Washington, DC: *info*Dev/World Bank; Vancouver, British Columbia: Commonwealth of Learning.

Farrell, G., Isaacs, S. and Trucano, M. (eds) (2007c). *Survey of ICT and education in Africa: Vol. 2: 53 country reports*. Washington, DC: *info*Dev/World Bank. Retrieved at 22.09.2009. http://www. infodev.org/en/Publication.354.html.

Frank, K. A., Zhao, Y. y Borman, K. (2004), *«Social Capital and the Diffusion of Innovations Within Organizations: The Case of Computer Technology in Schools»,* Sociology of Education, 77 (2), 148-171.

Fuchs, T. and Woessman, L. (2004). "Computers and student learning: bivariate and multivariate evidence on the availability and use of computers at home and at school', *Brussels Economic Review/Cahiers Economiques de Bruxelles*, Editions du Dulbea, Université libre de Bruxelles, Department of Applied Economics (Dulbea), Vol. 47, No 3–4, 359–85.

Fullan, M. G. (1991). *The new meaning of educational change*. London: Cassell.

_____. (1993). *Change forces: probing the depths of educational reform*. London: Falmer Press.

Fullan, M. (2002) *The change leader, Educational Leadership,* 59; 16–20

Goolsbee, A., Guryan, J. (2002). "The Impact of Internet Subsidies in Public Schools". NBER Working Paper. No. 9090.

Gordó, G. (2010) *Centros educativos: ¿islas o nodos? Los centros como organizaciones-red.*

Barcelona: Graó.

Harasim, L.; Hiltz, S. R.; Turoff, M. i Teles, L. (2000): *Redes de aprendizaje. Guía para la enseñanza y el aprendizaje en red,* Barcelona, Gedisa.

Hopkins, D., Ainscow, M. and West, M. (1994) *School Improvement in an Era of Change.* London: Cassell.

Hopkins, D, A Harris and D Jackson (1997). Understanding the School's Capacity for Development: Growth States and Strategies. *School Leadership and Management,* Vol. 17, 3; 401-411.

Johannessen, Ø., 2009, In search of the sustainable knowledge base: multi-channel and multi- method. In Scheuermann, F. and Pedró, F., *Assessing the effects of ICT in education – Indicators, criteria and benchmarks for international comparisons*. Luxembourg: Publication Office of the European Union, pp. 13-20.

Kikis, K., Scheuermann, F. and Villalba, E. (2009) "A framework for understanding and evaluating the impact of information and Communications technologies in education" in: *Assessing the Effects of ICT in Education: Indicators, Criteria and Benchmarks for International Comparisons*. Luxembourg: Publication Office of the European Union.

Kozma R. B. (2003): "Technology and classroom practices: An international study", a *Journal of Research on Technology in Education,* 36 (1), pp. 1-14.

_____. (2008). 'Comparative analysis of policies for ICT in education', in: J. Voogt and G. Knezek (eds), *International handbook on information technology in primary and secondary education*. New York: Springer.

_____. (2011) "A Framework for ICT Policies to Transform Education" in *Kozma, R. B., Transforming Education: The Power of ICT Policies.* Paris: UNESCO, pp. 19-36.

Kulik. J.A. (2003). "Effects on using instructional technology in elementary and secondary schools: What controlled evaluation studies". Arlington: SRI International.

Leuven, E., Lindahl, M., Oosterbeek, H., & Webbink, D. (2004). The effect of extra funding for disadvantaged pupils on achievement. *IZA Discussion Paper*. No. 1122. Bonn, Germany: Institute for the Study of Labor.

Machin, S., McNally, S. and Silva, O. (2006). "New technologies in schools: is there a pay off" London: Centre for Economic Performance; Bonn: Institute for the Study of Labour.

Meneses, J. i Mominó, J.M. (2008) "La generación de capital social en el sistema educativo no universitario: un análisis del desarrollo comunitario de las escuelas de Cataluña" a *Papers 4 -75.*

Moersch, C. (1995). 'Levels of technology implementation (LoTi): a framework for measuring classroom technology use', Learning and Leading with Technology, Vol. 23, No 3, 40-42.

OECD (2006) "*Are Students Ready for a Technology-Rich World? What PISA Studies Tell Us*." OECD Publishing, Paris

OECD (2009) "*21st Century Skills and Competences for New Millennium Learners in OECD Countries*," *OECD Education Working Papers,* No. 41, OECD Publishing. Doi: 10.1787/218525261154

OECD (2010), *Are the New Millennium Learners Making the Grade?: Technology Use and Educational Performance in PISA 2006*, Educational Research and Innovation, OECD Publishing, Paris.

OECD (2011) Students on Line: Reading and Using Digital Information, OECD Publishing, Paris.

Pedró, F. (2011) *Tecnología y escuela: lo que funciona y por qué.* XXVI Semana Monográfica de la Educación: La educación en la sociedad digital. Madrid: Fundación Santillana

Pelgrum, W (2009) "Monitoring in education: an overview". In Scheuermann, F. and Pedró, F., *Assessing the effects of ICT in education – Indicators, criteria and benchmarks for international comparisons.* Luxembourg: Publication Office of the European Union, pp. 41-59.

Scheuermann, F. and Pedró, F. (Eds.) (2009) *Assessing the effects of ICT in education.*

Indicators, criteria and benchmarks for international comparisons. Luxembourg: Publications Office of the European Union.

Spillane, J.P., Halverson, R. i Diamond, J.B. (2004). Towards a theory of leadership practice: a distributed perspective. *Journal of Curriculum Studies,* 36; 3–34.

Thomson, P. (2007). *Whole school change: a review of the literature*. London: Creative Partnerships.

Trucano, Michael (2005). *ICT components in World Bank education projects (2001-04)*. Washington, DC: *info*Dev/World Bank.

Tyack, D., and Cuban, L. 1995. *Tinkering toward Utopia*. Cambridge, MA, Harvard University Press.

UNESCO 2002. *Information and Communication Technology in Education: A Curriculum for Schools and a Programme of Teacher Development*. Paris, UNESCO.

UNESCO. N.d. *Configuration of Radio Stations and Media Centres: A Practical Guide to Procurement of Technical Equipment for Community Media Initiatives*. Paris, UNESCO. "Educación para todos": http://www.unesco.org/new/es/education/themes/leading-the-international-agenda/education-for-all/

UNESCO (2002). *Information and Communication Technology in Education: A Curriculum for Schools and a Programme of Teacher Development.* Paris, UNESCO.

_____. (2003). *Towards policies for integrating information and communication technologies into education.* Paris, UNESCO.

_____. (2005). *Towards Knowledge Societies.* Paris, UNESCO.

UNESCO – IEU (2008). "Proposal for internationally comparable core indicators on ICT in education". Montreal: Instituto de Estadística de la UNESCO. http://www.UIS.unesco.org/template/pdf/cscl/ICT/bckgrdcore.pdf

UNESCO (2008b). ICT *Competency Standards for Teachers: Policy Framework.* Paris, UNESCO.

UNESCO – IEU (2009) Medición de las Tecnologías de la Información y la Comunicación (TIC) en educación – Manual del usuario Montreal: Instituto de Estadística de la UNESCO.

Zao, Y. i Frank, K. A. (2003): "Factors affecting technology uses in schools: An ecological perspective" in *American Educational Research Journal, 40 (4), pp. 807-841.*